

Product: KOMATSU 960E-2 Rigid Dump Truck Service Repair Field Assembly Manual(CEAW007301)

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CEAW007301

Field Assembly Manual

960E-2

DUMP TRUCK

SERIAL NUMBERS

A30027 & UP

KOMATSU®

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FOREWORD

This manual is provided to aid assemblers during field assembly of the standard Komatsu 960E dump truck. Variations of design required for specific truck orders may require some modification of the general procedures outlined in this manual. Follow all safety notices, warnings, and cautions provided in this book when assembling the truck.

General assembly pictures and illustrations are used in this manual. At times the illustrations may not reflect the current production truck model.

This manual lists metric (SI) and U.S. standard dimensions throughout.

All location references to “front”, “rear”, “right”, or “left”, are given in respect to the operator's normal seated position.

It is recommended that all maintenance personnel read and understand the materials in the service manual before performing maintenance and/or operational checks on the assembled truck.



This alert symbol is used with the signal words, CAUTION, DANGER, and WARNING in this manual to alert the reader to hazards arising from improper operating and maintenance practices.

DANGER

DANGER identifies a specific potential hazard which will result in either injury or death if proper precautions are not used.

WARNING

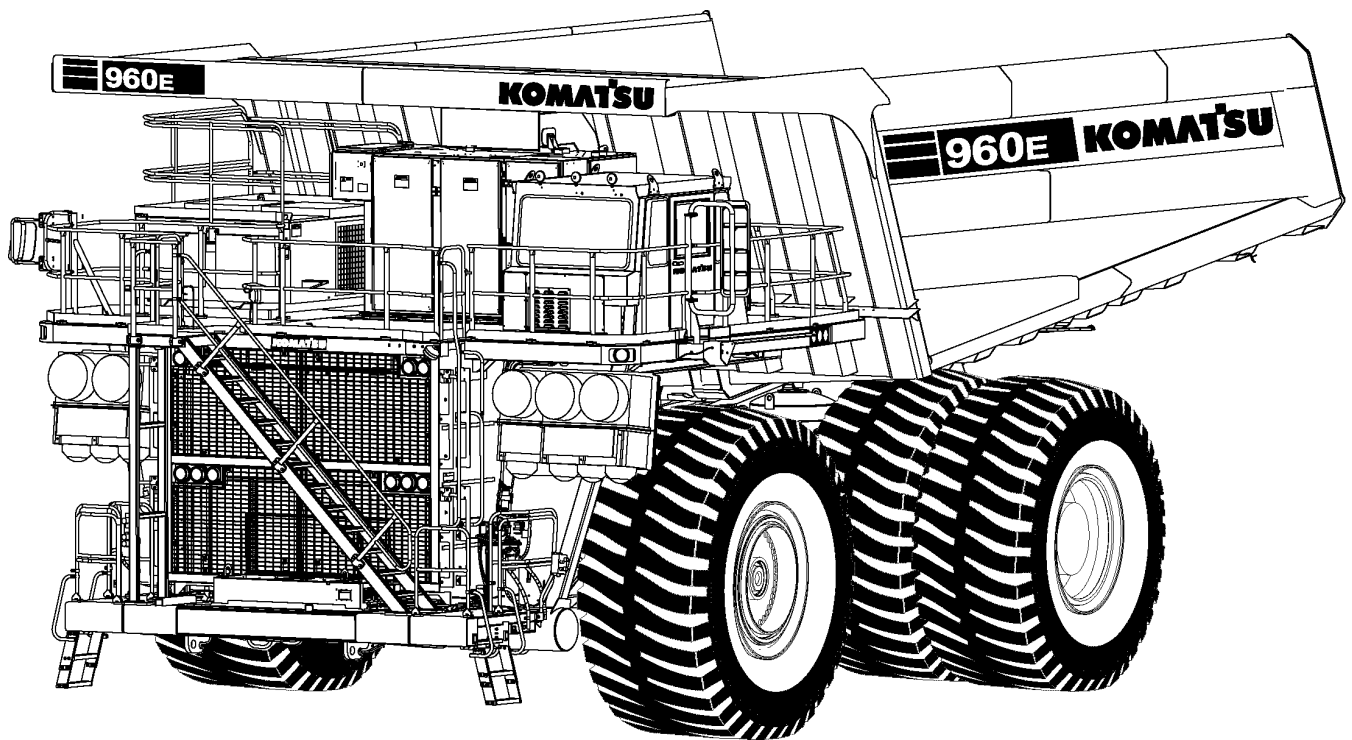
WARNING identifies a specific potential hazard which may result in either injury or death if proper precautions are not used.

CAUTION

CAUTION is used for general reminders of proper safety practices or to direct the reader's attention to avoid unsafe or improper practices which may result in damage to the equipment.

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SAFETY RULES, TOOLS & EQUIPMENT

SAFETY RULES

The following list of safety practices is intended for use by personnel during field assembly of the truck.

This list of safety rules is not intended to replace local safety rules or regulations and federal, state, or local laws. The safety precautions recommended here are general and must be used in conjunction with all prevailing local rules and regulations.

1. All personnel must be properly trained for the assembly process.
2. Wear safety equipment such as safety glasses, hard toe shoes and hard hats at all times during assembly.
3. Thoroughly inspect the assembly site. Remove weeds, debris and other flammable material.
4. Use only solid, hard wood for supports. When using metal support stands, place wood blocks between the support and the frame to prevent metal to metal contact.
5. Inspect all lifting devices. Refer to the manufacturer's specifications for correct capacities and safety procedures when lifting components.
6. Perform a daily inspection of all lifting cables and chains. Replace any questionable items. Use cables and chains that are properly rated for the load to be lifted.
7. DO NOT stand beneath a suspended load. Use of guy ropes are recommended for guiding and positioning a suspended load.
8. Maintain fire control equipment. Inspect fire extinguishers regularly to ensure they are fully charged and in good working condition.
9. Cap screws and/or nuts being replaced must be the same grade as originally supplied.



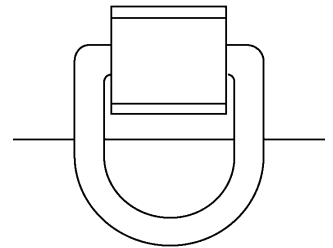
Before welding, refer to Special Precautions When Servicing An AC Drive System Truck in Section 4.

10. Disconnect the battery charging alternator lead wire before welding on the frame or its components.
11. When welding, connect the ground cable to the part being welded. DO NOT allow welding current to pass through bearings, engine, etc.

