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C H A P T E R

1



OPERATION and SAFETY

For maximum stability, tracks of chassis should remain extended out to maximum width unless traveling through a narrow area or gate.


WARNING
BOOM MUST REMAIN IN STOWED POSITION WHILE TRAVELING WITH TRACKS RETRACTED TO THE 35 INCH WIDTH. BOOM MUST REMAIN IN STOWED POSITION UNTIL OUTRIGGERS ARE DEPLOYED
WARNING

You may **ONLY** travel with the unit in high speed when driving it straight. The machine must be low speed when making turns.

Check and grease track tensioner every eight (8) to ten (10) hours of operation.

Once outriggers are deployed, make sure pins to lock socket are correctly inserted.

SAFETY DECALS


 **DANGER**

A MOVING OUTRIGGER
WILL CAUSE

SERIOUS CRUSHING INJURY

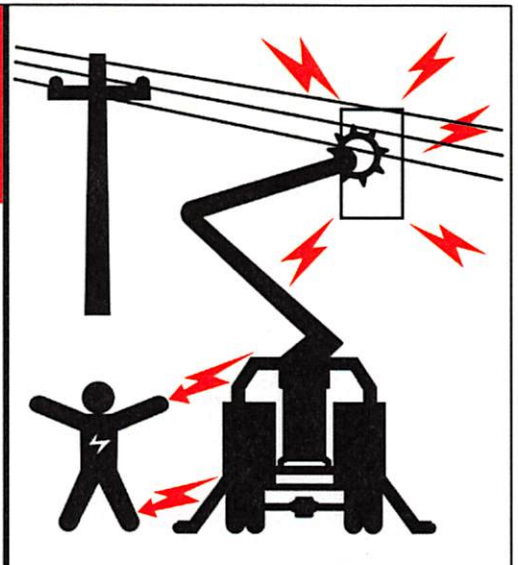
- DO NOT OPERATE ANY OUTRIGGER UNLESS YOU OR A SIGNAL PERSON CAN SEE THAT PERSONNEL AND OBSTRUCTIONS ARE CLEAR OF THE OUTRIGGER AND ITS CONTACT POINT.

601468

 **DANGER**

ELECTROCUTION HAZARD
DEATH OR SERIOUS INJURY
WILL RESULT FROM CONTACT WITH
THIS MACHINE, TRUCK OR TRUCK
ATTACHMENTS IF THEY SHOULD
BECOME ELECTRICALLY CHARGED
KEEP CLEAR OF TRUCK AND LOAD

617894



 **DANGER**

FALLING FROM PLATFORM
WILL RESULT IN

DEATH OR SERIOUS INJURY

- PLATFORM PERSONNEL MUST WEAR A BODY HARNESS WITH AN APPROPRIATE LANYARD ATTACHED TO ANCHOR PROVIDED.
- PLATFORM DOORS AND/OR CHAINS, IF PROVIDED, MUST BE SECURELY LATCHED.

617902



WARNING HOT EXHAUST

SAFETY DECALS



DANGER

AN UNTRAINED OPERATOR
SUBJECTS HIMSELF AND
OTHERS TO
DEATH OR SERIOUS INJURY
YOU MUST NOT OPERATE
THIS MACHINE UNLESS

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

601427



DANGER



OUTRIGGER CONTACT WILL CAUSE
SERIOUS CRUSHING INJURY
STAND CLEAR

601450

DECALS

**CHECK ROTATION
BOLTS WEEKLY!**

**DC PUMP
ON**



**OFF
DC PUMP**

**LIGHT ON INDICATES
OUTRIGGERS EXTENDED
AND PINNED IN PROPER
LOCATION FOR MACHINE
OPERATION**

Pre-Heat **Off** **On** **Start**

ALIGN



ALIGN

 **FAST**



 **SLOW**

**BOOM
CONTROLS**

**DRIVE
CONTROLS**

DECALS

**GROUNDING
LUG**

**PULL OUT
E-STOP
FOR
OPERATION**

DIESEL ONLY

**ATF
ONLY**

**DO NOT DRILL
HOLES IN BUCKET**

DECALS

REMOVE FOR OPERATION

DOWN	DOWN	RETRACT →	↑	↑	RETRACT ←	DOWN	DOWN
FRONT OUTRIGGER	REAR OUTRIGGER	TRACK EXTENSIONS	DRIVE	DRIVE	TRACK EXTENSIONS	REAR OUTRIGGER	FRONT OUTRIGGER
UP	UP	EXTEND ←	↓	↓	EXTEND →	UP	UP

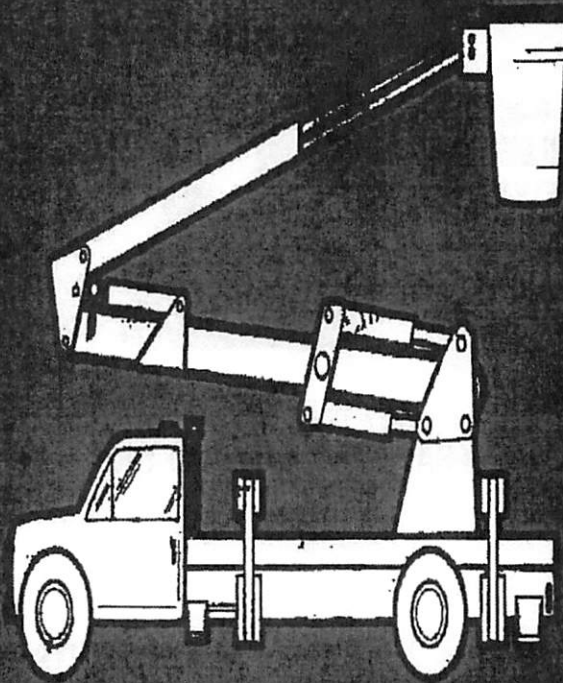
CAUTION

**OUTRIGGERS MUST BE PINNED
FOR BOOM OPERATION!**

Aerial Devices



**safety
manual**



Safety alert symbol

**This Safety Alert Symbol means:
ATTENTION! BECOME ALERT!
YOUR SAFETY IS INVOLVED!**



The Safety Alert Symbol identifies important safety messages on machines, safety signs, in manuals, or elsewhere. When you see this symbol, be alert to the possibility of personal injury or death. Follow the instructions in the safety message.

Why is SAFETY important to You?

3 BIG REASONS:

- **ACCIDENTS CAUSE INJURY AND DEATH**
- **ACCIDENTS COST TIME AND MONEY**
- **ACCIDENTS CAN BE PREVENTED**

Foreword



This Safety Manual is intended to point out some of the basic safety situations which may be encountered during the normal operation and maintenance of your machine and to suggest possible ways of dealing with these conditions. This manual is **NOT** a substitute for the manufacturer's manual(s). Additional precautions may be necessary, depending on attachments used and conditions at the worksite or in the service area. The manufacturer has no direct control over machine application, operation, inspection, lubrication, or maintenance. Therefore, it is **YOUR** responsibility to use good safety practices in these areas.

The information provided in this manual supplements the specific information about your machine that is contained in the manufacturer's manual(s). Other information which may affect the safe operation of your machine is contained

on safety signs, or in insurance requirements, employer's safety programs, safety codes, local, state/provincial, and federal laws, rules, and regulations.



ATTENTION! IF YOU DO NOT HAVE THE MANUFACTURER'S MANUAL(S) FOR YOUR PARTICULAR AERIAL DEVICE, GET A REPLACEMENT MANUAL FROM YOUR EMPLOYER, EQUIPMENT DEALER, OR FROM THE MANUFACTURER OF YOUR AERIAL DEVICE. KEEP THIS SAFETY MANUAL AND THE MANUFACTURER'S MANUAL(S) WITH THIS AERIAL DEVICE. READ AND UNDERSTAND THE MANUFACTURER'S MANUAL(S) BEFORE OPERATING.

A word to the user/operator

It is **YOUR** responsibility to read and understand this safety manual and the manufacturer's manual(s) before operating this aerial device. This safety manual takes you step-by-step through your working day.

In reading this manual, you will note that any illustration depicting an unsafe work procedure or situation is labeled both with the words "wrong" and the mark of an "X" on the illustration. Each illustration is also numbered and the same number appears in the text in parenthesis. This number is placed at the end of the written text that refers to the illustrations.

While some of the illustrations appearing in this manual are in the nature of "cartoons", this approach is intended

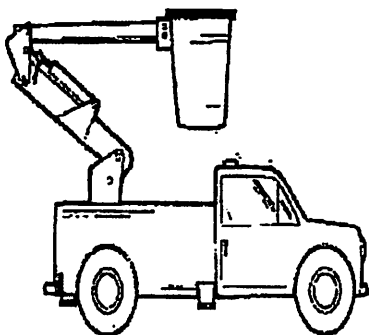
solely as a means to promote your attention to the text. As noted repeatedly throughout this manual, EMI and its Manufacturers of Aerial Devices and Digger Demicks Council ("MADDDC") are very serious about risks to human life and health caused by unsafe practices.

Remember that **YOU** are the key to safety. Good safety practices not only protect you but also protect the people around you. Study this manual and the manufacturer's manual(s) for your specific aerial device. Make them a working part of your safety program. Keep in mind that this safety manual is written only for vehicle mounted aerial devices. Practice all other usual and customary safe working precautions, and above all —

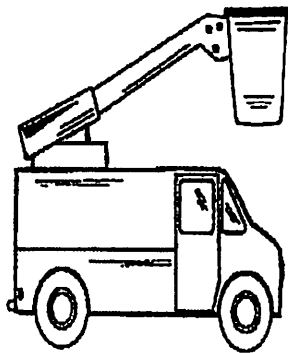
**REMEMBER - SAFETY IS UP TO YOU
YOU
CAN PREVENT SERIOUS INJURY OR DEATH**

Types of aerial devices

There are two basic types of aerial devices:



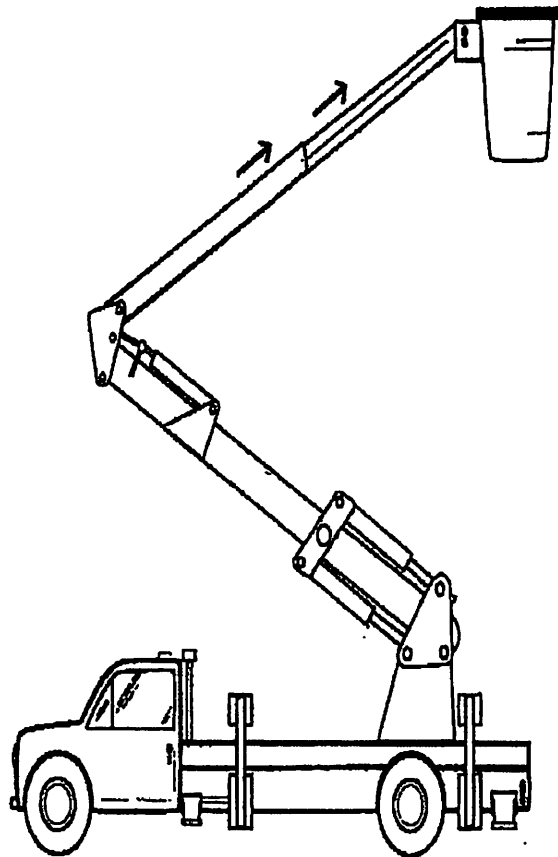
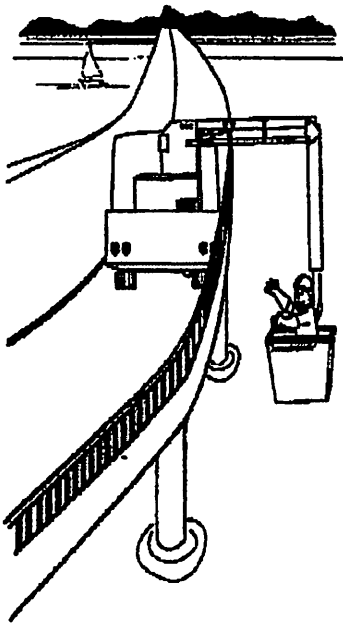
**Articulated Boom Aerial Devices
(insulated or non-insulated)**



**Extendible (telescopic) Boom Aerial
Devices (insulated or non-insulated)**

Types of aerial devices

There are also hybrid aerial devices which are essentially articulated aerial devices with extendible (telescopic) booms.



Safety - before you do anything

For Safe Operation

WARNING: For safe operation of this aerial device, all members of the crew must be qualified and authorized to perform their particular duties. (2)

To be qualified, you must:

- understand the written instructions supplied by the manufacturer, company rules, and OSHA regulations;
- have training, including actual operation of this aerial device;
- know and follow the safety rules and regulations for the jobsite.

DANGER: Use of this machine by an untrained person can result in severe injury or death.

On the job, you and your crew must not use drugs or alcohol; they can impair alertness and coordination. Anyone on prescription or over-the-counter drugs needs medical advice regarding whether or not he can safely operate machines.

The ground crew member must know how to lower the unit from the lower controls and rescue procedures.



2
RIGHT

Know the rules — LIVE by them.

Safety - before you do anything

- Do not use an aerial device to lift equipment or pull cable unless it is specially designed and rated for such loads.
- Wear your insulated gloves and sleeves when required.
- Alert crew members when lowering outriggers.
- Use Outrigger pads (when applicable).
- Communicate with crew members when erect in platform.
- Use liftroom (if applicable).
- Discuss your work plans prior to performing job.
- Wear your insulated hard hat.
- Use vehicle barrier kit.
- Whenever you leave your aerial device unattended, always lower the boom and platform or other attachments to their transport position. Engage the parking brake, stop the engine, and remove the key.
- Know when the next insulating dielectric test for the unit is due, and do not operate the unit if the test has not been performed.
- Understand hand, flag and horn signals.
- Make sure you understand the rules covering traffic at your jobsite. Know what all signs, flags, and markings mean. Know when to use lights, turn signals, flashers, and horns.
- Never use an aerial device to lift equipment or pull cable unless it is specially designed and rated for such loads.
- Wear your insulated gloves and sleeves when required.
- Alert crew members when lowering outriggers.
- Use Outrigger pads (when applicable).
- Communicate with crew members when erect in platform.
- Use liftroom (if applicable).
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- Whenever you leave your aerial device unattended, always lower the boom and platform or other attachments to their transport position. Engage the parking brake, stop the engine, and remove the key.
- Know when the next insulating dielectric test for the unit is due, and do not operate the unit if the test has not been performed.
- Understand hand, flag and horn signals.
- Make sure you understand the rules covering traffic at your jobsite. Know what all signs, flags, and markings mean. Know when to use lights, turn signals, flashers, and horns.
- Never use an aerial device each day, following the manufacturer's guidelines set forth in the manuals for the equipment, including all boom and stabilizer functions before beginning work (use lower controls).
- Know the capacity and operating characteristics of the machine, including maximum permitted ground slope.
- Do not overload the boom system or platform.
- Know the weight of items to be lifted. (See page 31 "Lifting Loads With An Aerial Device".)
- Never remove any part of the aerial device (except for service).
- If your aerial device is insulated, keep the insulated part of the booms clean, dry and free of oil or grease.
- Never modify any part of the aerial device without manufacturer's permission.
- Latch platform door (if equipped).
- Securely fasten any safety chains across door openings (if equipped).
- Fasten your fall protection device to the anchor point before you start.
- Never allow unauthorized persons on your aerial device.
- Keep others away from vehicle with boom in operation.
- Electrically ground the vehicle (if applicable).
- Maintain specified distances from electric power lines and apparatus.
- Use insulated shields, covers, mats when required.
- Never use non-insulated aerial devices near power lines.

Know and understand the rules.

Safety - before you do anything


Protect Yourself

Wear or use all the protective clothing and personal safety devices issued to you or called for by job conditions. You must always use fall protection.

You may also need:

- Safety belt or harness & lanyard
- An insulated hard hat
- Safety shoes
- First aid kit
- Safety glasses, goggles, or face shield
- Insulated gloves, sleeves
- Insulated shields, covers, mats & blankets
- Insulated tools
- Wet weather gear
- Cotton clothing

Wear whatever is needed, don't take chances. (3)

 **WARNING:** Do NOT wear loose clothing, neckties, scarves or unrestrained long hair. Do NOT wear rings, watches, bracelets or chains. Wrapping or entanglement can result in severe injury or death.

3
RIGHT



Use your head — and your hard hat.

Safety - before you do anything

Be Alert!

Know where and how to get assistance. Know how to use a first aid kit and fire extinguisher/fire suppression system and be certain these items are available and easy to get to. Know CPR. (4)

Be Aware!

Take advantage of training programs offered.

Be Carefull

Human error is caused by many factors: carelessness, rushing to get a job done quickly, fatigue, overload, preoccupation, drugs, and alcohol to name a few. Damage to the aerial device can be fixed in a short period of time, but serious injury or death has a devastating effect. For your safety and the safety of others, encourage your fellow workers to act safely. Do not force or overextend yourself beyond your capabilities based on training and experience. Use the proper tool for the job at hand. Do not use tools and equipment beyond their design capabilities.



Play it safe. Know how to summon help.

Safety - before you do anything

Know Your Equipment

Aerial devices differ in their operation, capacity, mechanisms, maintenance, intended uses, etc., so your knowledge of one aerial device may not help you safely operate another.

Know your aerial device. Know how to operate all equipment on your aerial device. Know the purpose of all the controls, gauges, warning labels and indicators. Know the rated load capacity, speed range, braking and steering characteristics, turning radius, operating clearances, and ground slope limits. Keep in mind that rain, snow, ice, wind, loose gravel, soft ground, slope, etc., change the operating capabilities of your aerial device. Study the DANGER, WARNING, and CAUTION safety signs on your aerial device and all DANGER, WARNING, CAUTION and INFORMATION notes in the operator's manual.

STUDY THE MANUFACTURER'S OPERATOR'S MANUAL BEFORE OPERATING THE AERIAL DEVICE. IF THERE IS NO MANUAL WITH THE AERIAL DEVICE — GET ONE. STUDY IT BEFORE YOU START WORK. (5)

IF THERE IS SOMETHING IN THE MANUAL YOU DON'T UNDERSTAND, ASK YOUR SUPERVISOR TO EXPLAIN IT TO YOU.

ATTENTION: This manual covers safe practices for Aerial Devices. If your aerial device is equipped with other devices or special accessories, read the manufacturer's operating and safety manuals pertaining to that equipment before using it.



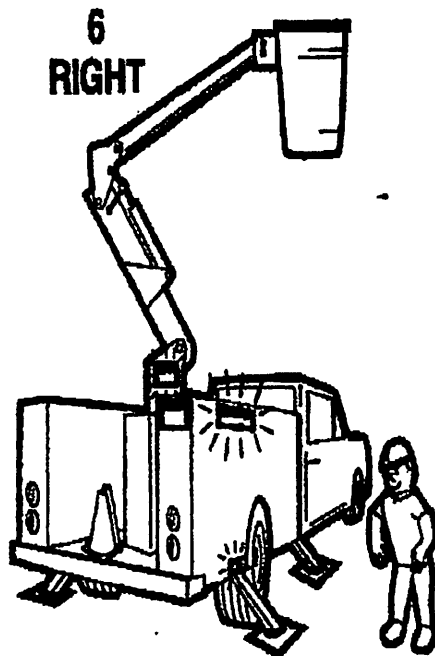
**5
RIGHT**

Respect your equipment. Make sure you know how it operates.