12. DO NOT weld the fuel tank or hydraulic tank unless the tanks have been properly purged and ventilated.
13. Use the proper tools for the job to be performed. Never improvise wrenches, screw drivers, sockets, etc. unless specified.
14. Lifting eyes and hooks must be fabricated from the proper materials and rated to lift the intended load.
15. When the weight of any component(s) or any assembly procedure is not known, contact your customer support manager for further information.

Use of Tie-Off Anchor During Maintenance and Repair

While working at heights during assembly, maintenance or repair of the haul truck, workers should wear an appropriate fall protection harness and attach it to a tie-off anchor or tie-off point.



Komatsu anchor (58B-98-75190) is available for use with fall protection harnesses. Carefully read and understand the harness maker's instructions before using any fall protection harness.

The load carrying capacity of anchor (58B-97-75190) is 2 270 kg (5,000 lb).

NOTE: The anchor must not be used for lifting.

BODY-UP RETENTION SLING



To avoid serious personal injury or death, the body up retention sling must be installed anytime personnel are required to perform maintenance on the vehicle with the dump body in the raised position.

The Komatsu body-up safety sling can only be used with a Komatsu body. Non-OEM body may not accommodate the Komatsu body-up safety sling. The end user must ensure that a proper cable/sling is used.

TOOLS AND EQUIPMENT FOR ASSEMBLY

The following equipment is recommended for field assembly of the truck.

1. Equipment and tool storage trailer with a lockable door. Approximately 12 x 2.5 m (40 x 8 ft)
2. Cranes
 - a. Two, 45 metric ton (50 ton) cranes to remove the chassis from the freight trailer and place on cribbing. These cranes can also be used to lift the assembled body onto the chassis.
 - b. One, 109-136 metric tons (120-150 ton) crane. The crane is needed to turn the body over after completion of the underside welding. A 45 metric ton (50 ton) crane is also required for this task.
3. One fork lift - 6804 kg (15,000 lb) capacity, with high lift capability.
4. Two, 300 amp portable welding units and an oxy-acetylene cutting set.
5. One, propane torches for weld preheating.
6. Portable air compressor - 3.5 cmm (125 cfm) and 690 kPa (100 psi) capacity.

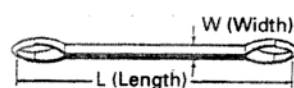
Two, 15 m (50 ft) air hoses.
7. Metal stands and a sufficient amount of wood cribbing - sizes from 1.2 m x 30.5 cm x 30.5 cm (14 ft. x 12 in. x 12 in.) and 1.2 m x 15 cm x 15 cm (4 ft. x 6 in. x 6 in.) - such as railway cross ties
8. Tire handler - Wiggins/Iowa Mold Tooling.
9. Miscellaneous air tools
10. Ladders - 3.5 m (12 ft), 2.5 m (8 ft), & 2 m (6 ft)
11. Chains, lifting cables, slings:
 - Two, 4 point slings, 3 m (10 ft) in length
 - Two, 4 point slings, 2 m (6 ft) in length
 - Two, 1 m (4 ft) and two, 2 m (6 ft)
 - Two, 3 m (10 ft) nylon straps
 - Four lengths of 2.54 cm x 15 m (1 in. x 50 ft) of rope
12. Two, ratchet pullers - 2.7 metric ton (3 ton)
13. Two, ratchet pullers - 1.4 metric ton (1.5 ton)
14. Set of standard master mechanics hand tools.
 - Thread taps and dies of both inch and metric sizes.
 - Metric sockets and open end wrenches, 6mm to 36mm.
 - Inch sockets and open end wrenches up to 1 3/4 in.
 - Torque wrenches - 339 N·m (250 ft lb) with 18:1 multiplier. Torque wrenches - 339 N·m (600 ft lb) with 4:1 multiplier. Hydrotorque - 1 1/2 in. drive with capability of 5559 N·m (4100 ft lb) or greater.
 - Box wrench 1 3/8 in. (Snap-On p/n X440B) with 12 inch extension to tighten ROPS cap screws.
 - Sockets: 2 1/4 in. (Snap-On P/N J15036) and 2 5/8 in. (Snap-On P/N J15042) to tighten front suspension hardware.
15. Heavy duty 3/4 in. & 1 in. square drive impact wrench sets.
16. Impact sockets for 3/4 in. & 1 in. square drive tools.
17. Special tools (see list, following pages)
18. Two, hydraulic or pneumatic porta-power jacks, 4.5 and 9 metric ton (5 and 10 ton)
19. Various hooks and shackles
20. Miscellaneous: i.e. grinders, containers, rags.
21. Spreader bars for cab and decks.
22. Two ratchet hoists of 2.7 metric ton (3 ton) capacity.
23. Pry bars
24. Solvent - 38 liters (10 gal)
25. Paint remover - 19 liters (5 gal)
26. Rust preventive grease

LIFTING SLING GENERAL INFORMATION

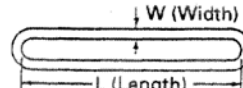
• Nominal Designation

Product name – Type – Belt width – Length
(Example) Poly type – Type E – 50 mm x 3 m