Safety before operation

Check The Safety Equipment

To protect you and others around you, see that applicable safety equipment is securely in place and in operating condition. Make certain all guards, railings, covers and safety signs are installed on the aerial device and vehicle as required by the manufacturer. (6)



- Platform door latch
- Fall protection device
- Safety chains across door openings (if equipped)
- Emergency controls
- Ground controls
- Intercom
- Interlock devices
- Barricade or barrier kits for vehicle
- Deadman control
- Outrigger pads (if applicable)
- Upper and/or lower boom latches
- Warning lights
- Safety signs
- Guards
- Insulated shields, covers and mats
- Back-up alarm
- Fire extinguisher/fire suppression system
- First aid kit
- Grounding equipment

Use them! Never remove or disconnect any safety device.

Play it safe. Take advantage of all the protection available.

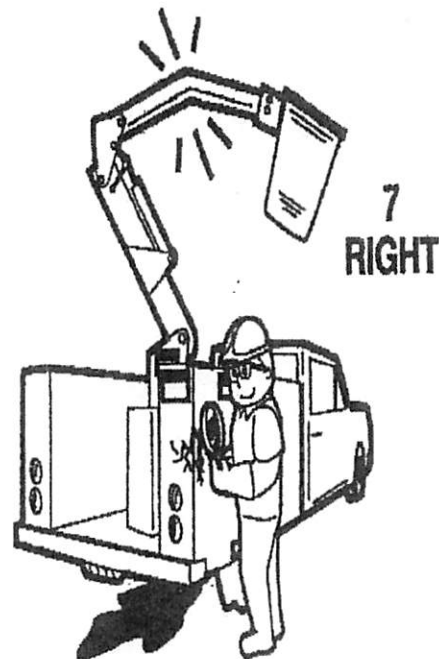
Safety before operation

Check The Aerial Device

Before you begin your workday, you should inspect your aerial device and have all systems in good operational condition as set forth in the manufacturer's manual. Do not operate the aerial device until all deficiencies are corrected by a qualified individual.

- Do pre-travel inspection test.
- Check for broken, missing or damaged parts. Have a qualified person make the necessary repairs. (7)
- Check the tires for cuts, bulges and correct pressure.
- Replace badly worn or damaged tires; properly inflate tires.
- Check the outriggers, if so equipped, or other stabilization equipment such as torsion bars.
- Check service, parking, and swing brake for proper operation.
- Check the boom, platform, rotation, rotation brake and boom winch operation (if so equipped) at both upper and lower controls.

- Check the hydraulic system. Repair any leaks. If the outriggers have crept down overnight, test check valve system.
- Ensure that regular lubrication is performed in accordance with the manufacturer's guidelines.
- Check cooling system.
- Check the electrical systems and components for deterioration or wear including those not readily visible on a frequent inspection.

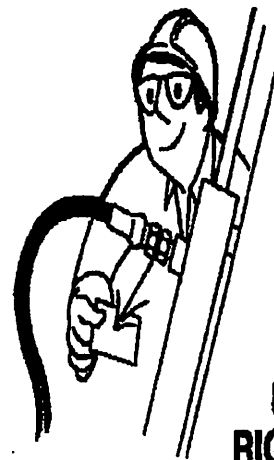


Safe operation begins with a safety-conscious operator.

Safety before operation

- Check bolts and fasteners for proper tightness and signs of wear.
- Examine welds for cracks or signs of rust, which can indicate potential problems.
- Check platform door latch for proper operation.
- If the boom is insulated, check insulation components to be certain they are dry and free of grease, oil, or dirt.
- Perform all maintenance procedures outlined by the manufacturer of your aerial device.

Refer to pages 9 and 13.



8
RIGHT



WARNING: Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes and cause serious injury, blindness or death. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks but do not use your bare hand. (8) Wear a face shield or safety goggles for eye protection. If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury.

Don't let fluids get under your skin.

Safety before operation

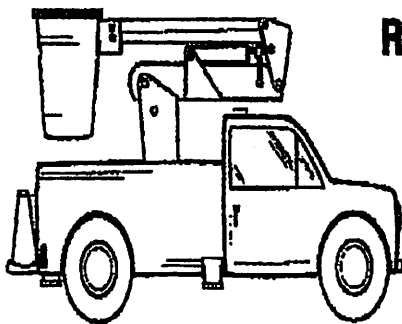
Safe Transport

While traveling on public roads or streets, be sure all local and state/provincial laws and regulations are followed.

Refer to your manufacturer's manual for instructions on preparing the unit for transport. Secure the boom and platform in the transport position. Make sure that outriggers are up and secured in the transport position. Make sure that all accessory equipment is properly stored and secure. (11)

When driving at night, use appropriate lights. Make sure you know your machine travel height and the height of all underpasses.

Always use hazard warning lights when parked at a job-site. Never park in traffic areas.



11
RIGHT

Obey your local traffic laws.

Know The Working Area



WARNING: Failure to properly evaluate the work area can lead to serious injury or death.

Learn — beforehand — as much about your working area as possible. Check for:

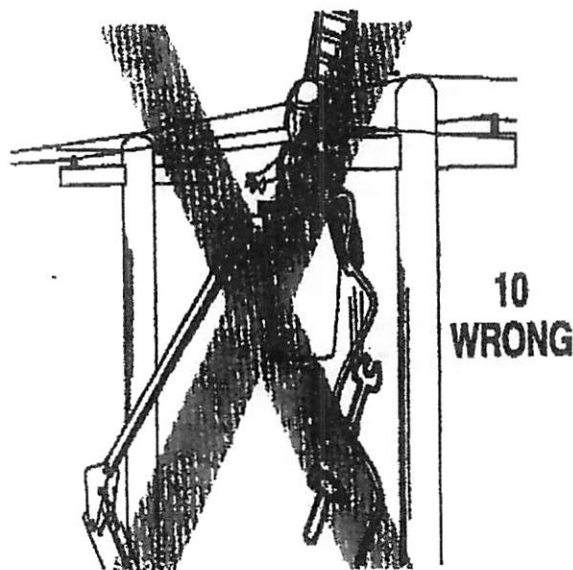
- Exact location of any overhead electrical, telephone, TV cable, or other utility lines.
- Location of slopes. Follow manufacturer's maximum slope lift can operate on.
- Potholes
- Broken curbs
- Open trenches
- Dropoffs or overhangs
- Soil conditions (soft or hard)
- Standing water and marshy areas
- Rocks, stumps and tall grass
- Overhead or side obstructions
- Conditions of roads
- Mud, snow or ice
- Heavy traffic
- Underground structures
- Thick dust, smoke, fog

Safety before operation

Use Caution When Fueling

WARNING: Never fill the fuel tank when the engine is running, while you're smoking or when the truck is near an open flame. Never overfill the tank or spill fuel. If fuel is spilled, clean it up immediately.

Ground the fuel funnel or nozzle against the filler neck to prevent sparks and be sure to replace the fuel tank cap. For additional information on fire hazards, refer to the section on Fire and Explosion Hazards.



Dirt, grease and moisture decrease insulation protection.

Clean Up

Make sure the operator's area, lift, platform, truck bed, steps and hand holds are clean and free of debris. Oil, grease, snow, ice or mud in these areas can cause you to slip and fall. Clean your boots of excess mud before getting on the machine.

Remove all loose personal items or other objects from the truck cab and operator's area on the aerial device. Secure these items in the tool box or remove them from the machine. (10)

WARNING: If the aerial device is insulated, the insulated portions of the aerial device **MUST** be dry and free of grease or oil to maintain maximum insulation protection.

WARNING: Dirt, grease, other foreign matter, moisture, and humidity will all dramatically increase the conductivity of synthetic rope.

Safety before operation



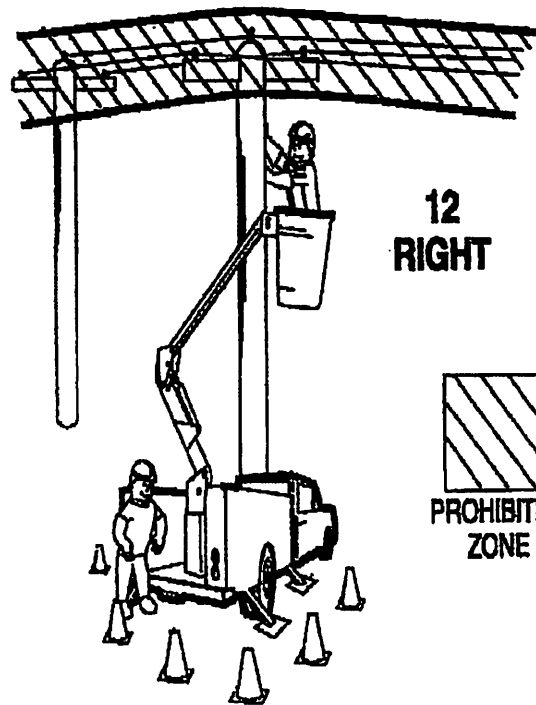
DANGER: Never approach any power line with any part of your machine unless all local, State/Provincial, company work rules and Federal (OSHA) required safety precautions have been taken. Use extreme caution; serious injury or death can result with contact from any power line.



DANGER: DO NOT maneuver machine or personnel inside PROHIBITED ZONE. (12) Allow for sway, drift, and platform movement in calculating safe distances.

ASSUME all electrical parts and wiring are ENERGIZED unless known otherwise.

Always follow State/Provincial, company work rules and Federal (OSHA) standards.



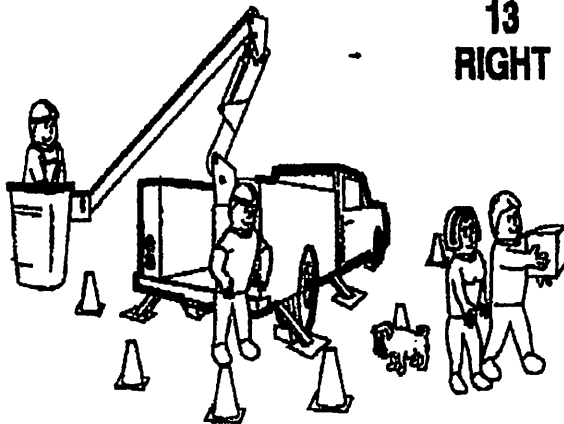
You must know your electrical safety zones.

Safety before operation

Before Starting

Before starting, walk around the equipment. Make sure no one is under, on or close to the unit. Let other workers or bystanders know you are starting up. Don't start until everyone is clear of the unit. (13)

When operating an aerial device inside a building, know what clearances you will encounter — overhead, doorway, sides, etc.; also the weight limitations of floors and ramps. Make sure there is sufficient ventilation for inside operation.



13
RIGHT

Position Unit For Operation

1. Position vehicle on the most level ground, but the equipment must not be operated on an incline greater than as permitted in the manufacturer's operations manual. If on an incline, position the vehicle so that the platform would be operated on the upgrade side in a stable position.
2. Set the brakes.
3. Use wheel chocks (both sides).
4. Engage power source.
5. Set the outriggers (if so equipped). Use outrigger pads if ground is soft. Level the vehicle as much as possible, but observe manufacturer's maximum ground slope.
6. Spot your vehicle as close to the work as possible to minimize reach, but be sure there are no obstructions to prevent safe and proper lift and rotation.
7. Make sure the vehicle is stable.

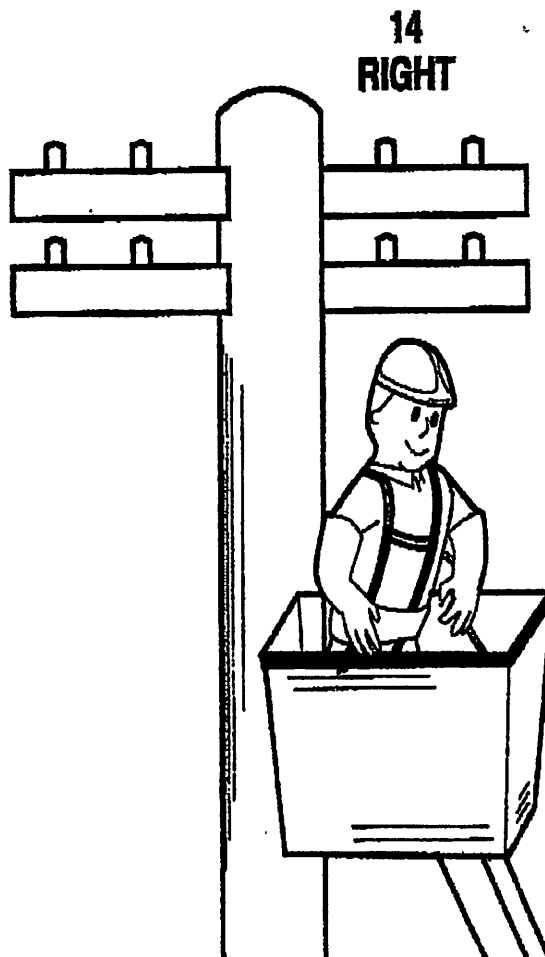
Look out for the other guy.

Work safely

Remember These Rules

When operating the boom(s):

- Keep your fall protection device fastened and comfortably snug. (14)
- Securely fasten any safety chain (if equipped).
- Use your personal protective equipment.
- Be in control of your aerial device at all times.
- Look and listen for malfunctions.
- Stop if a malfunction or erratic operation is detected.
- Correct or report trouble immediately.
- Keep both feet on the floor of the platform.
- Know your clearances.



Keep yourself safe and secure.

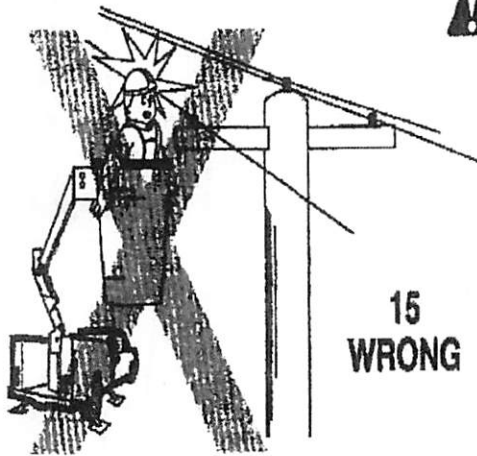
Work safely

Remember The Other Person

- Never allow an untrained or unqualified person to operate your aerial device. Handled improperly, this aerial device can cause severe injury or death.
- Know the pinch points and moving parts on the aerial device. Awareness on your part can prevent accidents.
- When traveling, never allow anyone to ride in the back of the truck or in the lift platform.

Aerial Device Safety Precautions

- Never allow the booms or turntable to enter traffic lanes without proper barricading. Exercise extreme care, especially with articulating boom and/or large offset turntable while rotating. Park to block traffic.
- Check the clearance overhead. Note any obstructions. Know exactly how much clearance all parts of your aerial device have around electric power lines.

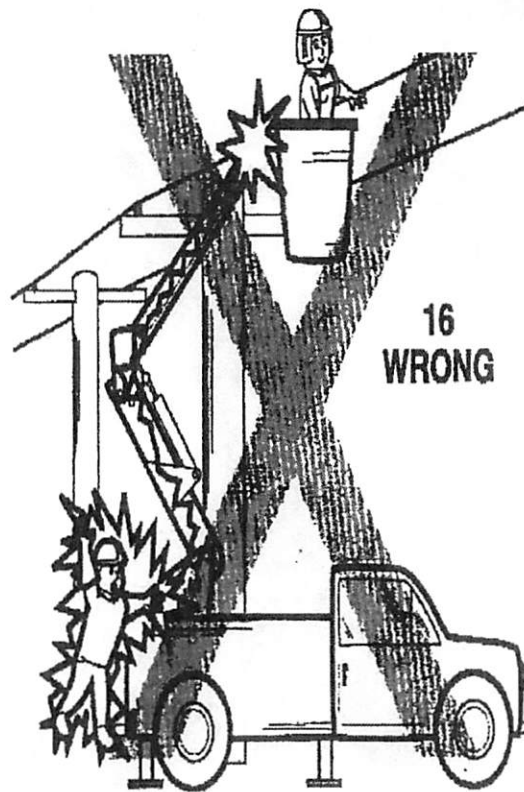


⚠ DANGER: NON-INSULATED machines shall **NOT** be used on or near any power line. Death or serious injury will result from contact or inadequate clearance to electrical power lines or apparatus.
(15)

DO NOT use non-insulated machinery near high tension power lines.

Work safely

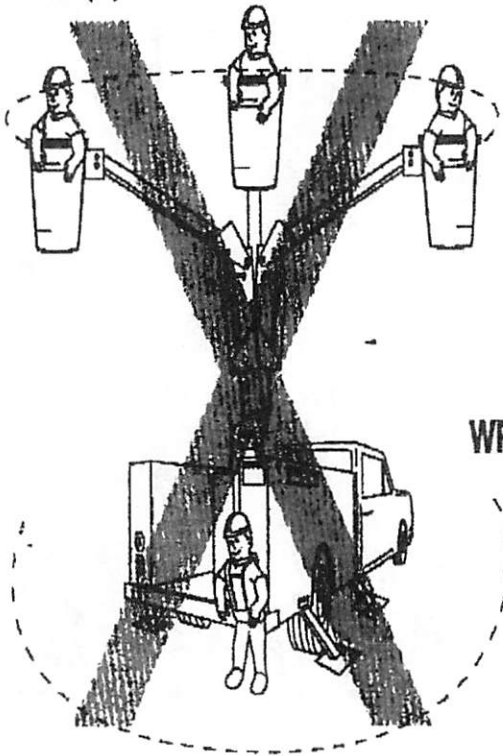
- MAINTAIN SPECIFIED DISTANCE FROM ELECTRICAL LINES AND APPARATUS. Never approach power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution.
- YOU MUST ALLOW FOR PLATFORM SWAY, ROCK AND CREEP, ALSO ELECTRICAL LINE SWAYING.
- Ground personnel must not contact the vehicle when the unit is working on energized power lines. (18)
- Beware of strong and/or gusty wind conditions.
- Set brakes and chock the wheels before operating.
- Make sure the area is clear of all persons before you start operating.
- As necessary, use a signal person to control traffic.
- Keep yourself and others away from the outriggers when they are being operated.
- Always have outriggers in view when they are being extended, and/or use a signal person to watch.
- Always make sure that you follow the manufacturer's recommendations while operating the aerial device.



Keep your distance from power lines.

Work safely

WARNING: Never allow anyone else to enter aerial device's rotation area or walk under the platform or suspended load. Death or serious injury can result. (17)



Repositioning Vehicle

If your machine has a separate power source to operate the lifting and rotation functions, shutoff the vehicle engine and remove key. Before moving the vehicle, stow the boom and platform in the transport position and secure if required, raise the outriggers (if so equipped), remove the wheel chocks, disengage PTO, and then drive the machine forward or backwards, as required. After the machine has been repositioned, engage the parking brake, chock the wheels, and shift transmission controls to neutral or to gear for PTO operation. Lower the outriggers and level the machine.

Stand clear of outriggers and from under the aerial platform.

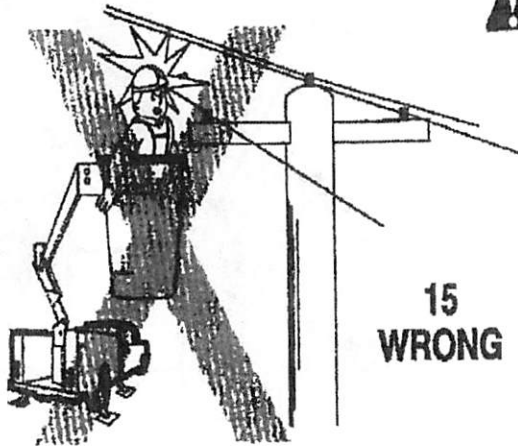
Work safely

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- Know the pinch points and moving parts on the aerial device. Awareness on your part can prevent accidents.
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Aerial Device Safety Precautions

- Never allow the booms or turntable to enter traffic lanes without proper barricading. Exercise extreme care, especially with articulating boom and/or large offset turntable while rotating. Park to block traffic.
- Check the clearance overhead. Note any obstructions. Know exactly how much clearance all parts of your aerial device have around electric power lines.