<Type E>



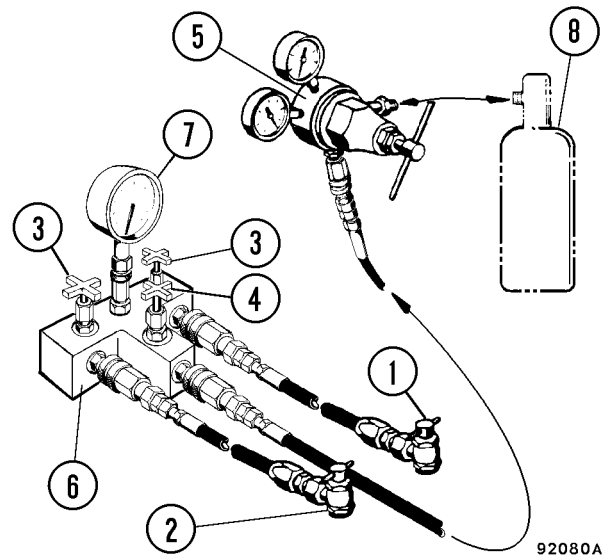
<Type N>



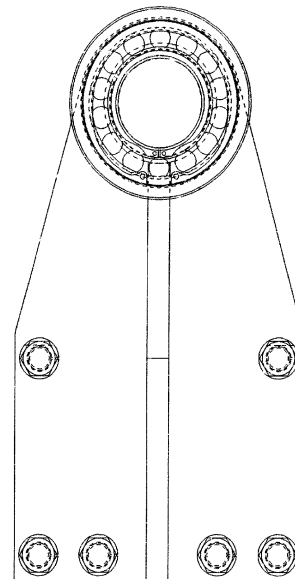
Product Name (Material)		Belt width (mm)	Shape (Type E (I specification) and Type N (Endless specification) are available for all products.)	Color
Belt Sling (Available in any your desired length)	Poly Type (P Type) (Polyester) Class III for general use	25 mm 40 mm 50 mm 75 mm 100 mm 150 mm 200 mm 300 mm		Light blue
	Features: Soft belt with little elongation and great wear resistance.			
	Limit Type (L Type) (Nylon and Polyester) Class III for general use	25 mm 35 mm 50 mm 75 mm 100 mm 150 mm 200 mm 300 mm		Blue
	Features: The disposal criterion can be found at a glance.			
	Just Type (J Type) (Nylon) Class III for general use	25 mm 35 mm 50 mm 75 mm 100 mm		Yellow
	Features: Great wear resistance			
Soft Sling	Medical Type (M Type) for oxidation rinsing (Polypropylene) Class I for chemical	25 mm 50 mm 75 mm 100 mm		Off-white
	Features: Great chemical resistance			
	SS Type (Nylon & Polyester)	Working load (tf) 0.5 t 1.0 t 1.5 t 2.0 t 3.0 t 5.0 t		Gray Violet Blue Green Yellow Red
	Length: Available in any length between 0.5 m and 10 m			
	SS Type for heavy goods (Nylon & Polyester)	10 t 15 t 20 t 25 t		Blue
	Length: Available in any length between 2 m and 10 m			

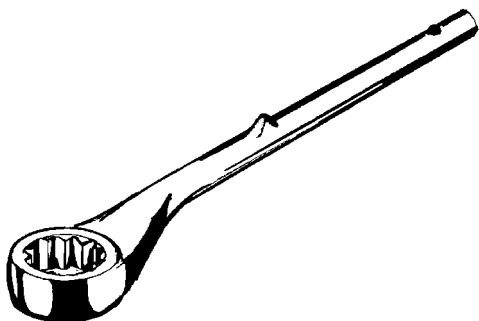
Part Number	Description	Use
EB1759	Nitrogen Charging Kit	Suspension & Accumulator Nitrogen Charging

1. "T" Handle Valve
2. Charging Valve Adapter
3. Manifold Outlet Valves (from gauge)
4. Inlet Valve (from regulator)
5. Regulator Valve (Nitrogen Pressure)
6. Manifold
7. Charging Pressure Gauge (Suspensions)
8. Dry Nitrogen Gas

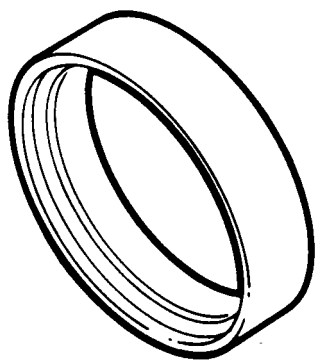


Part Number	Description	Use
EH8687 (No longer available as complete unit)	Roller Assy.	Power Module Remove & Install
EH8681	Roller Mount	
PC0706	Bearing	
TH9449	Bearing Retainer Ring	
TG1680	Roller Retainer Ring	
C1645	Cap screw 0.75 -10 NC x 2 1/4 in.	
C1542	Lockwasher 0.75 in.	
EH8686	Roller Ring	

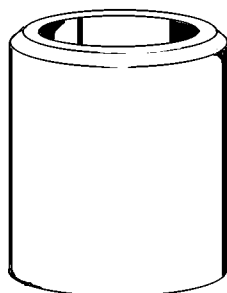




Part Number	Description	Use
PC1980	Offset Box End Wrench - 1 11/16"	Cab Mounting & Miscellaneous

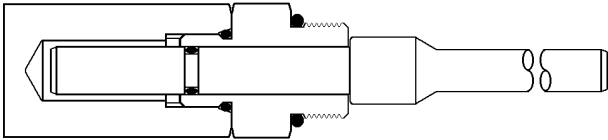


Part Number	Description	Use
BF4117	Seal Installation Tool	Front and Rear Disc Brake Floating Ring Seal Installation
ED3347	Seal Installation Tool	Rear Axle/ Hub Adapter Floating Ring Seal Installation

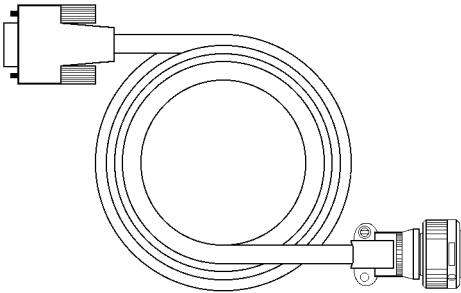


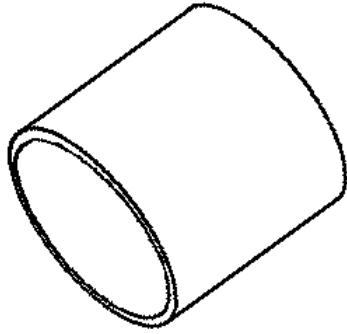
Part Number	Description	Use
EK5877	Sleeve Alignment Tool	Steering Linkage and Tie Rod Assembly

Part Number	Description	Use
EM3708 (Rear)	Wear Indicator	Brake Disc Wear Inspection
EM1275 (Front)		
EB1723	Cap, Indicator	
EM3707 (Rear)	Pin, Indicator	
EM1274 (Front)		
WA0010	O-ring, Indicator Pin	
TL3995	O-ring, Indicator Cap	
EB4813	Housing, Indicator	
SV9812	O-ring, Housing	

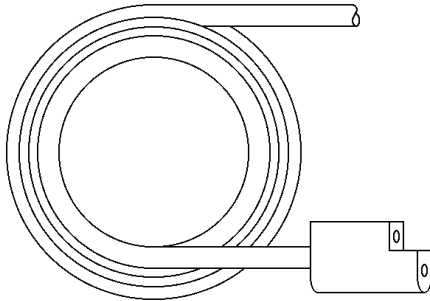


Part Number	Description	Use
PC2525	Harness	Payload Meter Download

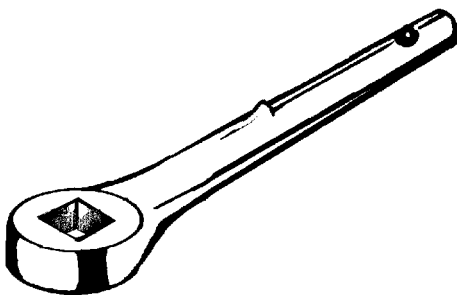




Part Number	Description	Use
EH7817	Alignment Tool	Upper Hoist Pin

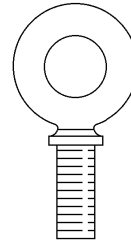


Part Number	Description	Use
PB9067	Bulkhead Connector	Battery Jumper

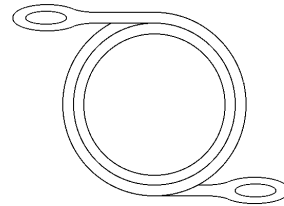


Part Number	Description	Use
PC2228	3/4 in. Square Drive Wrench	Miscellaneous

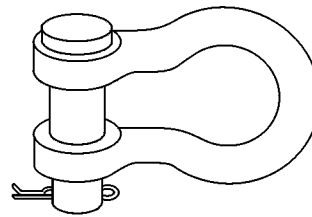
Part Number	Description	Use
WA4826	Lifting Eye Bolt	Miscellaneous



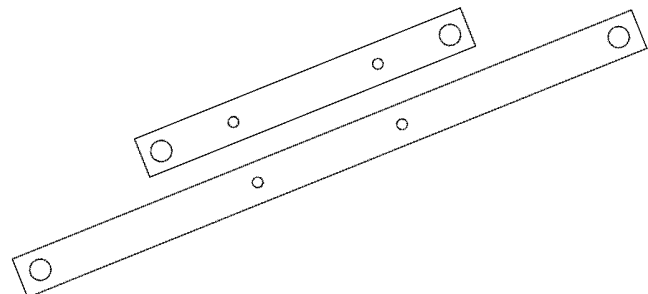
Part Number	Description	Use
PC2660	Sling	Body Retention



Part Number	Description	Use
PC0367	Shackle	Body Retention Miscellaneous

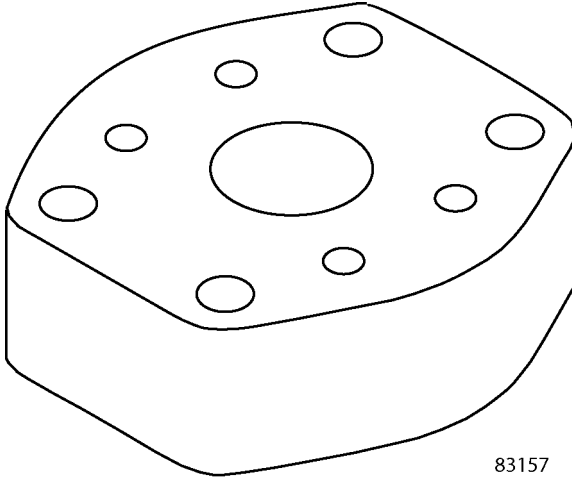


Part Number	Description	Use
EK6089	Brake Assembly Tool Group (Front)	Brake Assembly & Disassembly
EK6090	Brake Assembly Tool Group (Rear)	Brake Assembly & Disassembly

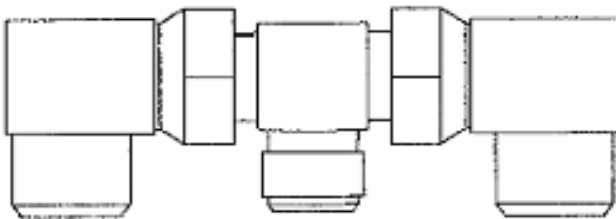




Part Number	Description	Use
XB5777	Hose Assembly	Flush Steering Circuit
PC3074	Flushing Block (bypass hoist cylinders)	Flush Hoist/Brake Cooling Circuit



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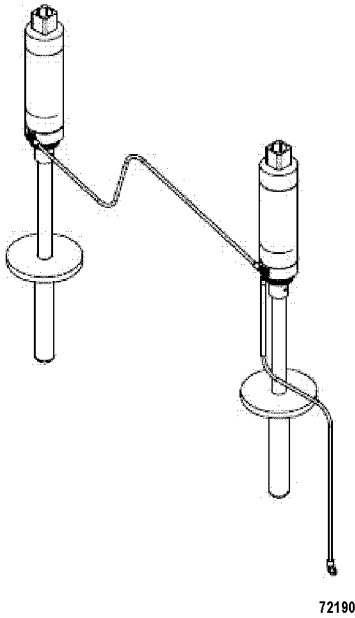


Part Number	Description	Use
XB7075	Fitting Assembly	Flush Hoist/Brake Cooling Circuit

Part Number	Description	Use
XB0887	Vacuum Pump	To hold oil back while the system is open



Part Number	Description	Use
PC3186	0-2000VDC Custom Meter Kit	Discharge AC drive system capacitors
PC3299	2000VDC Capacitor Discharge Tool	Discharge AC drive system capacitors



	PLACE CHASSIS ON SUPPORT BLOCKS ARRANGE ALL PARTS	CLEAN SURFACES INSTALL DECK SUPPORTS	WELD DECK SUPPORTS INSTALL ROPS BEAMS	WELD DECK SUPPORTS SUB DECKS	HOIST CYLINDERS HYDRAULIC & FUEL TANKS	BRAKES TO WHEEL MOTORS WHEEL MOTOR AND CONNECTIONS	SPINDLES REAR AXLE CONNECTIONS
	DAY ONE	DAY TWO	DAY THREE	DAY FOUR	DAY FIVE	DAY SIX	DAY SEVEN
CHASSIS ASSEMBLY 3 ASSEMBLERS 							
2 ELECTRICIANS 							
2 WELDERS 							
2 CRANES 	↑	1 CRANE					
BODY ASSEMBLY							
3 WELDERS 							

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TRUCK COMPONENTS AND SPECIFICATIONS

Truck And Engine

The 960E Dump Truck is an off-highway, rear dump truck with AC Electric Drive. The gross vehicle weight is 576 062 kg (1,270,000 lb). The engine is a Komatsu SSDA18V170 rated @ 2 611 kW (3,500 HP).

Main Alternator

The diesel engine drives an in-line alternator at engine speed. The alternator produces AC current which is rectified to DC within the main control cabinet. The rectified DC power is converted back to AC by groups of devices called "inverters", which are also within the main control cabinet. Each inverter consists of six phase modules under the control of a gate driver power converter (GDPC). The two GDPCs control the operation of each phase module.

Each phase module contains paired positive and negative semiconductor switches referred to as insulated gate bipolar transistors (IGBT). The IGBTs cycle on and off at varying frequencies to create an AC power signal from the DC supply.

The AC power signal produced by each inverter is a variable-voltage, variable-frequency (VVVF) signal. Frequency and voltage are changed to suit the operating conditions.

Cooling air for the control/power group and wheel motors, as well as the alternator itself, is provided by dual fans mounted on the alternator shaft.