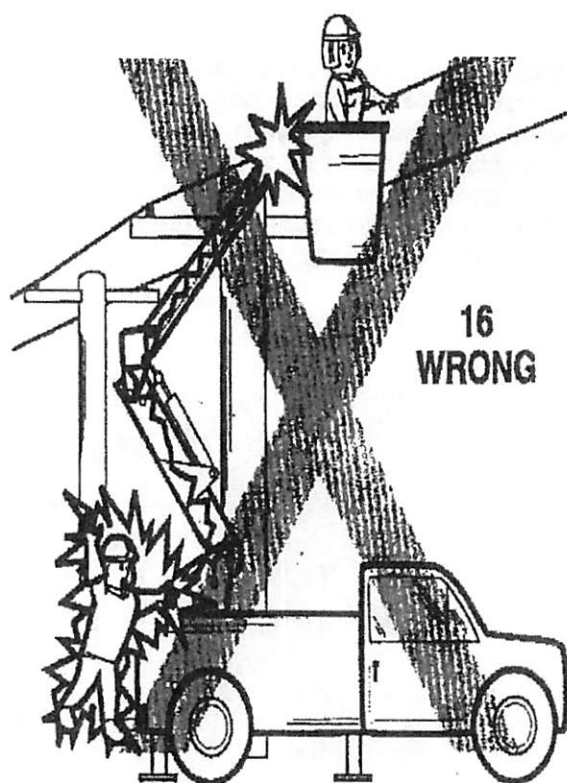


⚠ DANGER: NON-INSULATED machines shall NOT be used on or near any power line. Death or serious injury will result from contact or inadequate clearance to electrical power lines or apparatus.
(15)

DO NOT use non-insulated machinery near high tension power lines.

Work safely

- MAINTAIN SPECIFIED DISTANCE FROM ELECTRICAL LINES AND APPARATUS. Never approach power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution.
- YOU MUST ALLOW FOR PLATFORM SWAY, ROCK AND CREEP, ALSO ELECTRICAL LINE SWAYING.
- Ground personnel must not contact the vehicle when the unit is working on energized power lines. (16)
- Beware of strong and/or gusty wind conditions.
- Set brakes and chock the wheels before operating.
- Make sure the area is clear of all persons before you start operating.
- As necessary, use a signal person to control traffic.
- Keep yourself and others away from the outriggers when they are being operated.
- Always have outriggers in view when they are being extended, and/or use a signal person to watch.
- Always make sure that you follow the manufacturer's recommendations while operating the aerial device.



Keep your distance from power lines.

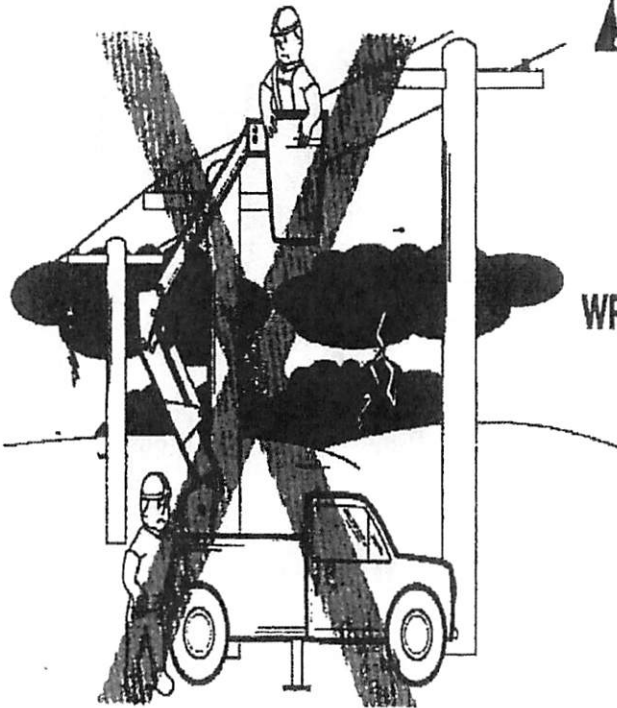
Work safely

⚠ DANGER: Contact with energized power lines can cause DEATH or serious injury to persons in the platform and those on the ground in contact with the machine. Maintain adequate clearance.

⚠ WARNING: Do not operate your aerial device during electrical storms. (19)

⚠ WARNING: Your platform and platform liner, synthetic winch cable and insulated boom section must be dry and clean before operating your aerial device on or near power lines and apparatus. Moisture, grease and debris will defeat the insulating value of these components, which could result in serious injury or death.

⚠ WARNING: DO NOT drill drain holes in insulated platform or platform liners.




19
WRONG


Lightning is dangerous.


Work safely

Utilities - Overhead

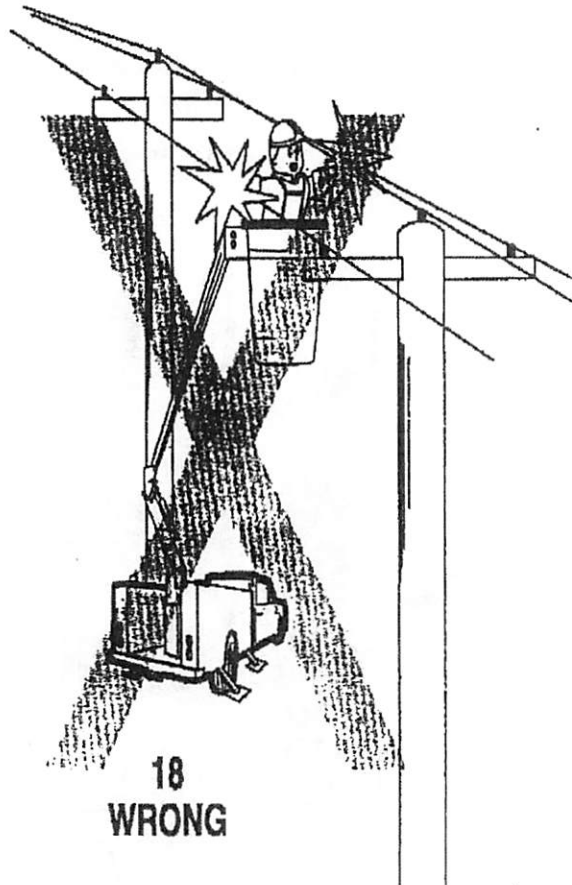
Electrocution can result from contacting or approaching overhead power cables. Only INSULATED machines are suitable for this work.

 **DANGER:** An insulated platform provides no protection from contact between two energized conductors or between an energized conductor and a grounded conductor by the operator, even with insulated machines. (18)

 **DANGER:** Never pass platforms between power lines, even with insulated machines. (18)

 **DANGER:** With an insulated machine, never approach overhead power lines with any part of your machine unless all local, State/Provincial, company work rules and Federal (OSHA) required safety precautions have been taken. Use extreme caution. **YOU MUST ALLOW FOR PLATFORM SWAY, ROCKING AND CREEP, AS WELL AS ELECTRICAL LINE SWAYING.**

Check overhead clearances: Know your margin of safety. If possible, have power to the lines disconnected. If not possible, request a signal person for guidance to maintain at least minimum distance required by OSHA from overhead power lines.



Inadequate clearance can be fatal.

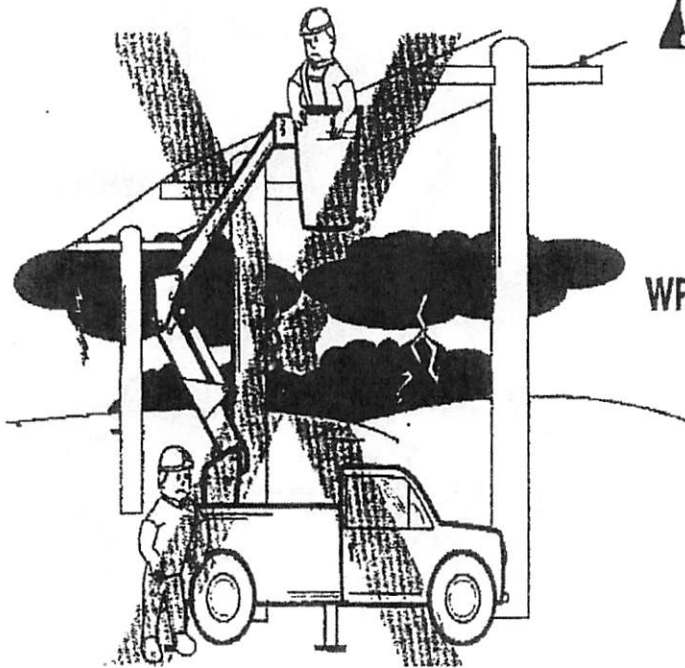
Work safely

⚠ DANGER: Contact with energized power lines can cause DEATH or serious injury to persons in the platform and those on the ground in contact with the machine. Maintain adequate clearance.

⚠ WARNING: Do not operate your aerial device during electrical storms. (19)

⚠ WARNING: Your platform and platform liner, synthetic winch cable and insulated boom section must be dry and clean before operating your aerial device on or near power lines and apparatus. Moisture, grease and debris will defeat the insulating value of these components, which could result in serious injury or death.

⚠ WARNING: DO NOT drill drain holes in insulated platform or platform liners.



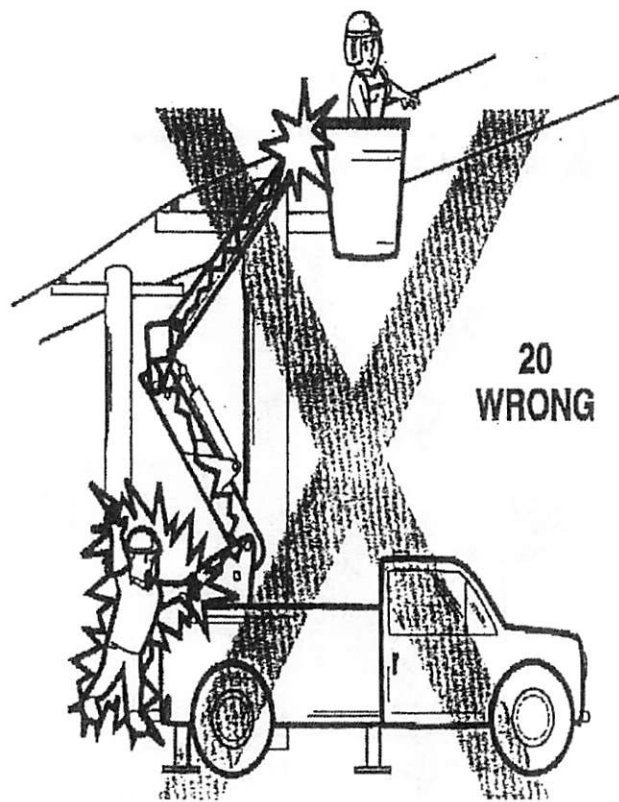
19
WRONG

Lightning is dangerous.

Work safely

⚠ DANGER: NO AERIAL DEVICE, WHETHER INSULATED OR NOT, PROVIDES ANY ELECTRICAL PROTECTION TO ANY OCCUPANT OF THE PLATFORM IF THERE IS PHASE-TO-PHASE OR PHASE-TO-GROUND CONTACT. SUCH CONTACT WILL CAUSE SEVERE INJURY OR DEATH. (20)

⚠ DANGER: Contact can be made when any portion of the boom tip is in contact with a phase or ground and the operator is in contact with another phase or ground and contact is made with any area of the boom tip by the operator.

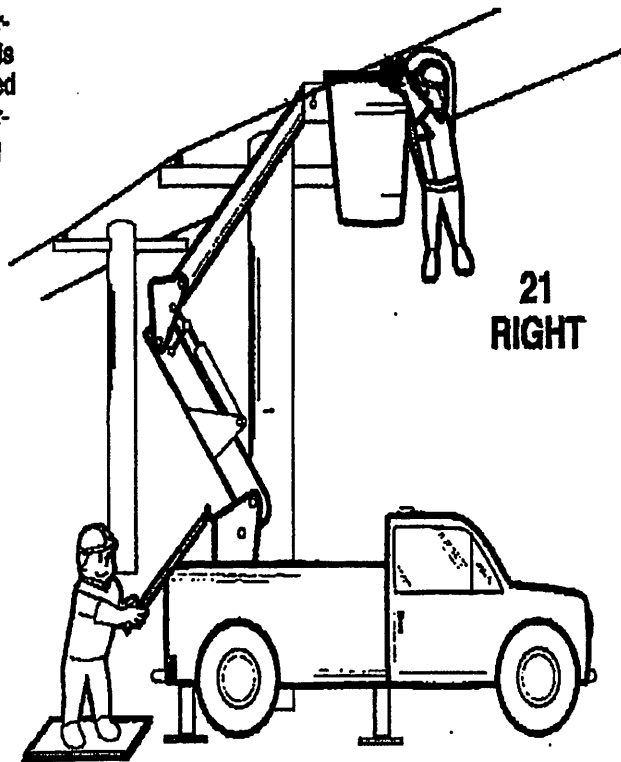


Contact with energized power lines can cause DEATH.

Work safely



WARNING: In case of an accident, or other emergency, involving any electrical source, **DO NOT** approach or enter the vehicle unless you are certain the vehicle is **NOT** energized. If the vehicle is energized, or you are not sure, stand on insulated pad or blanket, use a long insulated pole to operate the emergency/lower control system to bring the platform down. (21)



Don't risk yourself during a rescue.

Work safely

Aerial Device Operation



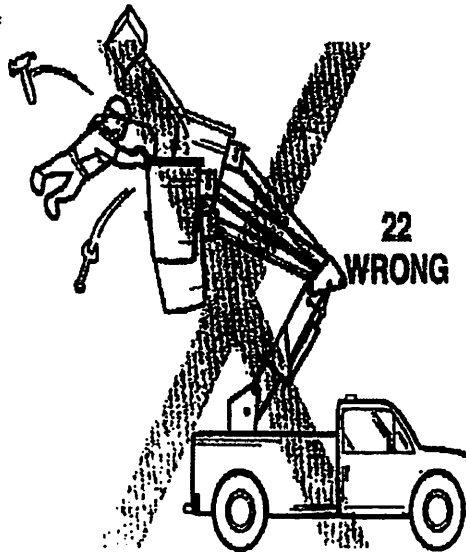
WARNING: You must wear the fall protection device. Before raising the platform, attach the lanyard to an anchor point.



WARNING: Never allow anyone to tamper with, service, or operate an aerial device from the lower control station while personnel are in the platform, except in an emergency or equipment malfunction. Move the controls smoothly. For final positioning of the platform, gently "feather" the controls.



WARNING: Jerking the controls will cause sudden starts and stops in aerial device operation. This can cause damaging shock loads and/or cause the platform to sway violently. When the platform has been raised to the working position, be extremely cautious to prevent any objects from striking or interfering with the operating controls. Secure all tools, equipment or other materials placed on the platform to keep them from shifting or falling. (22)



Position the platform with a "feathering" touch.

Work safely

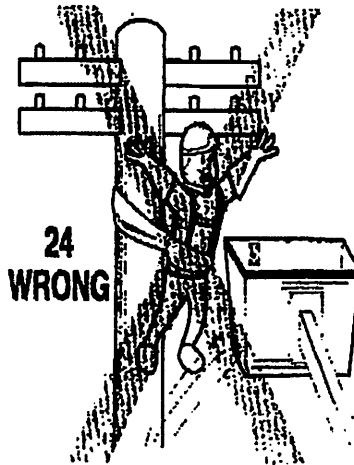
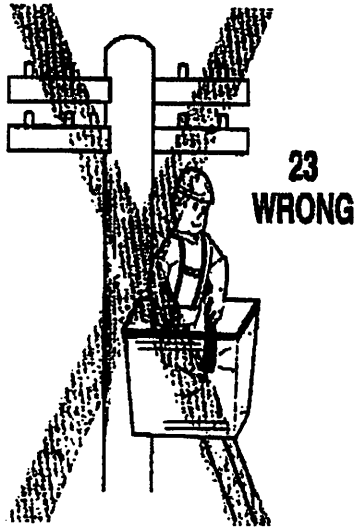
⚠ **WARNING:** Never disconnect your fall protection device while aloft. Any sudden machine movement can cause you to fall from the platform. (23)

⚠ **WARNING:** Never use ladders, planks, steps or other devices to provide additional reach or gain greater height. Do not lean over or sit or climb on the platform railing. Always keep both feet on the platform floor at all times.

⚠ **WARNING:** Never belt off to an adjacent pole, tree or other structure when working from an aerial platform. (24)

⚠ **WARNING:** Never attempt to transfer from the platform to a pole, tower, tree or any adjacent structure while the booms are in a raised position.

⚠ **WARNING:** On non-overcenter machine, do not attempt to readjust the boom safety stops for more reach. When raising, lowering or rotating the platform, use extreme caution. Always look in the direction of movement. Watch out for obstructions above, below and to all sides. If necessary, use a signal person on the ground to guide you.



Don't get hung up where you don't belong.

Work safely

Lifting Loads With An Aerial Device

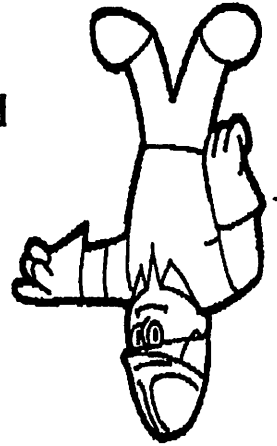
Do not use an aerial device to lift loads unless the aerial device has been specifically designed and equipped with attachments for material handling. Understand the lifting capabilities of the boom and its attachments.

Before lifting a load, see the manufacturer's manual or load chart attached to the boom for the lifting capacity of your machine with the boom in various positions. (25)

Lift loads only if designed and equipped with attachments for material handling.



RIGHT
25



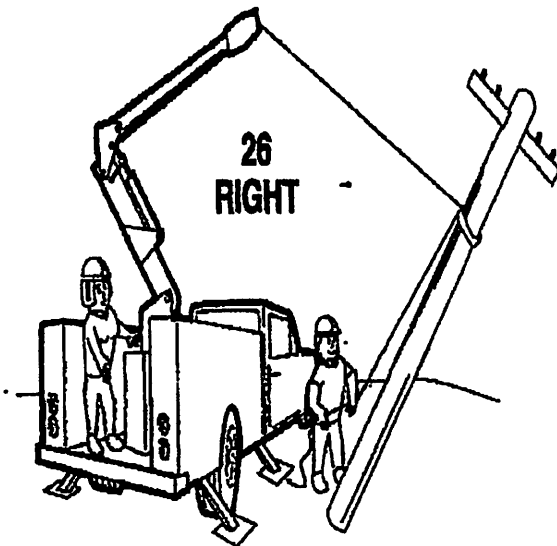
Don't overload your machine. Know your machine's lifting capacity.

WARNING: OVERLOADING IS DANGEROUS. Know the weight you are lifting. If you do not know the weight, you must determine its weight before lifting load. Make certain you are within the safe load and work radius limitations of the aerial device and are on solid level ground within manufacturer's maximum slope before lifting any load. Never attempt to lift an object at an angle. The boom head must be directly over the load before lifting. Always lower the cuttigers to the ground before lifting. If ground is soft, place flotation pads under each outigger. When lifting, be sure the load is properly balanced. Move slowly so the load does not sway or swing around. If necessary, use a tag line for additional control. Avoid shock to loads when lowering a load. Lower slowly and smoothly. DO NOT attempt to pull a pole from the ground with your aerial device. Use a pole puller. DO NOT attempt to pull cable. This creates abnormal stresses in the booms, which can lead to pin failure and boom collapse.

Work safely

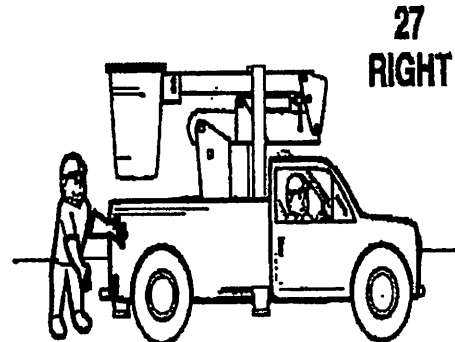
WARNING: Never tie a load to the platform or boom. The platform may bounce or sway violently when the load falls. Only use lifting device provided. (26)

WARNING: Allow extra overhead clearance in case boom does raise when load is relieved.



Stowing the Unit

1. Gently settle the boom(s) onto supports using a "feathering" movement of the controls.
2. Secure the boom(s) in the supports per manufacturer's instructions. (27)
3. Raise the outriggers (if so equipped) to their full "up" travel position.
4. Disengage the PTO.
5. Stop the engine.



Use proper lifting devices.

Perform maintenance safely

Definition of Qualified Individual:

A "Qualified Individual" is defined as a person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to the subject matter, the work, or the project.

If you have been authorized to do maintenance, READ THE MANUFACTURER'S SERVICE AND OPERATOR'S MANUALS. Study the instructions; check the lubrication charts; examine all the instructions and warning messages on the machine for readability. Maintenance can be dangerous unless performed properly. Be sure you have the necessary skill, information, correct tools and equipment to do the job correctly. Use manufacturer's recommended hydraulic oil.

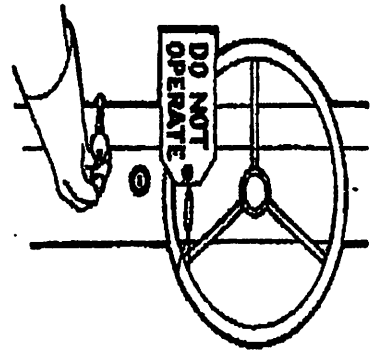
Attach a "DO NOT OPERATE" tag or similar warning tag to the starter switch or steering controls before performing maintenance on the machine.

If the machine should not be started, remove the ignition key. (28)

Proper maintenance is necessary to provide safe, reliable operation of the aerial device.

Be certain that the aerial device you are operating has been properly maintained by qualified personnel. Read and understand the manufacturer's manual(s) pertaining to your equipment. Perform all operator's inspections required by the manuals and or federal, local, or state/provincial regulations.

WARNING: Do not perform any work on a machine unless you are authorized — and qualified — to do so.



28
RIGHT

If you don't know what you're doing — don't do it.

Perform maintenance safely

Prepare The Work Area

Choose a clean, level work area. Make sure you have sufficient room. Check clearances. Make certain there is adequate light and ventilation. Clean the walking and working surfaces. Remove oil, grease, and water to eliminate slippery areas. Put sand or other absorbent material on slippery areas. (29)

29
RIGHT



Prepare Yourself

Wear all the protective clothing the job requires. Wear a rubber apron and rubber gloves when working with corrosive materials. Wear gloves and safety shoes when handling wooden blocks, wire rope or sharp-edged metal or heavy objects. Safety shoes must be worn at all times. (30)

Safety glasses, goggles or a face-shield are always needed for eye protection from electric arcs from shorts, fluids under pressure, while grinding, servicing batteries, and from flying debris or loose material when engine is running or tools are used. Wear a face-shield when you disassemble spring loaded components or work with battery acid. Wear a helmet or goggles with special lenses when you weld or cut with a torch.

30
RIGHT



Get a safe start.

Perform maintenance safely

Do not sand, grind, flame-cut, braze or weld without a NIOSH/MSHA approved respirator or appropriate ventilation. If welding is required on this machine, refer to the manufacturer's manuals or consult your equipment dealer for proper procedures including welder certification requirements, proper grounding procedures and disconnecting of alternator or battery.

Block the boom or purge the cylinders of all air when doing maintenance to prevent free fall.

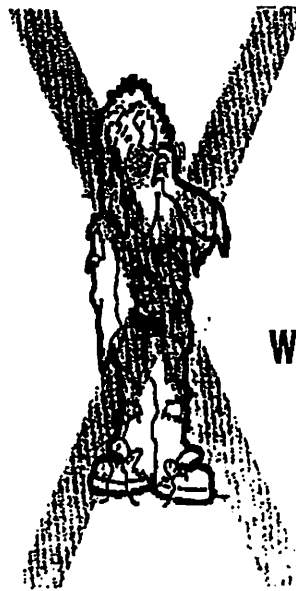


31
RIGHT

Handle tools and heavy parts CAREFULLY — with regard for yourself and other persons. LOWER ITEMS — DON'T DROP THEM. (31)



WARNING: Keep clear of all rotating components. Wrapping or entanglement may result in serious injury or death. **KEEP HANDS — AND CLOTHING — AWAY FROM ALL MOVING PARTS.** Don't tempt fate with dangling ties, loose sleeves, rings or long hair. Keep pockets free of all objects which could fall out — and into machinery. (32)



32
WRONG

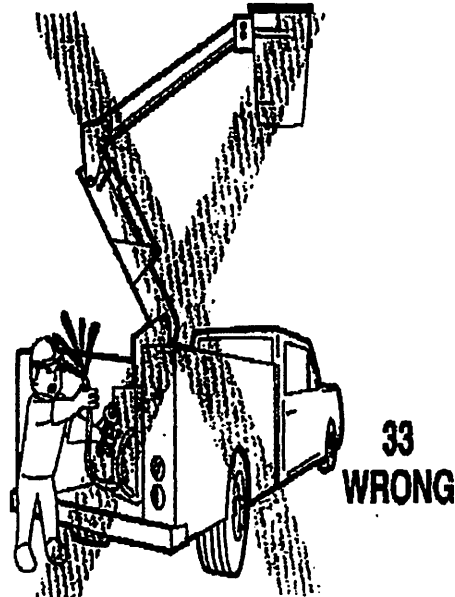
Protect yourself with the proper equipment.

Perform maintenance safely

Prepare The Machine

WARNING: START THE ENGINE FROM THE DRIVER'S SEAT ONLY. NEVER ATTEMPT TO START THE ENGINE BY SHORTING ACROSS STARTER TERMINALS OR REACHING FROM THE GROUND OR OUTSIDE THE CAB. It may start in gear if neutral-start circuitry is bypassed. This could cause the unit to move suddenly and cause serious injury or death to anyone in its path. Move the machine onto a level surface. Stop engine, release all hydraulic pressure. Attach the cylinder rod support struts or block all hydraulically operated components if they must be in a raised position.

WARNING: DO NOT DISCONNECT HYDRAULIC COMPONENTS WHEN THERE IS PRESSURE IN THE SYSTEM. Disconnecting pressurized hose can result in serious injury to the exposed, unprotected face or other parts of your body. (33)



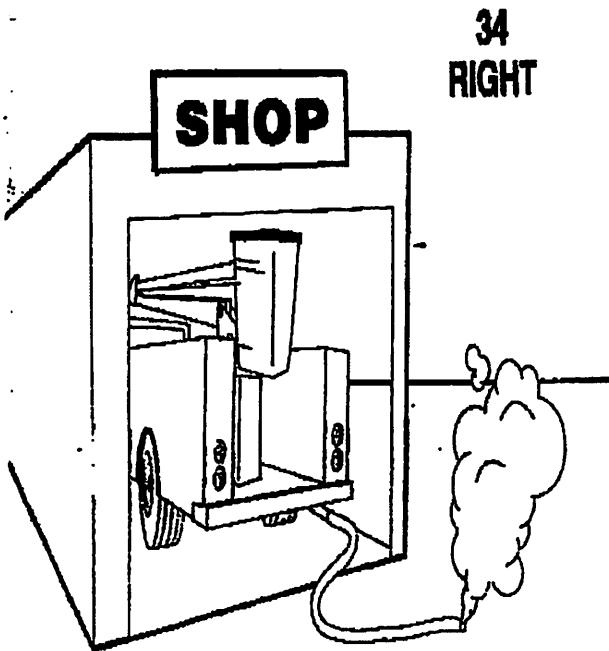
Relieve pressure before working on pressure components.

Perform maintenance safely

WARNING: Never work on machinery with the engine running unless so instructed for specific service, by the manufacturer's operator's or service manuals.

WARNING: Never operate any type of engine without proper ventilation — EXHAUST FUMES KILL (34)

If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension. If you do not have an exhaust pipe extension, make sure you open the doors and get outside air into the area. If adjustments must be made with the engine running, always work as a two-person team with one person sitting in the driver's seat while the other works on the machine. Remove only guards or covers that provide access. Wipe away excess grease and oil. Never leave guards off or access doors open when unattended. Keep bystanders away if access doors are open. Make certain all guards, screens or panels, and safety signs are reinstalled on the machine as recommended by the manufacturer.



Exhaust fumes kill.

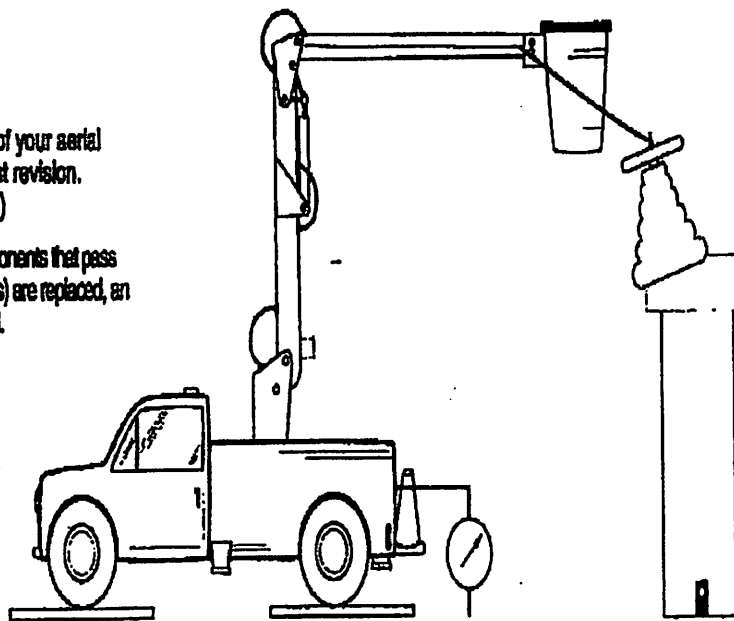
Perform maintenance safely

WARNING: Never substitute a conductive wire braid type hose for any insulated or nonconductive hose. Death or serious injury will result from the bridging of an insulated gap with a conductive hose. Most nonconductive hoses are orange in color and are marked as "nonconductive". Hoses must not have pinhole perforations, bubbles or cuts.

Insulated Test

Test the liner and insulated boom section(s) of your aerial device regularly per ANSF's A92 (A92.2) latest revision. (Periodic/Maintenance Test Procedures). (35)

WARNING: When hose, oil or other components that pass through the insulated section of the boom(s) are replaced, an electrical insulation test must be performed.



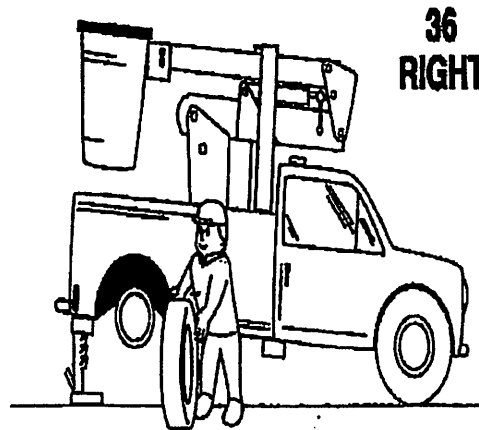
Perform a proper insulated test

Perform maintenance safely

Use Jacks And Hoists Carefully

If you must work beneath a raised vehicle during disassembly or maintenance, always use a truck lift or use wood (NOT CONCRETE) blocks, jack-stands or other rigid and stable supports to brace all movable portions of the aerial device. If these steps are not taken, components may shift or move during disassembly which could cause pinching or crushing injuries. When using jacks and hoists always be sure they are adequately supported. (36)

⚠ **WARNING:** Never use concrete blocks for supports. They can collapse even under light loads. Make sure the hoist or jacks you use are in good repair. Never use jacks with cracked, bent or twisted parts. Never use frayed, twisted or pinched cables. Never use bent or distorted hooks.



Use jacks and hoists carefully.

Perform maintenance safely

Avoid Electrical System Hazards

Disconnect the battery before working on the electrical system. Remove the ground cables first. When reconnecting the battery, reconnect the ground cable last. Never work on the electrical system unless you are thoroughly familiar with system details and the special handling required. (37)

37
WRONG



Use care when servicing batteries.

Brake Safety Tips

Always follow manufacturer's manual(s) when adjusting brakes. Improperly adjusted brakes can cause an accident. Block wheels before purging air from the brake system. Air trapped in brake lines can cause erratic performance or loss of brakes.

Use only brake fluid recommended by manufacturer.

Be Careful With Fluids Under Pressure

The hydraulic system may be under pressure whenever the engine is running and may hold pressure even after shutdown. Install cylinder rod support struts or block the cylinders and equipment securely before working on the hydraulic system. Cycle all hydraulic steering and other controls after shutdown to relieve system pressure. When venting or filling the hydraulic system, loosen the filler cap slowly and remove it gradually. If the system is equipped with an accumulator, see the manufacturer's service manual for discharge and recharge instructions. Do not permit an open flame around the hydraulic system. Clean up spilled fluid immediately.

Perform maintenance safely

Avoid Fire And Explosion Hazards

Stop the engine and shut off electrical equipment while filling the fuel tank. Use extra caution when fueling a hot engine. Always ground the fuel nozzle against the filler neck to avoid sparks.

⚠ WARNING: NEVER SMOKE WHILE HANDLING FUEL OR WORKING ON THE FUEL SYSTEM. (40) THE FUMES IN AN EMPTY FUEL CONTAINER ARE EXPLOSIVE, NEVER CUT OR WELD ON FUEL LINES, TANKS OR CONTAINERS. Handle all solvents and dry chemicals according to procedures identified on manufacturer's containers or MSDS bar material. Work in a well-ventilated area. Make sure you know where fire extinguishers are kept and how to use them. Remove all trash or debris from the vehicle. Make sure that oily rags or other flammable material are removed from the machine. Check for fuel, oil or hydraulic fluid leaks. Repair the leaks and clean the machine before you operate.

Ether is flammable. Do not smoke when using Ether. Always follow the instructions on the Ether can and in the manufacturer's manual(s) for your machine. Do not use Ether if the engine is equipped with a glow plug or other type of preheater. Always use a nonflammable solvent when you clean parts. Do not use gasoline, diesel fuel or other flammable fluids. Store all flammable fluids and material away from your work area in suitable containers, as per local regulations. Do not store flammable fluid or gas containers in compartments with electrical controls. Check readiness of fire extinguishers.



Fuel and flame are a dangerous combination.

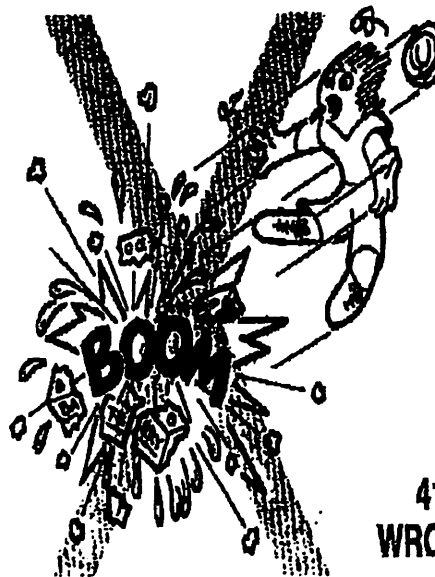
Perform maintenance safely

Avoid Battery Hazards

⚠ WARNING: Lead-acid batteries contain sulfuric acid which will damage eyes or skin on contact. Always wear a face shield to avoid acid in eyes. If acid contacts eyes, flush immediately with clean water and get medical attention. Wear rubber gloves and protective clothing to keep acid off skin. If acid contacts skin, wash off immediately with clean water, then seek medical attention.

⚠ WARNING: Lead-acid batteries produce flammable and explosive gases. Keep arcs, sparks, flames and lighted tobacco away. Use flashlight to check battery electrolyte level. Always check with engine stopped.

Do not charge a battery or jump-start the engine if the battery is frozen. Warm to 80°F (15°C) or the battery may explode. (41)



41
WRONG

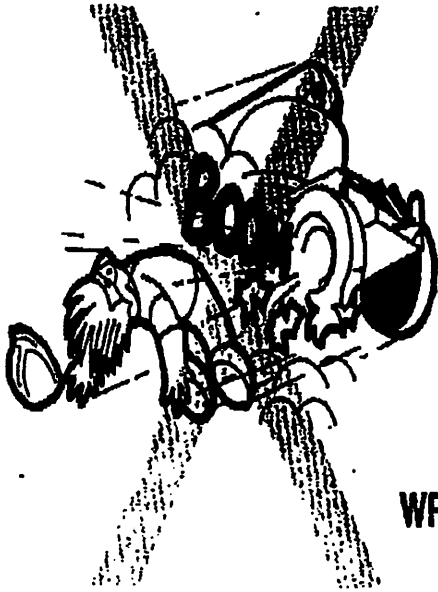
Use care when servicing batteries.

Perform maintenance safely

Tire Maintenance



WARNING: Explosive separation of a tire and/or rim parts can cause serious injury or death. Always follow the manufacturer's recommendations or see your tire supplier.



42
WRONG


Special tools and procedures are required to change truck tires. To do it safely, it must be done correctly. Follow the step-by-step instructions given in a tire repair manual. Changing tires is a job better done by your tire service company. (42) Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Be sure to replace tire ballast if machine is so equipped. See manufacturer's specifications for ballast requirements. Inspect tires and wheels daily. Do not operate with low pressure, cuts, bubbles, damaged rims or missing lug bolts or nuts. Never cut or weld on the rim or rim parts. This could cause explosive decompression. If the tires are filled with nitrogen DO NOT add air. Fill only with dry nitrogen, using proper inflating equipment. Keep wheel lug nuts tightened to manufacturer's recommendations. A rise in tire pressure is normal during operation. It should NOT be reduced. When adjusting tire pressure, do so from a distance. Use a long hose with self-attaching chuck. Always stand behind tread when adjusting tire pressure.

You're riding on them — you keep them safe.

Perform maintenance safely

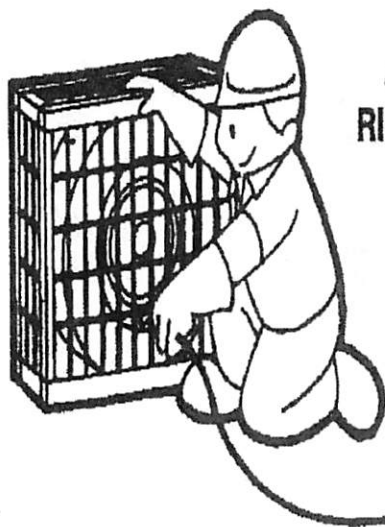
Tire Repair

Tires are to be repaired only by a qualified individual using the proper procedures and safety equipment.