AC Induction Traction Motorized Wheels

The alternator output supplies electrical energy to the two wheel motors attached to the rear axle housing. The motorized wheels use three-phase AC induction motors with full-wave AC power.

The two wheel motors convert electrical energy back to mechanical energy through built-in gear trains within the wheel motor assembly. The direction of the wheel motors is controlled by a directional control lever located on the center console.

Suspension

Hydrair II® suspension cylinders located at each wheel provide a smooth and comfortable ride for the operator and dampens shock loads to the chassis during loading and operation.

Operator's Cab

The operator cab has been engineered for operator comfort and to allow for efficient and safe operation of the truck. The cab provides wide visibility with an integral 4-post ROPS/FOPS structure and an advanced analog operator environment. It includes a tinted safety-glass windshield and power-operated side windows, a deluxe interior with a fully adjustable seat with lumbar support, a fully adjustable/tilt steering wheel, controls mounted within easy reach of the operator, and an analog instrument panel which provides the operator with all instruments and gauges which are necessary to control and/or monitor the truck's operating systems.

Power Steering

The truck is equipped with a full time power steering system which provides positive steering control with minimum operator effort. The system includes nitrogen-charged accumulators which automatically provide emergency power if the steering hydraulic pressure is reduced below an established minimum.

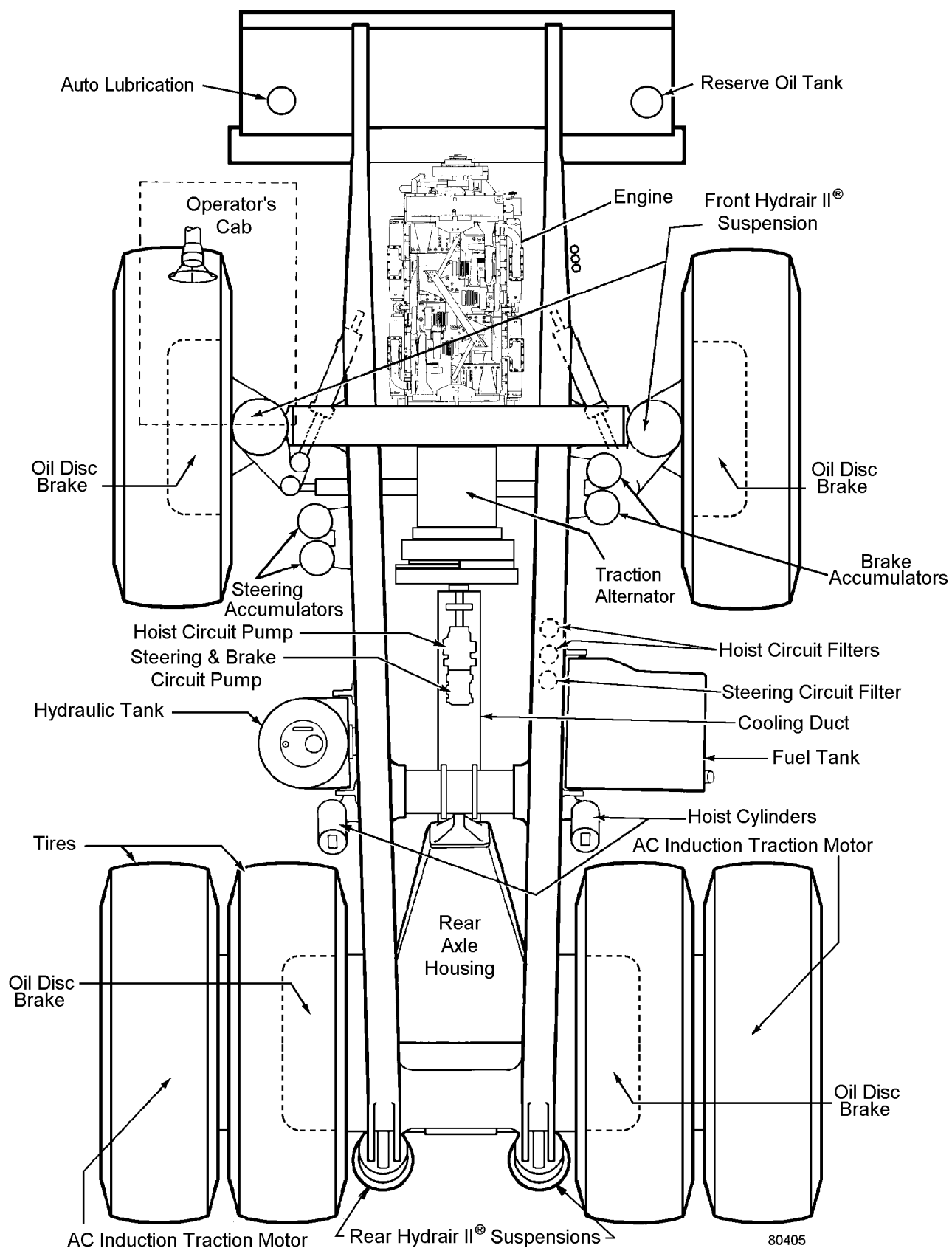
Dynamic Retarding

The dynamic retarding is used to slow the truck during normal operation or control speed coming down a grade. The dynamic retarding ability of the electric system is controlled by the operator through the activation of the retarder pedal (or by operating a lever on the steering wheel) in the operators cab and by setting the RSC (Retarder Speed Control). Dynamic retarding is automatically activated, if the truck speed goes to a preset overspeed setting.

Brake System

Service brakes at each wheel are oil-cooled multiple disc brakes applied by an all-hydraulic actuation system. Depressing the brake pedal actuates both front and rear brakes after first applying the retarder. All wheel brakes will be applied automatically if the brake system pressure decreases below a preset minimum.

The parking brake is a dry disc type, mounted inboard on each rear wheel motor, and is spring-applied and hydraulically-released with wheel speed application protection (will not apply with truck moving).



MAJOR COMPONENTS

SPECIFICATIONS

These specifications are for the standard Komatsu 960E truck. Customer options may change this listing.

ENGINE

Komatsu SSDA18V170

No. of Cylinders	18
Operating Cycle	4-Stroke
Rated Brake HP	2 611 kW (3,500 HP) @ 1900 RPM
Flywheel HP	2 558 kW (3,429 HP) @ 1900 RPM
Weight (Dry)*	10 300 kg (22,701 lb)

* Weight does not include radiator, sub-frame, or alternator.