 **WARNING:** Always use a safety cage or cable restraints when re-inflating a repaired tire. (43)

Air Reservoir Tank

Drain tank (if so equipped) daily. In cold weather, it is especially important that the air tank(s) be thoroughly drained at least once per shift. Be sure drain is closed before starting engine.



43
RIGHT

Tire repair is for qualified personnel only.

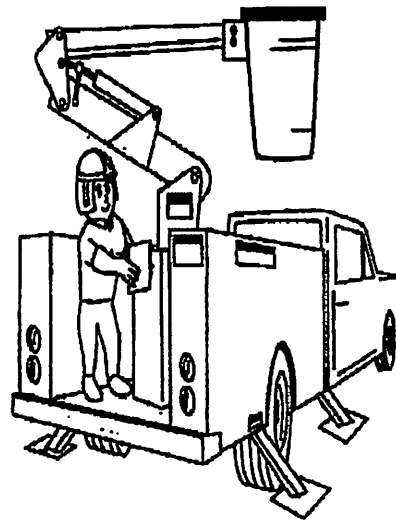
Perform maintenance safely

Complete Service And Repairs Before Machine Is Operated

Tighten all bolts, fittings, and connections to torques specified by the manufacturer. Install all guards, covers, and shields after servicing. Replace or repair any damaged ones. Refill and recharge pressure systems only with manufacturer approved or recommended fluids.

Start the engine and check for leaks. (See hydraulic fluid warning, page 40.) Operate all controls to make sure machine is functioning properly. Cycle the boom and swing controls several times to be sure cylinders are fully charged with oil. Road test machine if necessary. After testing, shut down, check the work you performed (any missing cotter pins, washers, locknuts, etc.). Recheck all fluid levels before releasing machine for operation.

Inspect all parts during repair and replace if cracked or damaged. Excessively worn or damaged parts can fail and cause injury or death. Replace any damaged or illegible decals. (44)



44
RIGHT

Wrong parts don't make a right machine.

Test your knowledge

Now that you have read this safety manual, do you understand . . .

- Your safety program?
- Your machine manufacturer's manual(s)?
- Proper clothing and personal safety equipment?
- Your machine's controls, warning signs, devices, and safety equipment?
- How to properly inspect, mount, and start your machine?
- How to check your machine for proper operation?
- Your work area and any special hazards that may exist?
- Proper operating procedures?
- Operating safety precautions?
- Under what conditions you should not operate your machine?
- Proper parking, shutdown, and dismounting procedures?
- Proper maintenance procedures?



A final word to the user

You have just finished reading the EMI Aerial Device Safety Manual. It is impossible for this manual to cover every hazardous situation you may encounter. But, your knowledge of these safety precautions and your adherence to the basic rules of safety will help build good judgment in all situations. Our objective is to help you develop good safety habits and make you a better and safer Aerial Device operator.

Remember: safety is your business AND your responsibility.



Equipment Manufacturers Institute
10 S. Riverside Plaza • Chicago, Illinois 60606-3710
www.emi.org

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2

MACHINE INSPECTION CHART

ITEM	DESCRIPTION	SERVICE	DAILY	WEEKLY	3 MOS	6 MOS	1 YR
1	HYDRAULIC FLUID	CHECK LEVEL	X				
		DRAIN FLUID AND REPLACE WITH MOBIL DTE 11 OR ATF (WHERE APPLICABLE)					X
2	ENGINE OIL	CHECK LEVEL	X				
		CHANGE OIL (SEE ENGINE MANUAL)					
3	LOAD HOOK	INSPECT HOOK & LATCH	X				
4	WINCH LINE	INSPECT FOR WEAR AND BROKEN STRANDS	X				
5	WINCH DRUM	CABLE IS WOUND EVENLY ON DRUM	X				
6	AUGER STRAP	INSPECT FOR WEAR AND BROKEN STRANDS	X				
7	ALL PIN RETAINERS	MAKE SURE PIN RETAINERS ARE IN PLACE AND TIGHTLY BOLTED	X				
8	TIE DOWN HOOKS	MAKE SURE BOLTS ARE TIGHT	X				
9	ALL WHEEL LUG NUTS	MAKE SURE BOLTS ARE TIGHT	X				
10	ROTATION BEARING BOLTS	MAKE SURE BOLTS ARE TIGHT TORQUE TO 159 FT.LB.			X		
11	LIFT CYLINDER GREASE FITTING	GREASE WITH MOBIL HP GREASE			X		
12	ROTATION BOX GREASE FITTING	GREASE WITH MOBIL HP GREASE			X		
13	ROTATION GEAR TEETH	GREASE WITH MOBIL HP GREASE			X		
14	NYLON SHEAVES	CHECK FOR SHARP EDGES, CUTS		X			
15	WEAR PADS	CHECK FOR WORN, LOOSE, OR MISSING PADS		X			
16	FIBERGLASS EXTENSION BOOM	CHECK FOR CRACKS, CHIPS, DIRT BUILDUP. DO NOT GREASE OR LUBE FIBERGLASS BOOM. CLEAN WITH SOLVENT.		X			
17	WINCH GEARBOX	REPLACE LUBE WITH EPSAE 90				X	
18	AUGER GEARBOX	REPLACE LUBE WITH EPSAE 90				X	
19	HYDRAULIC RETURN FILTER	REPLACE				X	
20	OUTRIGGER PIN GREASE FITTINGS	GREASE ADEQUATELY (4 PLCS.)		X			
	HYDRAULIC HOSES/FITTINGS	CHECK FOR LEAKS/ CRACKS. REPAIR LEAKS IMMEDIATELY.	X				

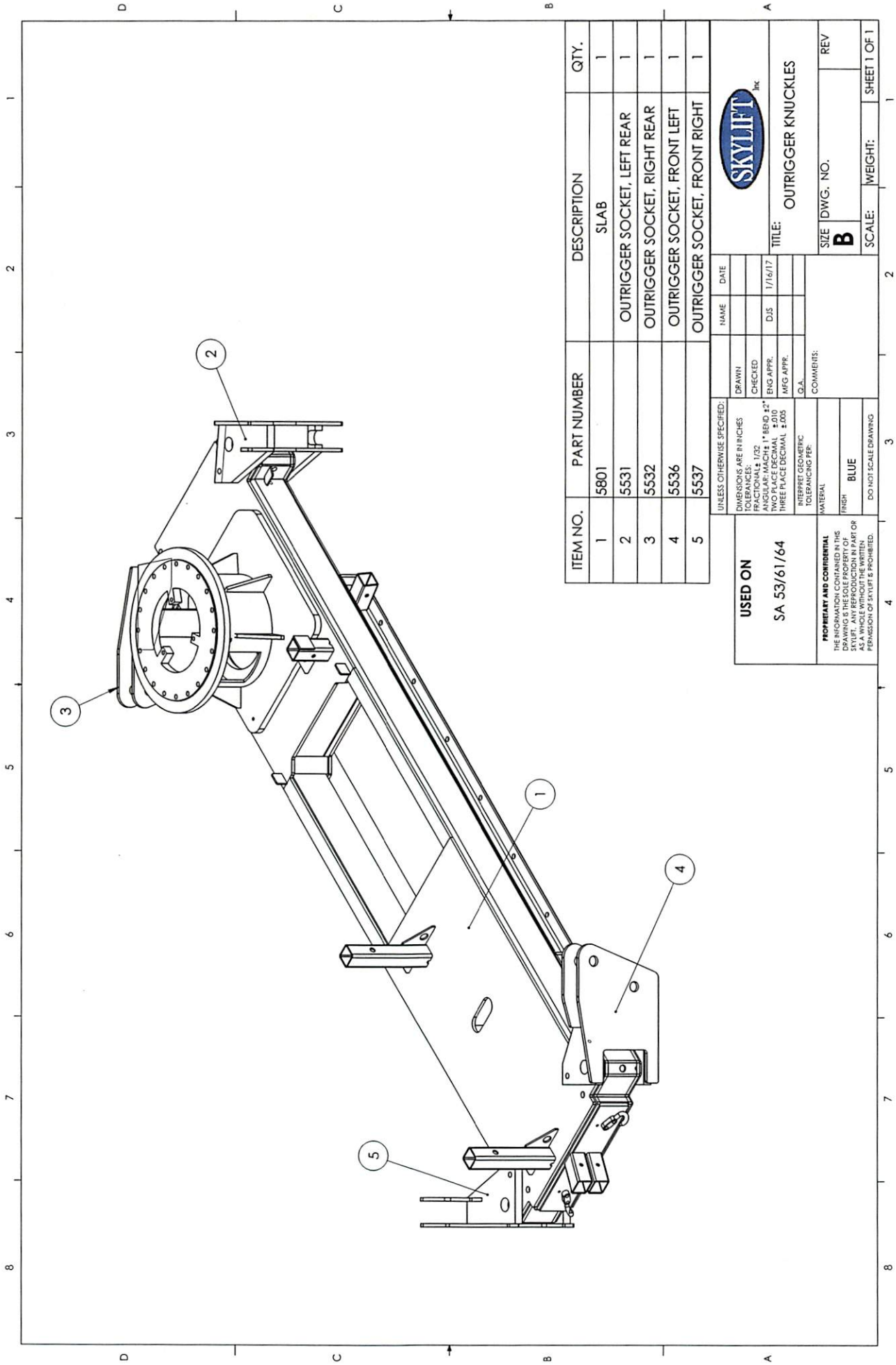
TRAILER INSPECTION CHECK LIST

There are a number of simple rules to follow in caring for your trailer axle assembly that can add to its life – and in the case of some of these rules, you may be protecting your own life as well. Using the following checklist before starting a trip with your trailer is highly recommended. Some of these items should be checked 2-3 weeks prior to planned trip to allow sufficient time to perform maintenance.

1. Check your maintenance schedule and be sure you are up-to-date.
2. Check hitch. Is it showing wear? Is it properly lubricated?
3. Fasten safety chains and breakaway switch actuating chain securely. Make certain the breakaway battery is fully charged.
4. Inspect towing hookup for secure attachment.
5. Load your trailer so that approximately 10% of the trailers total weight is on the hitch. For light trailers this should be increased to 15%.
6. *Do Not Overload.* Stay within your gross vehicle rated capacity. (Consult your trailer identification plate.)
7. Inflate tires according to manufacturer's specifications; inspect tires for cuts, excessive wear, etc.
8. Check wheel mounting nuts/bolts with a torque wrench. Torque, in proper sequence, to the levels specified in the trailer owner's manual.
9. Make certain brakes are synchronized and functioning properly.
10. Check tightness of hanger bolt, shackle bolt, and U-bolts nuts per torque values specified in trailer owner's manual.
11. Check operation of all lights.
12. Check that your trailer is towing in a level position and adjust hitch height if required.

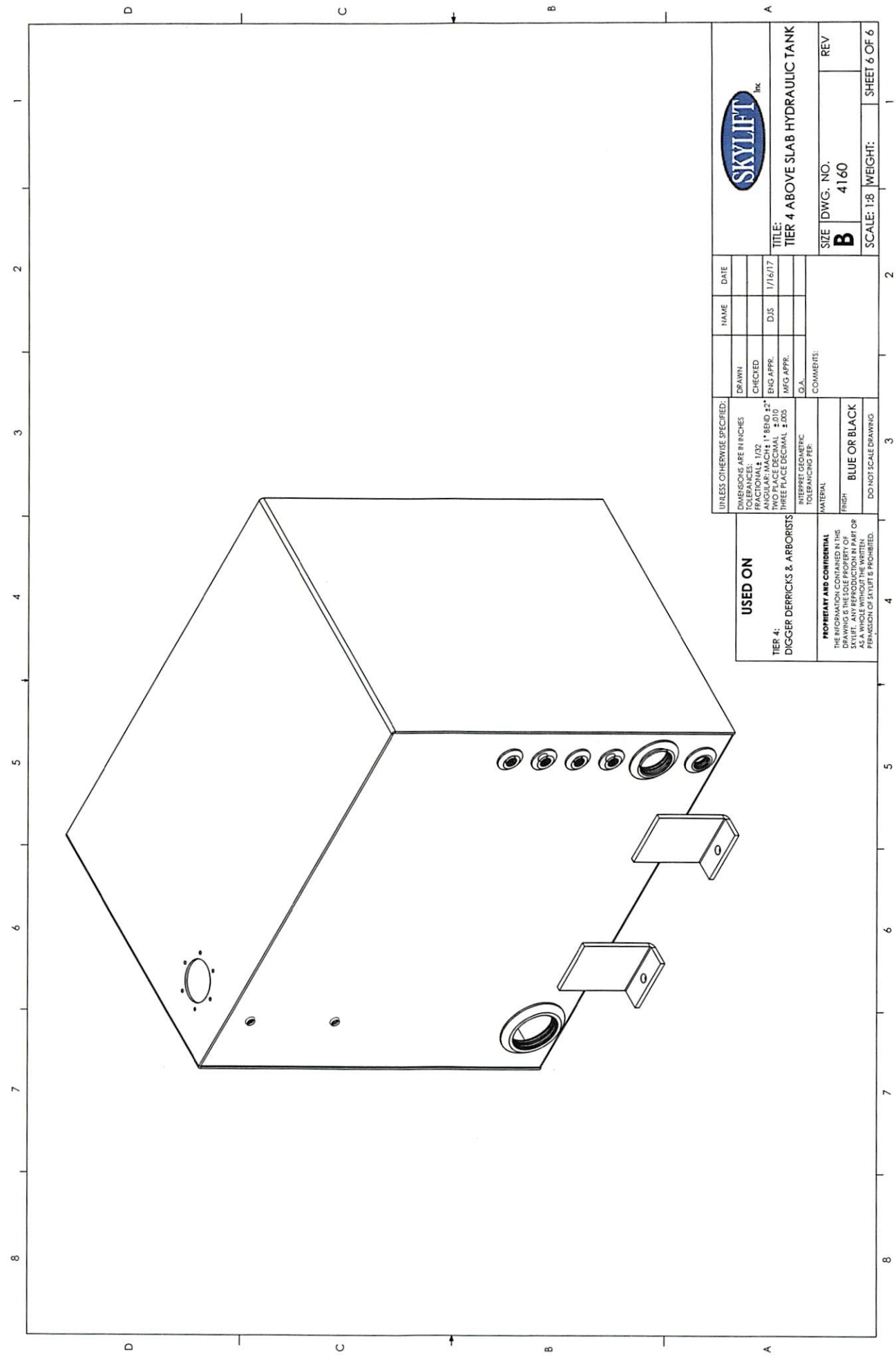
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3



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	5801	SLAB	1
2	5531	OUTRIGGER SOCKET, LEFT REAR	1
3	5532	OUTRIGGER SOCKET, RIGHT REAR	1
4	5536	OUTRIGGER SOCKET, FRONT LEFT	1
5	5537	OUTRIGGER SOCKET, FRONT RIGHT	1

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SA 53/61/64		DRAWN	DATE
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		ENG APPR.	DJS 1/16/17
		MFG APPR.	
		G.A.	
SKYLIFT Inc. TITLE: OUTRIGGER KNUCKLES		COMMENTS: MATERIAL: FINISH: BLUE DO NOT SCALE DRAWING	
SIZE DWG. NO. B SCALE: WEIGHT: SHEET 1 OF 1		REV	



TITLE:
TIER 4 ABOVE SLAB HYDRAULIC TANK

SIZE DWG. NO. **B** 4160 REV

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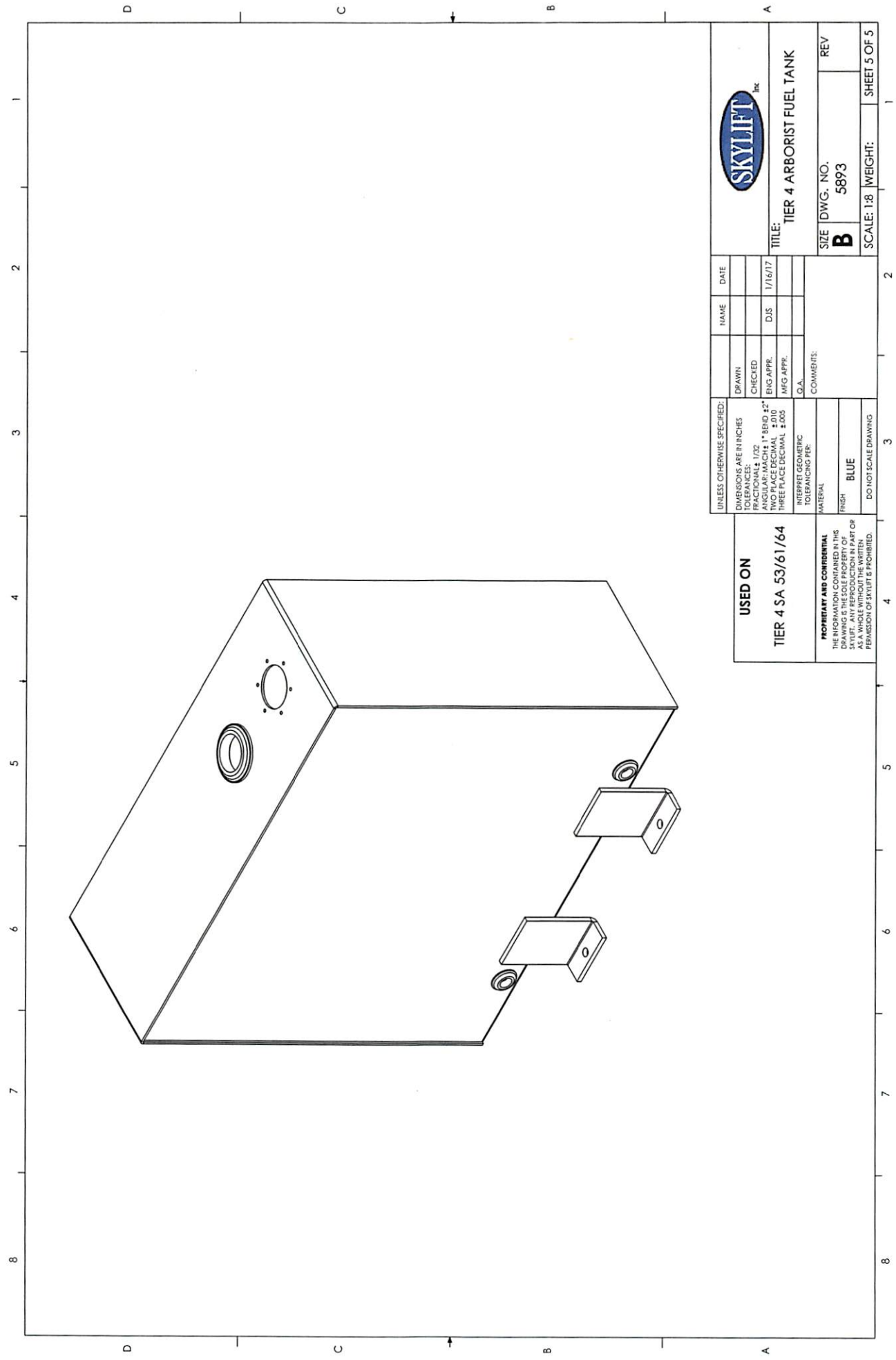
NAME	DATE
DJS	1/16/17