AC ELECTRIC DRIVE SYSTEM

AC/DC Current

Alternator	General Electric GTA-39
Dual Impeller, In-Line Blower	340 m ³ / min (12,000 cfm)
Motorized Wheels	AC Induction Traction Motors (GDY108)
Standard Gear Ratio*	32.62:1
Maximum Speed	64.5 kph (40 mph)

* Wheel motor application depends upon GVW, haul road grade and length, rolling resistance, and other parameters.
Komatsu and GE must analyze each job condition to ensure proper application.

DYNAMIC RETARDING

Electric Dynamic Retarding	Standard
Continuous*	4 476 kW (6,000 HP)

* Continuously rated high-density blown grids with retard at engine idle and retard in reverse propulsion.

BATTERY ELECTRIC SYSTEM

Batteries	Four 8D, 12 volt wet batteries with disconnect switch
Cold Cranking Amps	1450 CCA
Alternator	24 Volt, 140 Amp Output
Lighting	24 Volts
Cranking Motors (2)	24 Volts

SERVICE CAPACITIES

Crankcase (including lube oil filters)	382 liters (101 gallons)
Cooling System	799 liters (211 gallons)
Fuel Tank	5300 liters (1400 gallons)
Hydraulic System	1325 liters (350 gallons)
Wheel Motor Gear Box	95 liters (25 gallons) per wheel

HYDRAULIC SYSTEMS

Hoist and Brake Cooling Pump	Tandem Gear
Rating	931 L/min (246 gpm) @ 1900 RPM and 18 960 kPa (2,750 psi)
Steering/Brake Pump	Pressure Compensated Piston
Rating	246 L/min (65 gpm) @ 1900 RPM and 20 685 kPa (3,000 psi)
Relief Pressure - Hoist	18 960 kPa (2,750 psi)
Relief Pressure - Steering/Brake	27 580 kPa (4,000 psi)
Hoist Cylinders (2)	3-Stage Hydraulic
Tank (Vertical/Cylindrical)	Non-Pressurized
Tank Capacity	947 liters (250 gallons)
Filtration	In-line replaceable elements
Suction	Single, Full Flow, 100 Mesh
Hoist and Steering Filters (Dual In-Line, High Pressure)	Beta ₁₂ Rating =200

SERVICE BRAKES

All Hydraulic Actuation with Traction System Wheel Slip/Slide Control

Front and Rear Oil-Cooled Multiple Discs on each wheel

Total Friction Area / Brake 103 729 cm² (16,078 in²)

Maximum Apply Pressure. 18 960 kPa (2,750 psi)

STEERING

Twin hydraulic cylinders with accumulator assist to provide constant rate steering

Emergency power steering automatically provided by accumulators

Turning Circle (SAE). 31.9 m (104 ft. 8 in.)

TIRES

Radial Tires (standard). 53/80 R63

Rock Service, Deep Tread Tubeless

Rims patented Phase I New Generation™ rims

STANDARD DUMP BODY CAPACITIES AND DIMENSIONS

Capacity

Heaped @ 2:1 (SAE). 239 m³ (313 yd³)

Struck 191 m³ (250 yd³)

Width (Inside) 8.68 m (28 ft. 6 in.)

Depth 3.2 m (10 ft. 7 in.)

Loading Height 7.14 m (23 ft. 5 in.)

Dumping Angle 45°

WEIGHT DISTRIBUTION

Empty Vehicle

Front Axle (47%). 117 845 kg (259,804 lb)

Rear Axle (53 %) 130 885 kg (288,553 lb)

Total (with 50% fuel) 248 730 kg (548,357 lb)

Standard Komatsu body 30 362 kg (66,936 lb)

Standard tire weight 26 127 kg (57,600 lb)

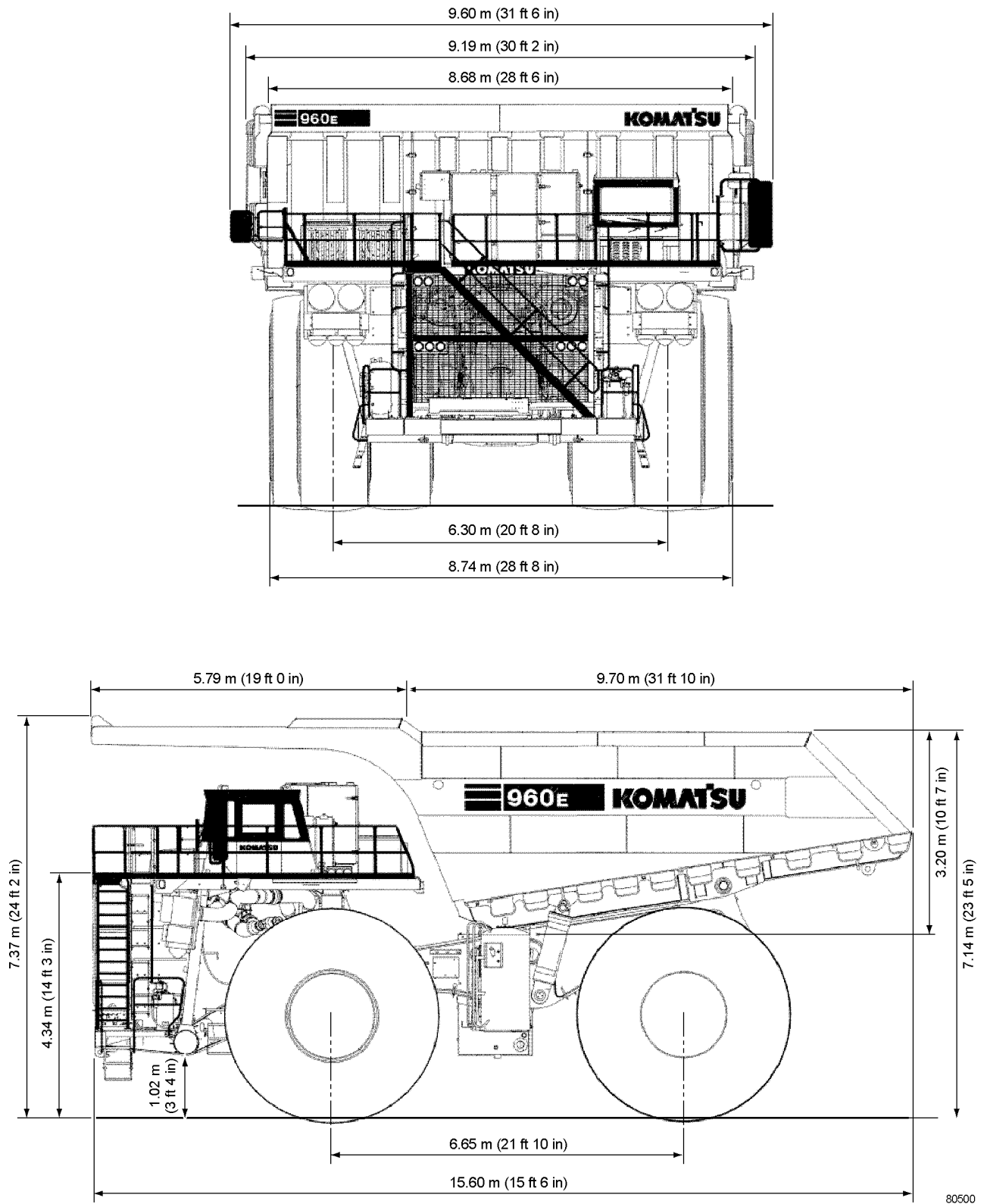
Loaded Vehicle

Front Axle (35%) 199 580 kg (440,000 lb)