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TOLERANCES:
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DECIMAL: ±.005
THREE PLACE DECIMAL: ±.010
MFG APPR. G.A.
INTERPRETING TOLERANCES PER:

USED ON
TIER 4:
DIGGER DERRICKS & ARBORISTS

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		TWO PLACE DECIMAL ±.010		DATE		
		THREE PLACE DECIMAL ±.005		COMMENTS:		
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		MATERIAL		SCALE: 1:8 WEIGHT: SHEET 5 OF 5		
		FINISH		REV		
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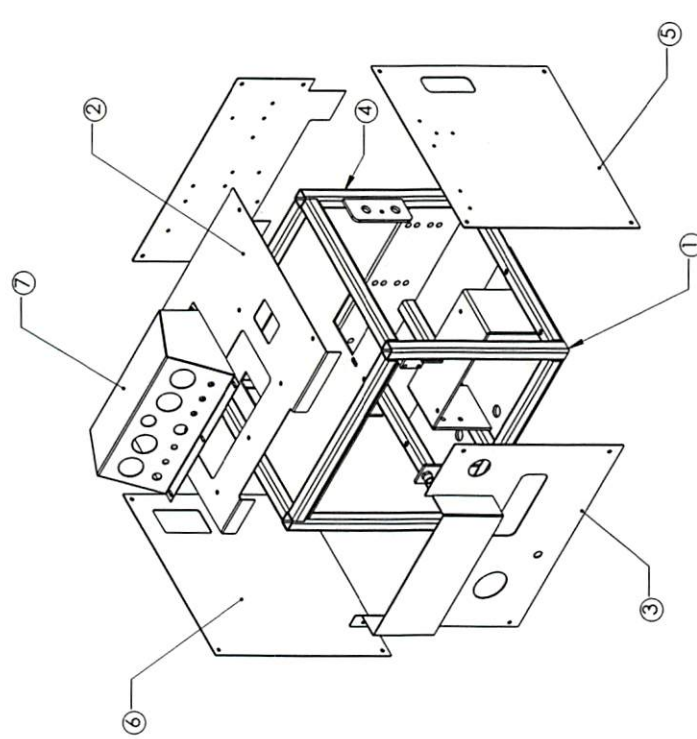
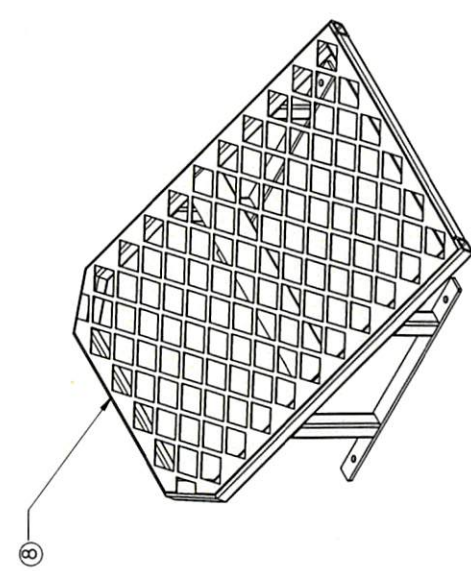
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SIZE DWG. NO. **B** 5893

SCALE: 1:8 WEIGHT: SHEET 5 OF 5

1 2 3 4 5 6 7 8

D C B A



ITEM NO.	PART NUMBER	DESCRIPTION	QTY
1	MD	VALVE FRAME ASSY W/ INTERNAL PARTS	
2	3109	TOP COVER VALVE FRAME SA61	
3	3118	FRONT COVER VALVE FRAME SA61	
4	3132	BACK COVER VALVE FRAME SA61	
5	3121	RIGHT COVER VALVE FRAME SA61	
6	3121	LEFT COVER VALVE FRAME SA61	
7	3125	GUARD/IGNITION BOX ASSY	
8	4561	VALVE FRAME GUARD	

USED ON			
APPLICATION	USED ON	DO NOT SCALE DRAWING	
NEXT ASY			

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TOLERANCES:		DRAWN	
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DECIMALS ± 0.005		ENG APPR.	
THREE PLACE DECIMAL ± 0.010		MFG APPR.	
D.A.		COMMENTS:	
INTERFEROMETRIC			
TOLERANCES FOR:			
MATERIAL			
FINISH			

TITLE:		SA61 VALVE FRAME ASSEMBLY AND GUARD	
SIZE	DWG. NO.	REV	
B	3117 SA61		
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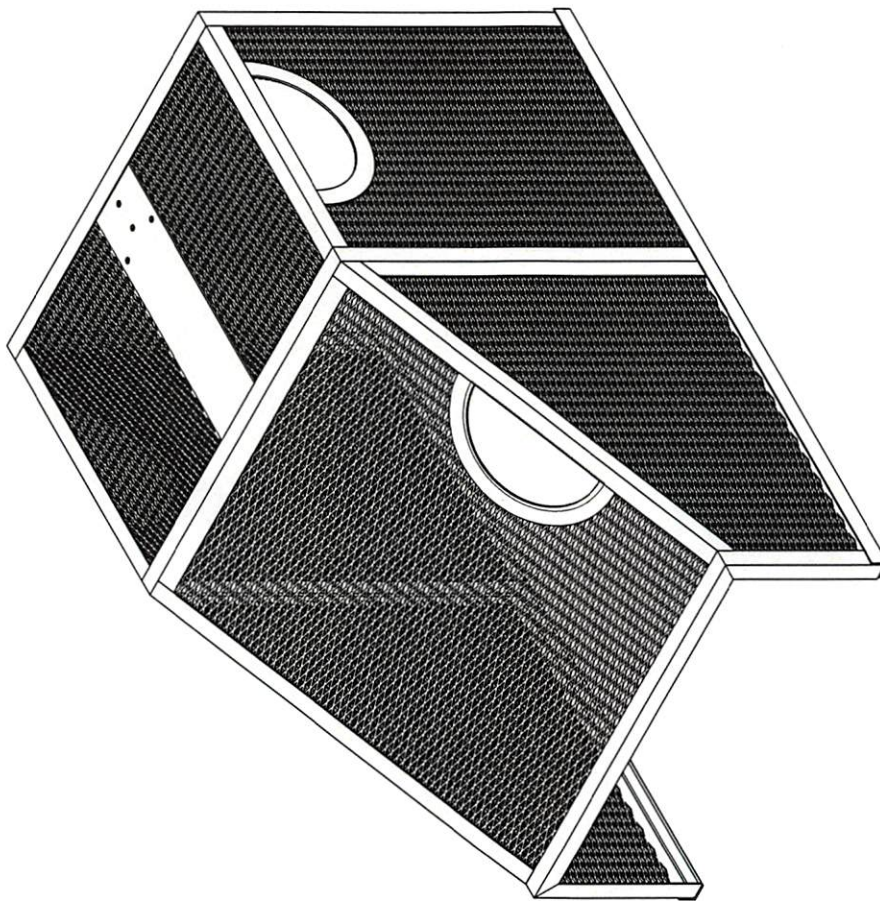



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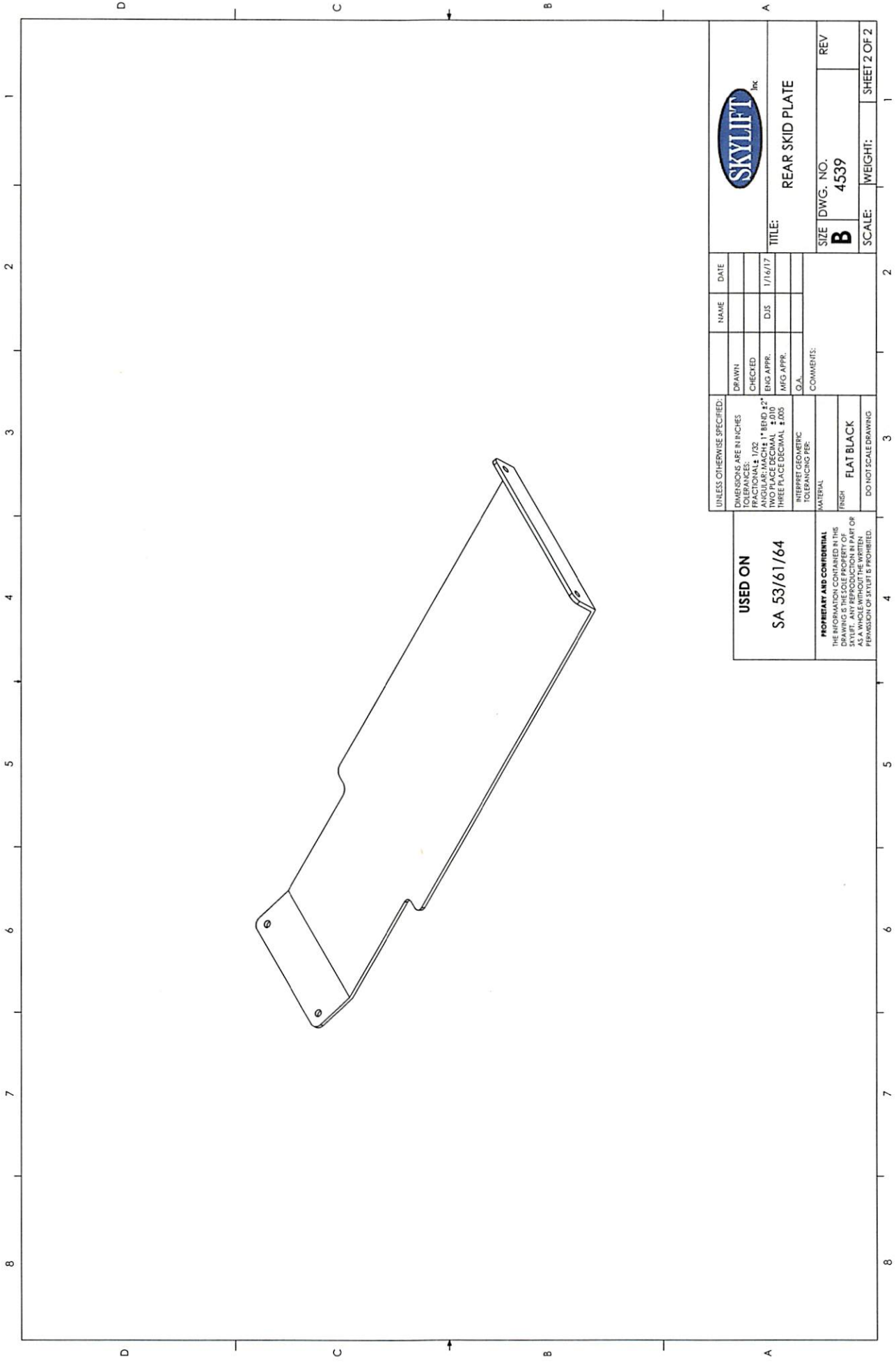
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D C B A

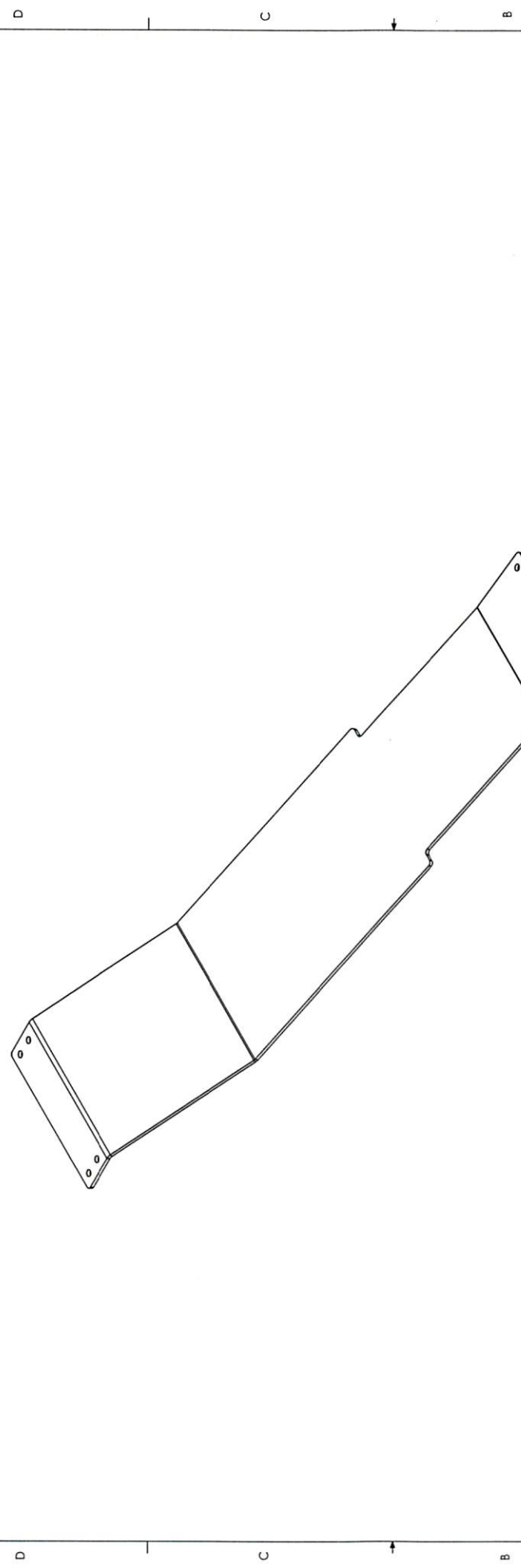



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	THREE PLACE DECIMAL ±.005		SIZE DWG. NO. B 4539	
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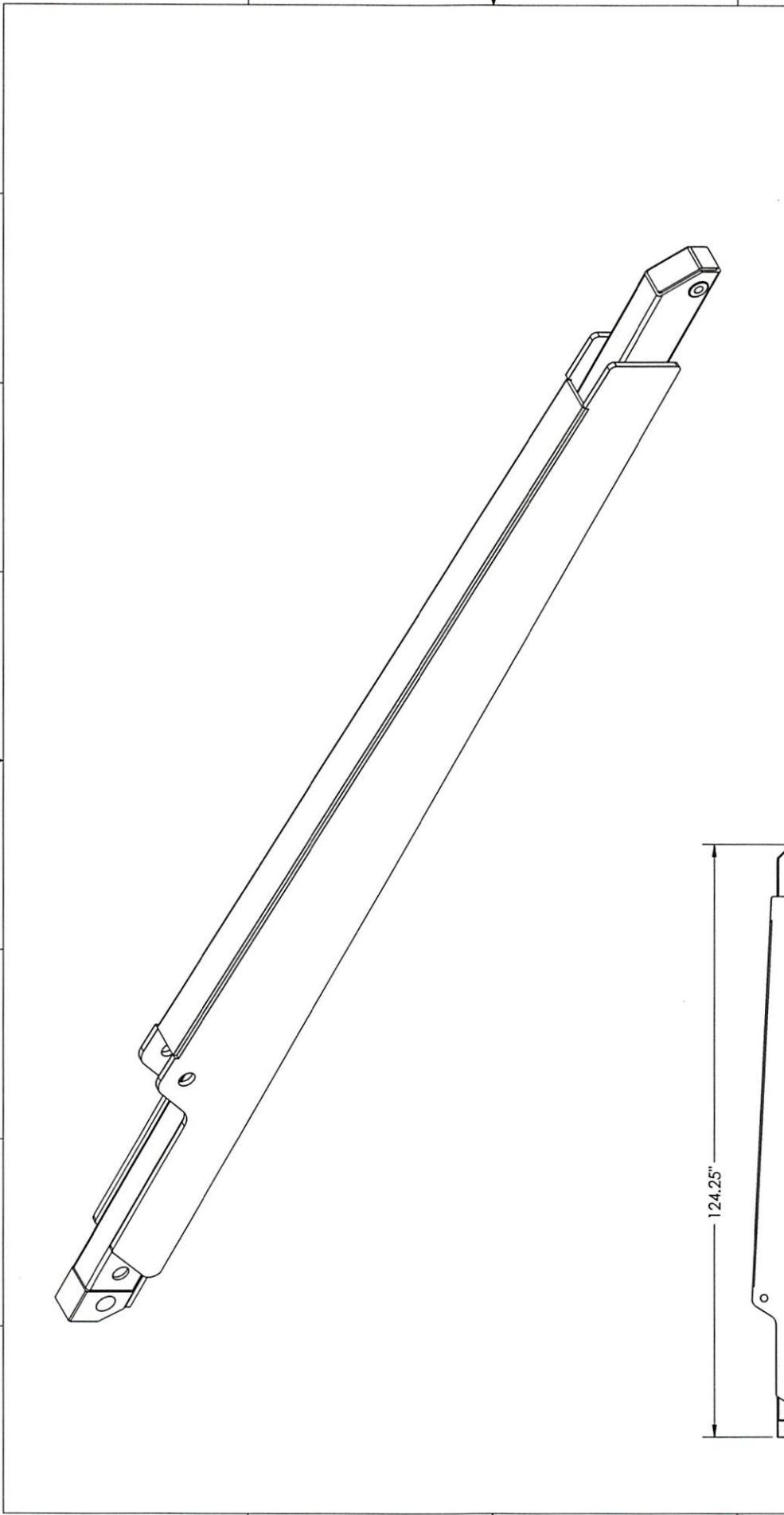
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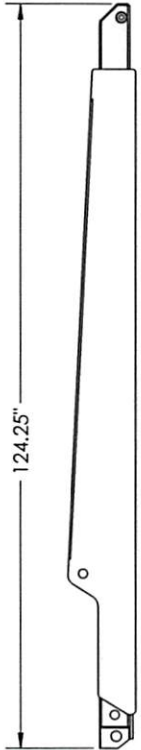
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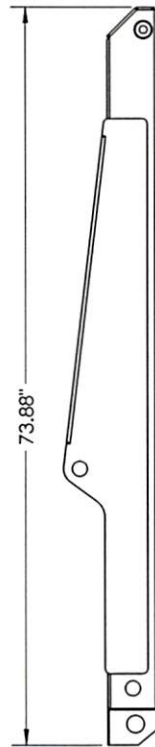
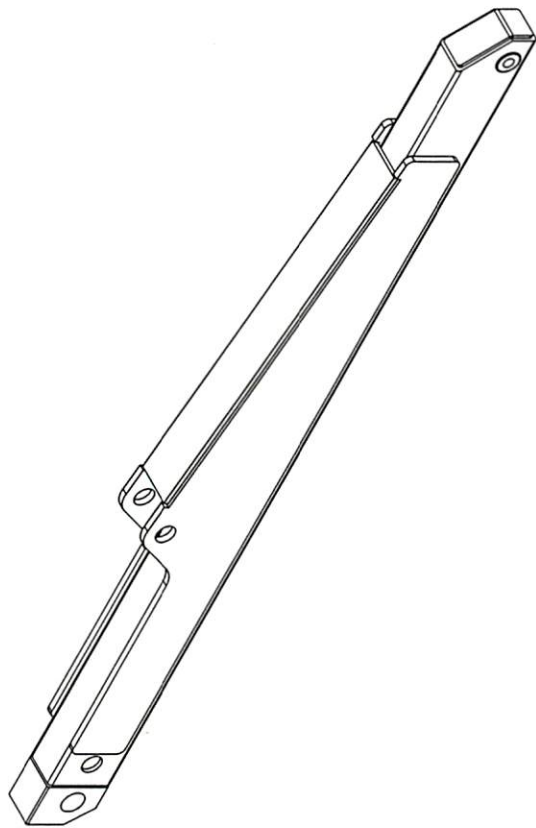
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		SIZE DWG. NO. B 5811		REV SCALE: WEIGHT: SHEET 2 OF 2	




DIMENSION IS FOR REFERENCE PURPOSES ONLY

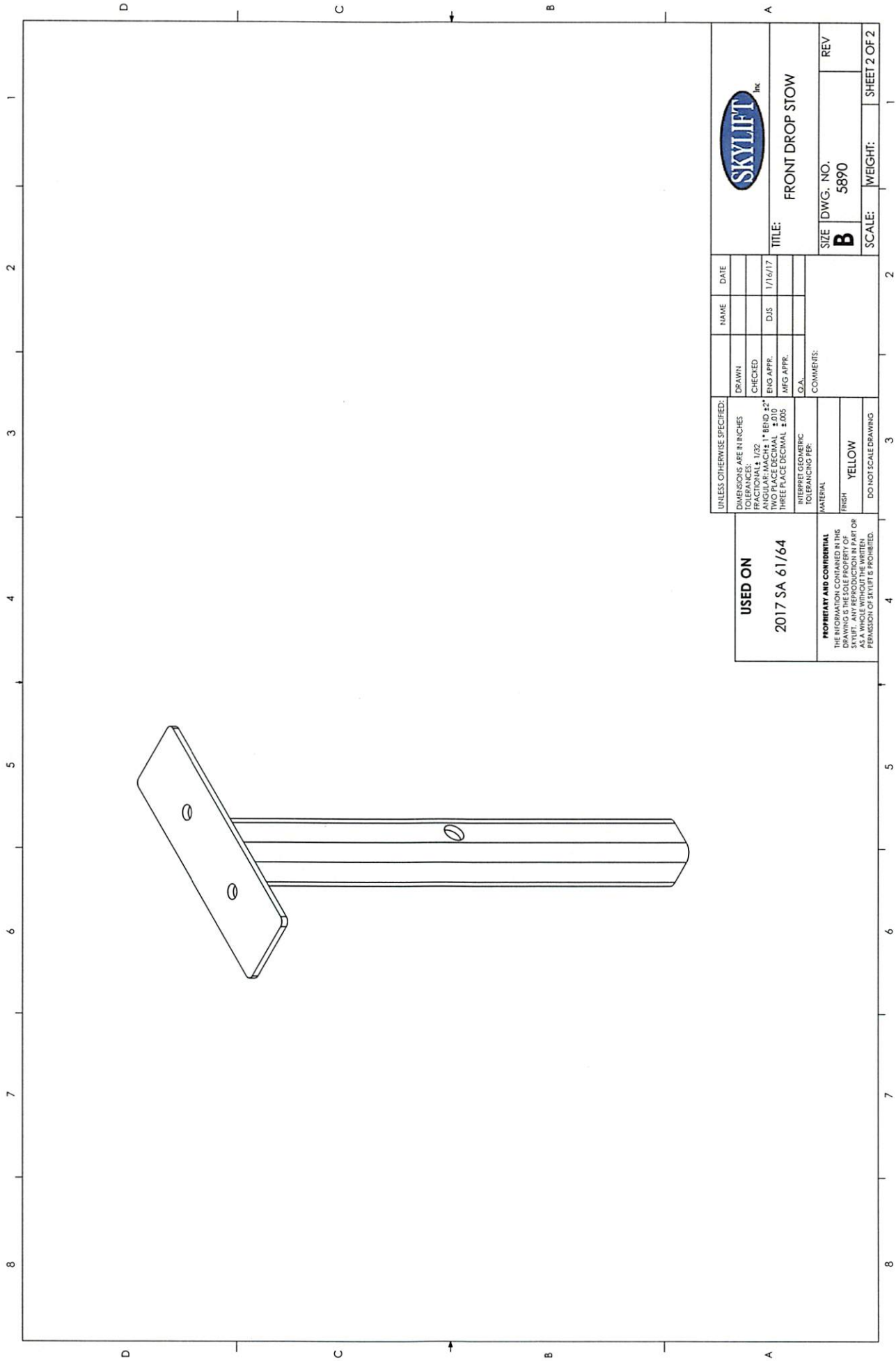
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DIMENSION IS FOR REFERENCE PURPOSES ONLY

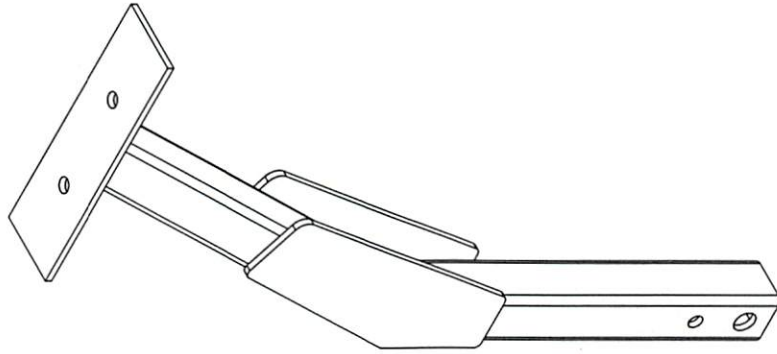
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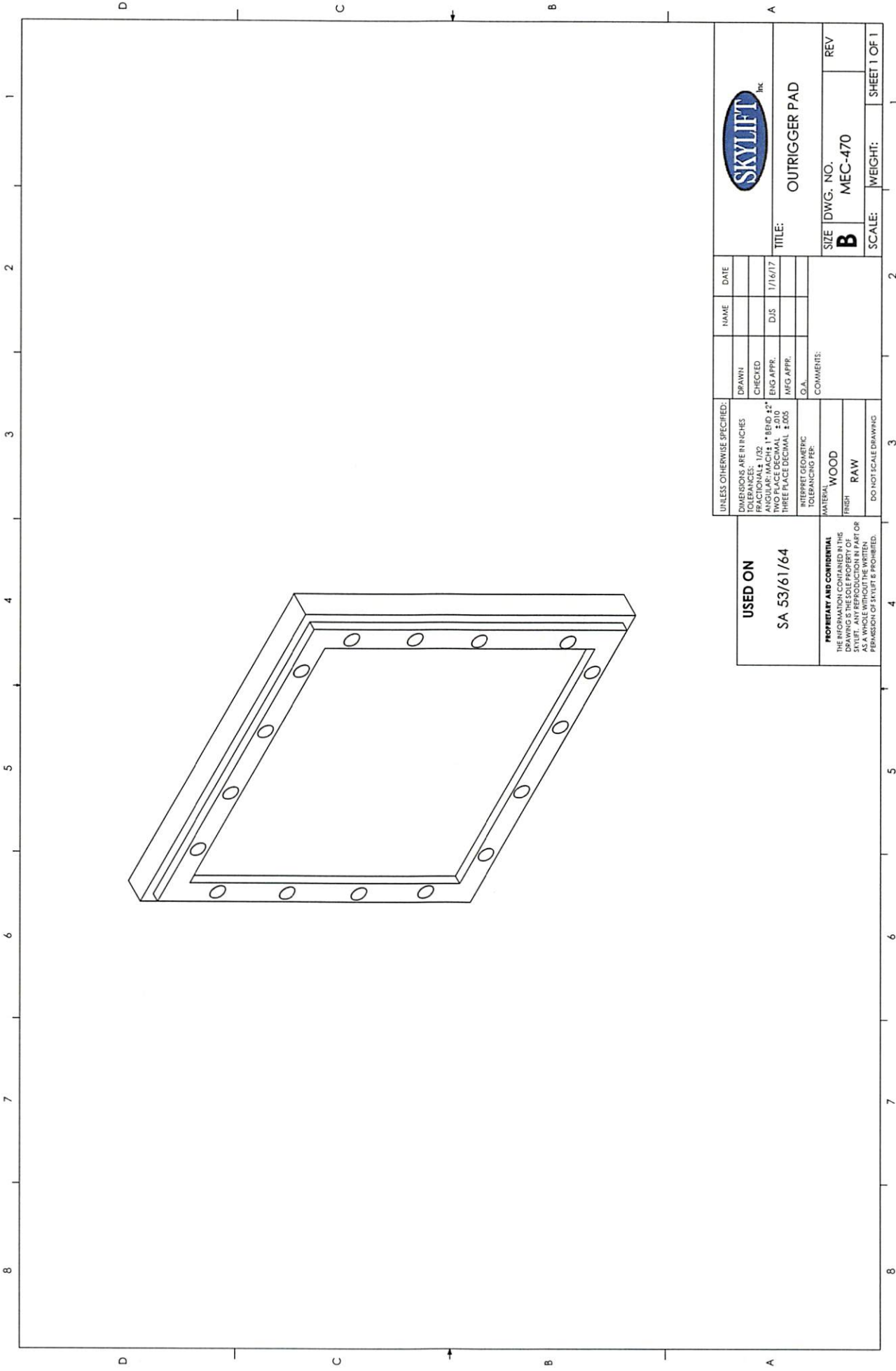
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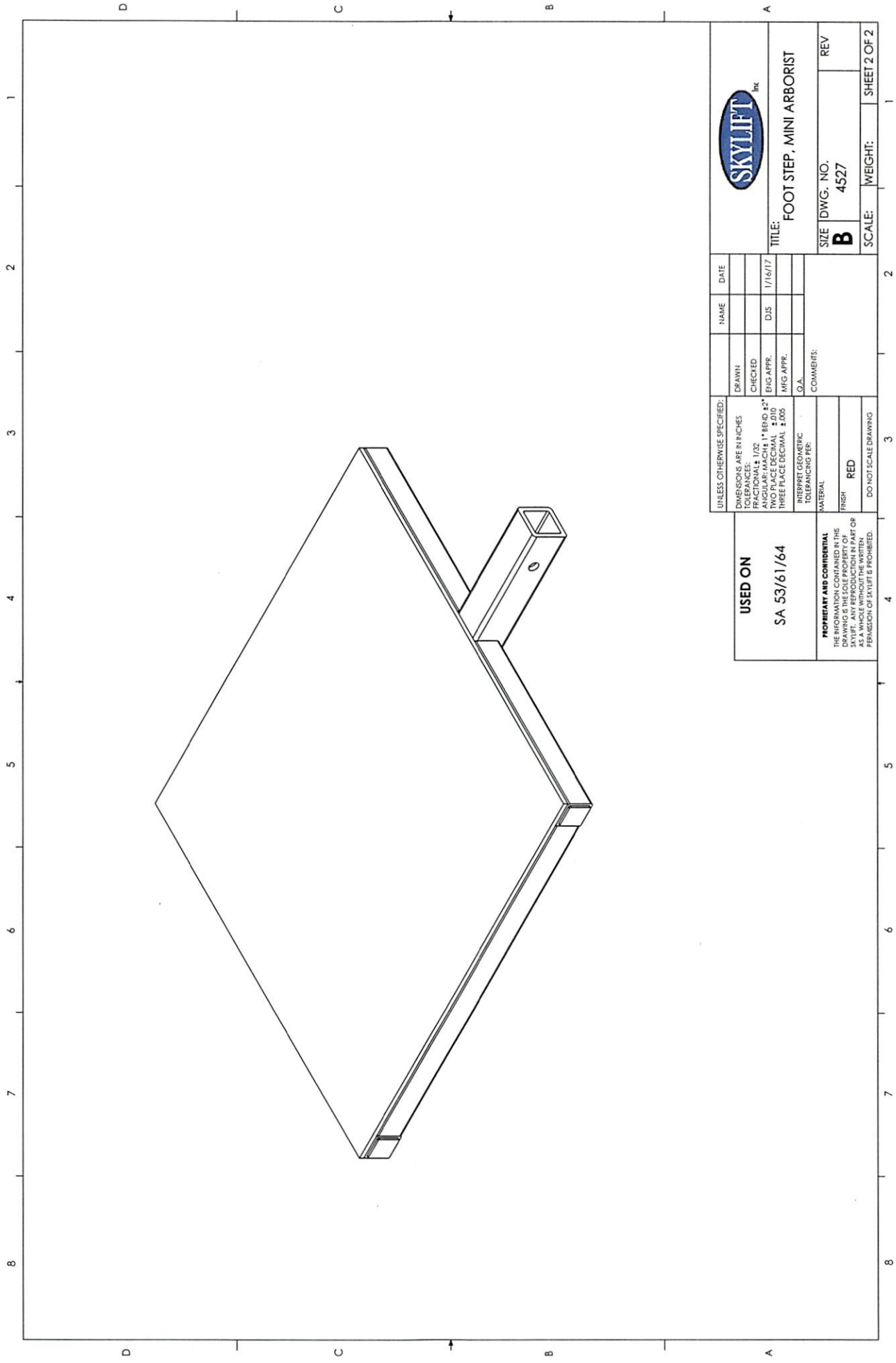
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TITLE: PIVOT STOW



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TITLE: FOOT STEP, MINI ARBORIST

SIZE DWG. NO. B 4527

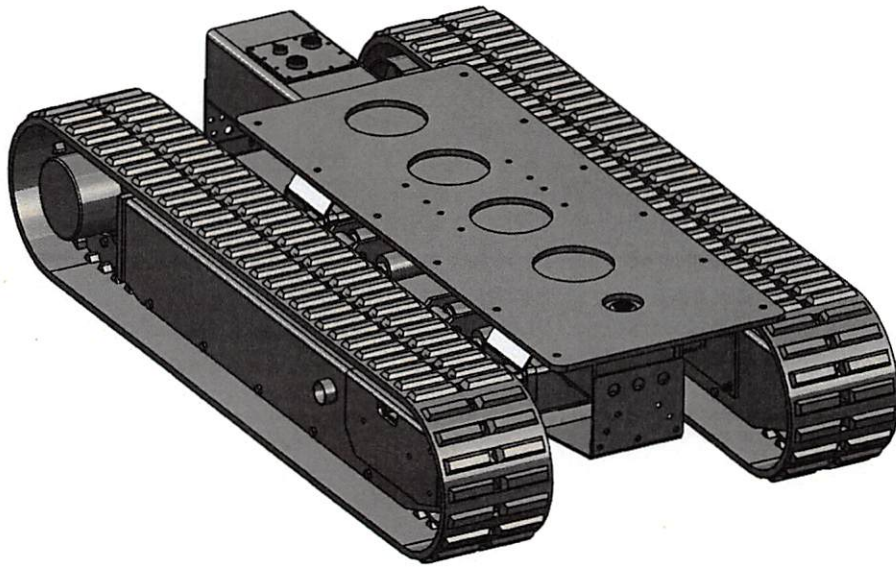
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90" TRACK UNDERCARRIAGE MANUAL



Skylift, Inc.
3000 Leavitt Road Unit 6
Lorain, Ohio 44052
Office: 440-960-2100
Fax: 440-960-2104
www.skyliftus.com

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SAFETY PRECAUTIONS

A brief definition of signal words that may be used in this manual:

! DANGER Indicates an imminently hazardous situation that, if not avoided, will result in serious injury or death.

! WARNING Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and includes hazards that are exposed when guards are removed.

! CAUTION Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.

! WARNING Do not operate, service, inspect or otherwise handle this equipment unless you have read the Owner's Manual supplied with your track-mounted machine and have been properly trained in its intended usage.

IMPORTANT: Should you find a discrepancy between the track-mounted owner's manual and this document, rely on the information supplied by the manufacturer of the machine or consult the factory.

EVERY TRACK UNIT HAS INHERENT DANGERS ASSOCIATED WITH IT.

FOR YOUR SAFETY:

- Keep all guards and shields in place. Moving parts can crush and dismember.
- Check that all connections and bolts are tight before operating.
- Check all hoses and fittings before start-up and periodically during operation.
- Clear the area before equipment startup.
- Do not allow bystanders near the operating unit.
- Keep hands, feet, and loose clothing away from operating track unit. Exposed, moving parts can crush or dismember.
- Use caution when traveling over uneven terrain and when approaching stops.

THERE ARE ADDITIONAL HAZARDS ASSOCIATED WITH THE SERVICE AND MAINTENANCE OF A TRACK UNIT.

FOR YOUR SAFETY:

- Always wear eye protection when operating or servicing the unit.
- Do not depend on hydraulic pressure applied to blades or backhoe to elevate machine for track unit service. Always service track units and undercarriage from outside or from above the unit rather than from underneath.
- Escaping hydraulic fluid under pressure can penetrate the skin and cause serious injury. Relieve all pressure from the hydraulic system before connecting or disconnecting the lines or making repairs.
- Never make any alterations or modifications to this equipment.

! WARNING NEVER ATTEMPT TO CLEAN, OIL, OR ADJUST A MACHINE THAT IS IN MOTION!

TECHNICAL INFORMATION

TRACK MAINTENANCE

Due to functional necessity the components of the undercarriage are open to soil, sand, rock, water, chemicals and the elements. Regular maintenance of the undercarriage is inevitable throughout the course of normal machine use.

PRECAUTIONS/HANDLING RECOMMENDATIONS

Installation and Repair

Only trained personnel should perform the mounting of rubber tracks. Incorrect assembly may result in premature failure and/or damage to the machine.

Tension of Rubber Tracks

Improper tension may result in track alignment problems which could ultimately lead to de-tracking or premature failure. Tension should be inspected regularly and adjusted if necessary. See maintenance section.

! WARNING Loose tracks can allow excessive machine motion resulting in decreased stability during operation.

Unfavorable Terrain Conditions

Rubber tracks should not be used in certain terrains because damage can occur to the lug sides of the tracks. Some common and unfavorable terrain conditions are hard surface roads, rocky fields, stump fields, large ruts or holes, scrap rebar, troughs, crowned ridges, and along walls or border stones. Inspect the work site before beginning operation and remove any of these items when possible.

If use of the rubber tracks under any of these terrain conditions is unavoidable certain precautions can help reduce the potential for de-tracking. Drive slowly and carefully, feathering the drive controls to even out the machine speed. Avoid making sharp turns which can cause the rubber track to curl and de-track.

If rubber tracks are run up against mounds, rocks or concrete walls, a crack may occur at the edges of the rubber tracks. Avoid these circumstances whenever possible.

High abrasion soils like coarse sand and clay will unavoidably reduce track life. High moisture soil will increase the likelihood of mud packing inside the track

drive and support rollers. Mud buildup on rollers increases track tension; therefore, very regular cleanup is required under this condition.

Operating Tips

Ideal operation is to keep both tracks equally loaded and both tracks fully and evenly supported by the ground. Since this is not always practical, manage the deviations wisely to conform as closely as possible to ideal conditions.

Following are some tips to deal with common deviations, as well as deviations that must be avoided.

Tight turns put torsional loads on the undercarriage. If unavoidable, alternate between left and right turns to equalize wear.

Avoid counter rotation maneuvers. This creates a very high stress on the tracks and undercarriage.

Do not make sharp turns on slopes. Always stop before carefully beginning any turns.

Avoid making quick turns on concrete roads. The high friction between the track and surface may result in de-tracking or abrasion.

Equalize track wear by making the same amount of right and left turns, the same front to rear wear loading, etc.

Carry only light loads on slopes when required.

If the machine operation is dozing or similar, alternate the work cycle in both directions to equalize the wear and terrain conditions.

Do not apply down pressure to implements that cause loss of traction and track spinning, such as when using a blade to back drag. To back drag, use the "float" mode.

Troughed and crowned surfaces place the load on the edges of the tracks. Avoid these surfaces when possible.

When going from flat to sloped terrain, go up and down the slope, not along the slope, thereby equalizing the load on each track.

When necessary to operate on slopes and only when safe, alternate directions so equal up slope and down slope time is put on each track.

Avoid non-productive travel. Transport track machines by truck or trailer to the job site to prolong track life. Always work in both directions, do not back up to work only in one direction.

Travel in reverse only when required. Less stress is applied to the track in forward and lug patterns are designed for forward travel.