Rear Axle (65%) 376 482 kg (830,000 lb)

Total 576 062 kg (1,270,000 lb)

Nominal Payload* 327 332 kg (721,643 lb)



* *Nominal payload* is defined within Komatsu America Corporation's payload policy documentation. Nominal payload must be adjusted if the weight of any customized body or tires vary from that of the standard Komatsu body and tires. Nominal payload must also be adjusted to take into account the additional weight of any custom/optional extras fitted to the truck which are not stated within the Standard Features list of the applicable specification sheet.

NOTES

MAJOR COMPONENT WEIGHTS



The condition of lifting slings, chains, and/or cables used for lifting components must be inspected before each use. Lifting equipment must be in good condition and rated for approximately two times the weight being lifted. DO NOT use worn or damaged lifting equipment. Serious injury and damage may result.

Optional equipment added onto the truck may cause an increase to the component weights listed in this chapter. Contact your customer support manager for concerns or questions about lifting truck components.

NOTE: All component weights are dry weights. The additional weight of coolant, fuel, and oil that may be in the components are not calculated into this list.

<u>ITEM</u>	<u>KILOGRAMS</u>	<u>POUNDS</u>
CHASSIS		
Wheel Rim.	2 970	6,548
Tire (56/80 R63).	4,309	9,500
Rim & Tire.	7,279	16,048
Main Frame	29 177	64,324
Fuel Tank.	2 056	4,533
DECK AND DECK SUPPORT COMPONENTS		
Cab	2 268	5,000
RH Deck	1 024	2,258
LH Deck	707	1,559
Center Deck	286	631
Left Deck Support	755	1,665
Right Deck Support	320	705
LH Upright	919	2,027
RH Upright	625	1,378
LH Diagonal Beam (ROPS)	135	298
RH Diagonal Beam	68	150
Diagonal Ladder	190	419
Diagonal Ladder Support.	55	121
Retarding Grid Assembly.	2 494	5,500

ITEM**KILOGRAMS****POUNDS****POWER MODULE**

Air Intake Ducts

Wheel Motor Blower337 743

Alternator Blower200 441

Air Cleaner Assembly

Single88 193

Double154 340

Electrical Control Cabinet 3 1767,000

Engine Sub-Frame9552,105

Traction Alternator 4 71010,384

Engine (Komatsu SSDA18V170) 10 30022,701

Radiator & Shroud 2 1004,630

HYDRAULIC COMPONENTS

Steering Accumulator173 380

Hoist Cylinder9982,200

Steering Cylinder193 426

Hydraulic Tank5901,300

FRONT AXLE COMPONENTS

Front Brake Assembly 1 4603,219

Spindle, Hub and Brake Assembly 5 18011,420

Steering Arm346 763

Front Suspension Cylinder 3 2557,176

REAR AXLE COMPONENTS

Rear Suspension Cylinder9132,013

Pivot Eye Assembly384 847

Rear Axle Housing w/Pivot Eye 7 31216,120

Anti-Sway Bar147 325

Wheel Motor Assembly 20 42545,030

Electric Wheel Transmission 12 88528,407

Rear Wheel Brake w/Hub Adapter 2 1004,630

Traction Motor 5 44011,993

Parking Brake Assembly159 350

Wheel Ring Adapter326 719

FIELD WELDING FOR ASSEMBLY OR REPAIR

When welding on Komatsu equipment, whether at initial field assembly or during normal maintenance repairs, special procedures must be followed.

Due to the continuous program of research and development, periodic revisions may be made to this publication. It is recommended that customers contact their distributors for information on the latest revision.

The welding information contained in this chapter is general information that must be followed unless otherwise specified in a detailed repair procedure provided on an engineering drawing or a detailed specific repair procedure. Additional specific information, or detailed instructions can be obtained through your local Komatsu customer support manager.

WELDER QUALIFICATION AND TRAINING

The welding technique must be of the highest standard to produce the soundest weld possible. Only welders who have been trained and qualified for structural steel welding in all positions, in conformance with the American Welding Society (AWS) D1.1 or (AWS) D14.3 only, are allowed to perform the welding. The welding instructions for field assembly of Komatsu components are normally provided by engineering drawings. Additional detailed welding instructions for field repairs are provided in the field repair manual SEB14001. A full understanding of the AWS standard welding symbols is necessary to perform and inspect such field welds. Weld sizes specified on the drawings are intended to reflect minimum requirements.

WELD PROCEDURES

Electric arc welding, either the semi-automatic "MIG" (GMAW), Flux Core (FCAW), or "Stick" electrode welding (SMAW), are approved processes for field installation and maintenance welding. Welding of highly stressed structural members such as castings, torque tubes, top and bottom plates on the frame rails, and the curved intersection points of frames should be done with the specific detailed instructions from Komatsu Product Service. See Annex A for repair procedures. These repair procedures are detailed instructions for most high stressed structural members.

APPROVED CONSUMABLES

GMAW - LW102-15 or ER80S-D2

FCAW - E70T-5, E71T-8, or E71T8-NI1

SMAW - E7018-1, E8018-C1, or E8018-C3

WELD QUALITY REQUIREMENTS

1. Each weld must be homogeneous with low porosity, free from cracks, and slag inclusions.
2. Each weld must have complete fusion between the base metal and weld metal added by the electrode.
3. All welds must be reasonably smooth, without excessive deformity, and all craters filled. No cracks are permitted.
4. The toe of a weld to a stressed member must have a smooth transition. Excessive convexity in multi-pass fillet welds is not permitted. Excessive convexity produces high residual stress in the throat of the weld, and is not permitted.
5. Undercut in excess of 0.8 mm (0.03 in.) on critical welds must be reworked by the application of welding an additional cover pass. It is important that this pass is blended with the existing weld.

6. When welding in the vertical position, always weld using the vertical up technique. Large wash weld weaves should not be used when welding on truck frames. Properly applied multiple pass welding is the required procedure on truck frames.
7. Slag is to be removed from all weld beads, and must be completely removed before each pass in a multiple pass procedure. It is also required that all slag is removed and tie in all areas. Grind all welds where a weld crosses or intersects with another weld.

MATERIALS, CONTROLS, AND PRECAUTIONS

The steel used in the fabrication of all Komatsu equipment is of high strength low alloy (HSLA) material of different grades. The standard dump body main plates are made from abrasion resistant materials. These materials offer themselves very well to welding during fabrication, and repair.

The welding consumables are often supplied by Komatsu America Corp. with the new equipment as part of the field welding / assembly package. For field welding and repairs, the approved consumables as detailed, should be procured from a local, reliable supplier. Other highly specialized welding consumables are available but have limited use on Komatsu structural components. Approval is required from your Komatsu customer support manager.

Control of the welding area environment is essential for producing proper and sound welds. Essentially, five areas require attention and control.

1. Air Movement - Avoid areas where air movement from wind, drafts, or blowers is prevalent. This is particularly important when a shielding gas is being used as part of the welding process.

2. Low Ambient Temperature - DO NOT weld in temperatures below 50°F (10°C). At low temperature conditions, preheating of all welding joint work areas is required. See preheat and post heating requirements as detailed in Annex A.
3. Weld Cooling - Protect the weld area from a rapid cooling rate. Heat retardation may be accomplished through the use of heat lamps, torches, insulating blankets, etc.
4. Moisture - Any moisture on the steel surfaces to be welded must be removed before welding. Electrodes must be stored in sealed containers until needed. Electrodes must be kept in a warming oven at the work location until used to prevent any moisture absorption which might affect weld quality.
5. Foreign Materials - Any foreign substances (dirt, paint, rust, scale, and carbon deposits from cuttings) must be removed prior to welding. Clean all weld areas and surfaces with a grinder to ensure that all foreign materials have been removed.

WELD INSPECTION

All welding repairs are subject to inspection by a Komatsu appointed inspector or laboratory to insure quality. After the weld has been made it can be inspected by a number of non-destructive evaluation techniques. The inspections can include any of the methods listed below. All assembly welds and weld repairs that are deemed unacceptable by the inspector must be corrected at no additional cost to Komatsu. All weld repairs are also subject to additional inspection.

1. Visual Inspection - This is the process of looking for potential defects such as undersized welds that can be checked with weld gauges for, surface cracks, surface porosity, craters, and undercuts.

2. Dye Penetrant Inspection - This is an easily applied process which indicates cracks or surface conditions. The process is relatively inexpensive, but does not produce a permanent record except by normal photography.
3. Fluorescent Penetrant Inspection - Similar to dye penetrant inspection. This process uses a black (ultraviolet) light for increased efficiency and accuracy.
4. Magnetic Particle Inspection - This process requires special equipment that is usually more costly than the dye penetrant inspections. This process does not provide a permanent record except by normal photography.
5. Ultrasonic Inspection - This is a popular method of examining weld discontinuities. Specialized equipment and operator certification is required. With some equipment printed data is available of the test providing a permanent record. Also, operator records with equipment settings and test results are normally recorded.
6. X-Ray Inspection - This process provides a view of the weld and base materials but it is highly specialized. This procedure provides a permanent visual record, but is more expensive than most other inspection techniques.

RECORDS

Komatsu requires record keeping of all welding work. This information is valuable when personnel or job conditions change. The service and warranty departments of Komatsu must be provided with inspection reports and photographs of the weld area before, during, and after the repair. The photographs must be clear and close enough to show the weld joint preparation complete, with backer bars installed, etc. just prior to welding. These photos easily identify if the required preheating and post heating have been done with a three inch circumference around the weld repair area. Without this documentation, Komatsu will not cover any weld repair claim made under warranty. No exceptions will be made.

ANNEX A

The following are general repair procedures, which must be followed for all repair and rework of major load carrying members on Komatsu equipment.

1. The repair or rework area must be protected from wind and moisture during the entire procedure. If the repair work is to be done outside additional precautions must be taken to protect the weld repair process from outside elements. All welding should be done at an ambient temperature of 10°C (50°F) or above.
2. Clean and grind the entire repair area to remove all rust, grease, oils, paint, and any other foreign materials likely to contaminate the weld.

3. Air arc the entire crack leaving a V-shaped joint.

The depth of the V- or U-shaped joint will be determined by the depth of the crack. The width to depth ratio should be approximately 1.25:1 and never less than 1:1. All cracks through the parent material will require a slightly wider root opening than the original, usually 6 mm (0.25 in.) to allow the installation of a backup strip. Backup strips are required for all cracks that have gone through the parent material and cannot be welded from both sides. If a weld repair allows access to both sides of the plate, no backup strip is required as long as complete weld penetration is achieved. If backup strips are not used, the surface profile on both sides must be ground smooth with no undercut. Documentation must support this repair. Photographs of surface condition are required by the service and warranty departments of Komatsu.

4. Use dye penetrant to ensure the cracks are completely removed.
5. After air arcing and inspections (Steps 3 & 4) all areas cut by the air arc should be cleaned thoroughly with a grinder to remove all possible carbon deposits and dye penetrant.
6. Fill gouges with weld and grind all surfaces smooth to avoid defects in the new weld.
7. Grind all surfaces to be welded so they are free of slag, rust, and any other foreign materials.
8. Preheat the entire weld joint area until the surrounding surface area reaches 150°C (300°F) at a distance of 76 mm (3 in.) from all areas to be welded.

9. All welds are to be made with approved consumables only. The SMAW (Stick) welding rod must be used within four hours after being removed from a new sealed container or from a 52°C (125°F) minimum drying oven. Any rod that exceeds this exposure time must be dried for one hour at 427°C (800°F) before being used. Keep all weld starts and stops to a minimum.

10. When the weld is complete, immediately (before the weldment cools) post heat the entire weld area to 150°C (300°F). Even if the area is over 150°C (300°F) heat must be applied to maintain this temperature for 15 minutes, and then allow it to cool slowly. In some cases this might require wrapping with insulation blankets.
11. Grind all butt-welded repairs smooth using 36 or finer grit grinding material. All grinding marks should be parallel to the direction of primary stress if possible (and if known).
12. Hammer peen the toes of repair fillet welds as detailed in Annex B, see attached.
13. Inspect repaired areas (for surface defects) using magnetic particle or dye penetrant inspection procedures.
14. If surface defects are found, remove all defects by grinding to a maximum depth of 1.5 mm (0.06 in.). Larger defects must be removed as per the above mentioned procedures. All spot welding also requires preheating and post heating.