Drive slowly and carefully to avoid unfavorable terrain and obstacles that could damage the track. It is recommended to make multiple large radius turns instead of making single, sharp turns. Make “Y” turns to change direction. Avoid slipping and spinning the tracks.

Drive carefully on rough terrain and gravel surfaces. Do not drive over sharp rocks or other obstructions that can puncture the track or concentrate forces on a small area of the track. Always strive to keep the full driving surface of the track in contact with the ground.

Drive to avoid turning into obstacles that could contact against the frame causing structural damage. Avoid tight turns that force dirt and debris between the track and track support rollers.

Do not allow obstructions to enter between the track and the track frame or roller support mechanism. Damage will result.

Never allow the edge of the track to ride up onto rocks, curbs, walls or other objects that bend the track edges. This will cause the track rubber to shear or crack along the ends of the steel inserts backbone of the track, allowing moisture and contaminants to infiltrate the track. Eventual chunking off of the rubber will occur and the steel cords will corrode leading to complete failure.

OPERATING ENVIRONMENTS

Temperature

The acceptable temperature range for problem free operation of standard rubber tracks is between -13°F[-25°C] and 131°F[+55°C]. If your application does not occur in this range, contact us for special rubber compounds.

Fuel & Oil Contamination

Fuel or hydraulic oil should not be allowed to come in contact with rubber tracks. If such occurs, it should be immediately wiped off or rubber deterioration may occur.

Salty Environment

Salty environments should be avoided because salt and salty air erode the adhesion of rubber to the core metals. After rubber tracks have been used in such conditions, the salt should be removed with high pressure water spray as soon as possible.

STORAGE

If rubber tracks are stored for long periods of time, they should be kept indoors to avoid exposure to direct sunlight and weather conditions to avoid deterioration.

Tracks should be stored on their side. Do not lay flat (as if it were on a machine) unless support has been provided to the inside of the track. This will prevent crimping in the track which could weaken the steel reinforcing cords and reduce track life.

Do not bend the track during storage or it may not track properly when installed.

MAINTENANCE

! WARNING Never attempt to clean, adjust or lubricate a track unit while it is in motion. Failure to heed may result in serious personal injury or death.

GENERAL

Proper tension of the rubber track is essential for maximum track and undercarriage life and will result in less down time. See ADJUSTMENTS.

Over tightening track can accelerate undercarriage bearing wear and overstress and stretch or crack the rubber track allowing contaminants to deteriorate the rubber compound and steel reinforcing components.

Loose tracks can derail during turning and can also reduce machine stability during operation. It is also possible for the drive sprocket to slip over the belt driving lugs causing wear to the rubber track and possible failure. Derailing causes track damage. Never repair with used or worn components (idler, sprocket, rollers).

! WARNING Loose tracks will allow excessive machine motion resulting in decreased stability during operation.

LUBRICATION

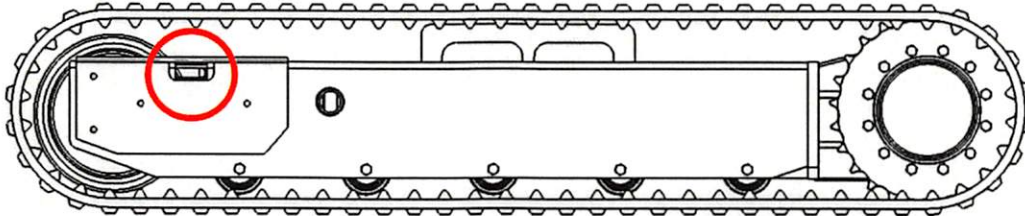
1. Different OEM brand hydraulic wheel motor drives are used on track unit assemblies, but the lubricating procedure is similar.
2. Park the unit so the fill plug is at the top. Some units will have a plug identified as "FILL". If the plug is not identified, the two opposite plugs are the same and either can be positioned at the top.
3. Check oil level at center check plug. Oil should seep out when plug is removed. Top off if required.
4. Lubrication Specifications: Consult the wheel motor manufacturer's instructions for the proper lubricant, quantity and operating temperature range.

ADJUSTMENTS

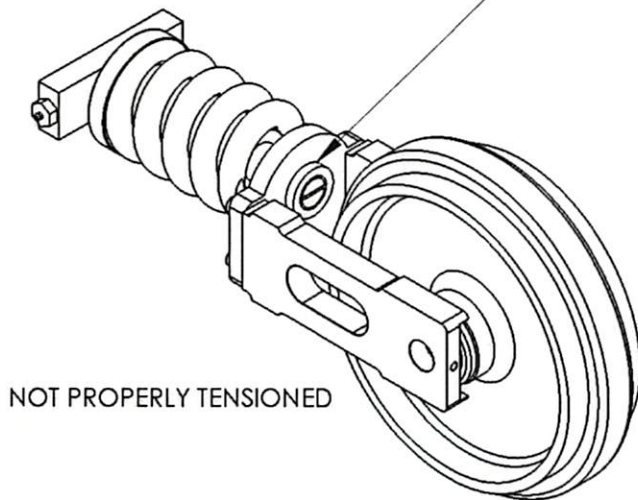
Inspect Tension

Check the tension at the tensioner viewport to ensure the engraved tensioner ring is in the correct position. The engraved tensioner ring should be flush with the tensioner mount plate. If the engraved tensioner ring is not in the correct location, you must adjust tension to prevent damage to the tracks.

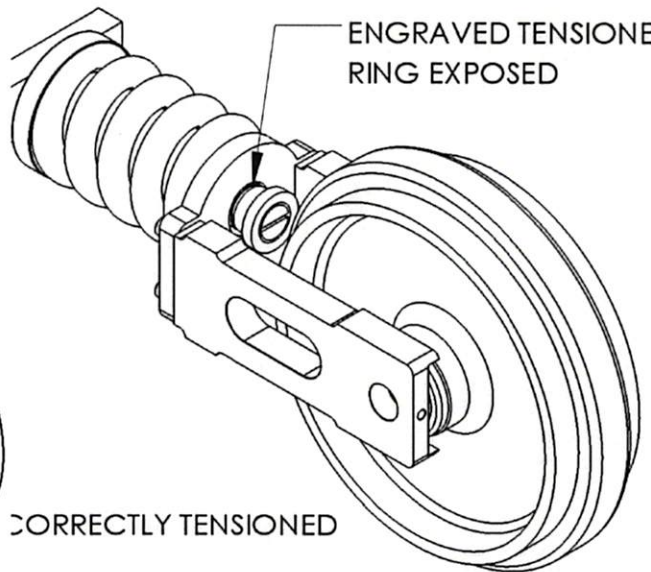
TENSIONER VIEWINGPORT



NO TENSION ON COMPRESSION SPRING
(ENGRAVED TENSIONER RING IS NOT EXPOSED)



ENGRAVED TENSIONER RING EXPOSED



Adjust Tension

1. Remove the protective plug that covers the grease relief valve.
2. Support track assembly so the track clears the ground.
3. Apply a standard grease gun to the grease valve fitting (zerk) and slowly pump grease to extend the track tensioner against the compression spring.
4. The grease valve has a check valve behind the zerk to prevent grease from coming back under pressure. If it is necessary to release track tension, turn the check valve CCW a few turns until the grease is allowed to expel. Retighten when complete.
5. Lower the track back onto the ground and replace the protective plug.

CLEANING

Keep driving system cleaned and properly maintained. Remove any debris or mud which could interfere with the operation of the machine.

If mud and debris is allowed in the undercarriage it can plug the spring-loaded tensioner preventing it from relieving stress on the track when traveling over irregular surfaces. Mud can build up on the track rollers thereby over-tensioning and stretching the track or the rollers can stop turning and then scrub on the track creating wear and failure.

Wash fuel and oil from the tracks.

REPAIR

In order to prevent bonding or corrosion failures, tracks should be repaired immediately when damaged.

Minor cracks in the rubber can be filled with rubber repair compound.

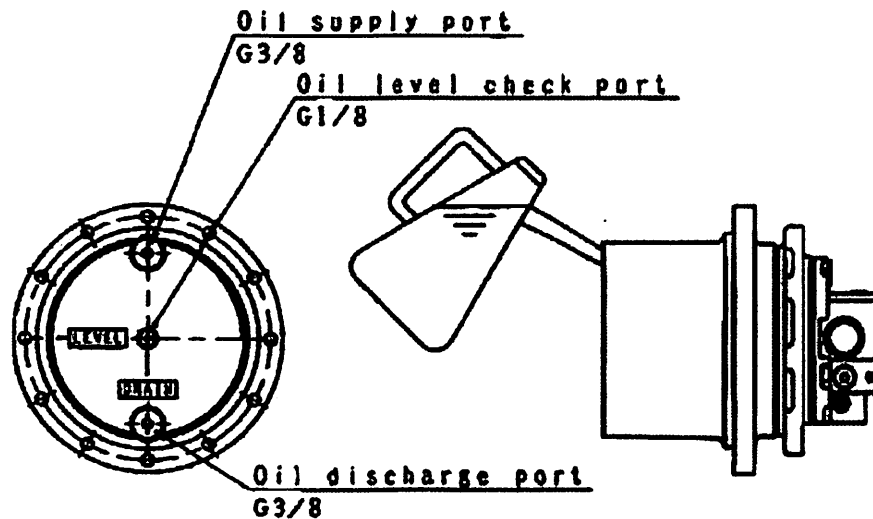
Once the steel cords have failed, the track is no longer serviceable.

Nachi PHV-4B Drive Motor:

Gear lubricating oil:

1. Use diesel engine oil SAE-30-CD or equivalent as gear lubricating oil. (When shipped, Idemitsu Apolol Diesel Molive S-330 is used.)
2. Any recommended gear oil can be used but first you must drain the old oil out completely. Do not mix.
3. When shipped, gear box is pre-filled. Take the follow steps to refill. All plugs are sealed by O-rings.
 - a. Remove the oil supply, discharge port plugs and the level check port plug.
 - b. Fill the oil from the oil supply port up to the "LEVEL." (about 1000cm^3).
 - c. Screw the oil supply, discharge port plugs and the level check port plug.
4. Gear oil amount: 1000cm^3
5. Gear oil change period
 - a. First change: 200 hours or 2 months
 - b. Second and after: 1000 hours or 1 year

	tightening torque
oil supply, discharge port plugs	46~51 N·m
level check port plug	12~18 N·m

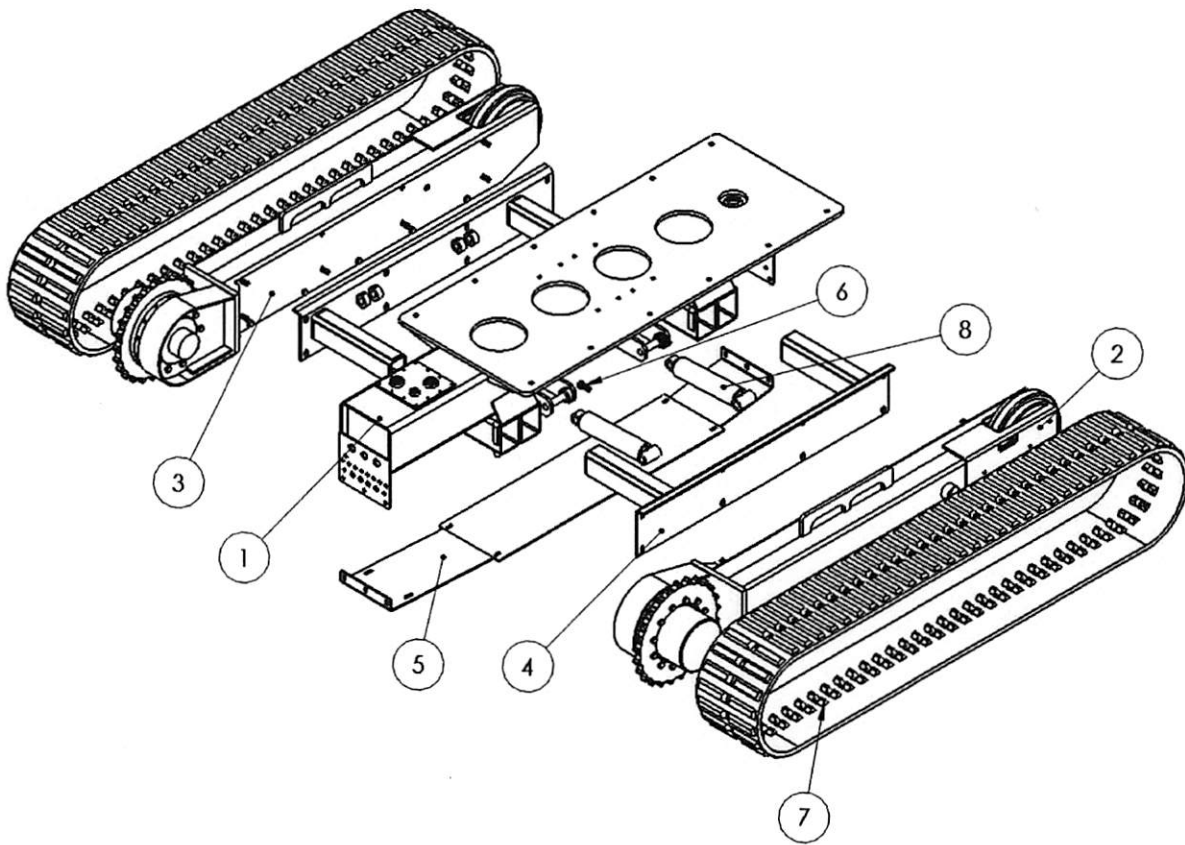


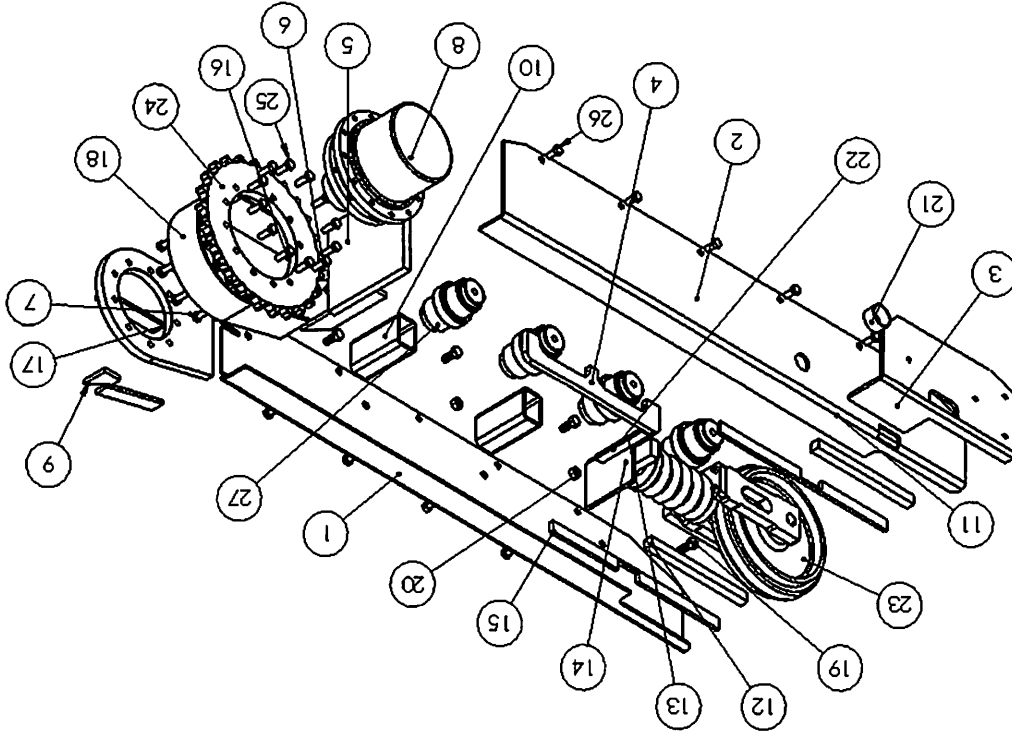
General Precautions:

1. Always pay attention to oil leaks and loose bolts. If leaks or loose bolts are detected, fix as soon as possible to avoid motor damage.

7790 - COMPLETE 90" TRACK ASSEMBLY

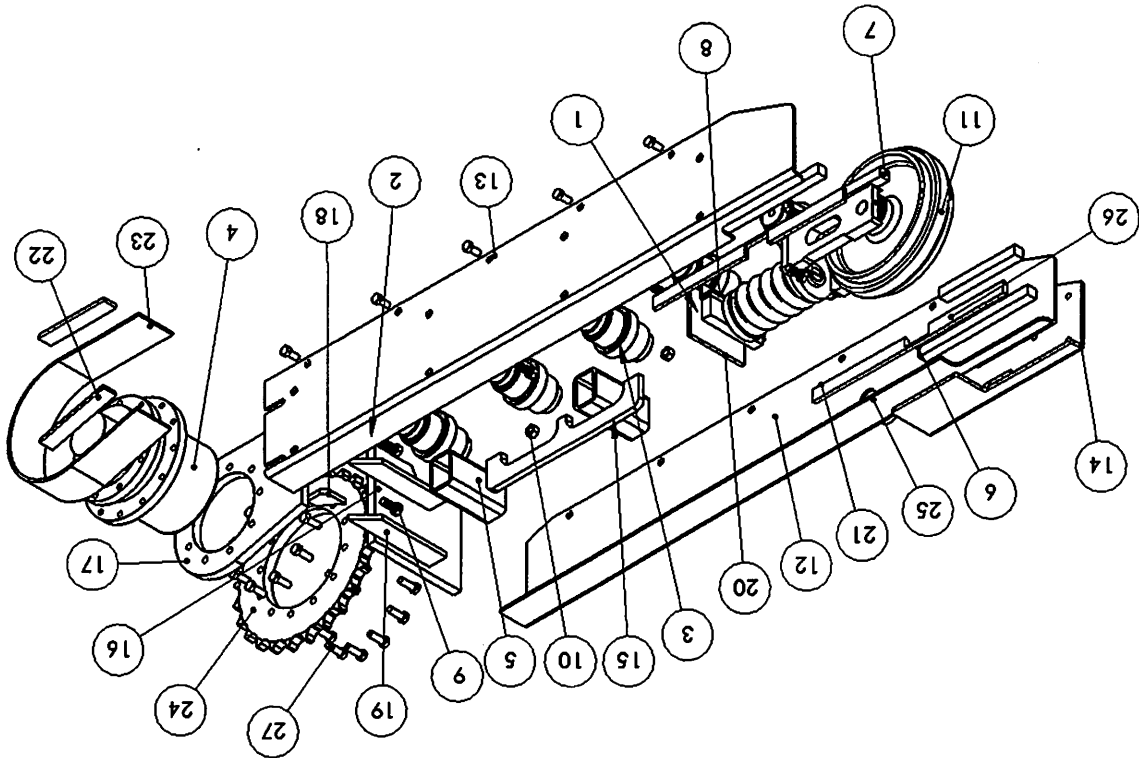
ITEM NO.	PART NUMBER	DESCRIPTION	Default / QTY.
1	7750	CENTER TRACK ASSEMBLY	1
2	7720	RIGHT TRACK ASSEMBLY	1
3	7700	LEFT TRACK ASSEMBLY	1
4	7725	EXTEND/RETRACT ASSEMBLY	2
5	7751	CENTER TRACK ASSEMBLY SKID PLATE	1
6	BOLT	5/8-11 UNC BOLT	4
7	7773	AGGRESSIVE RUBBER TRACK	2
8	7772	EXTENSION CYLINDER	4





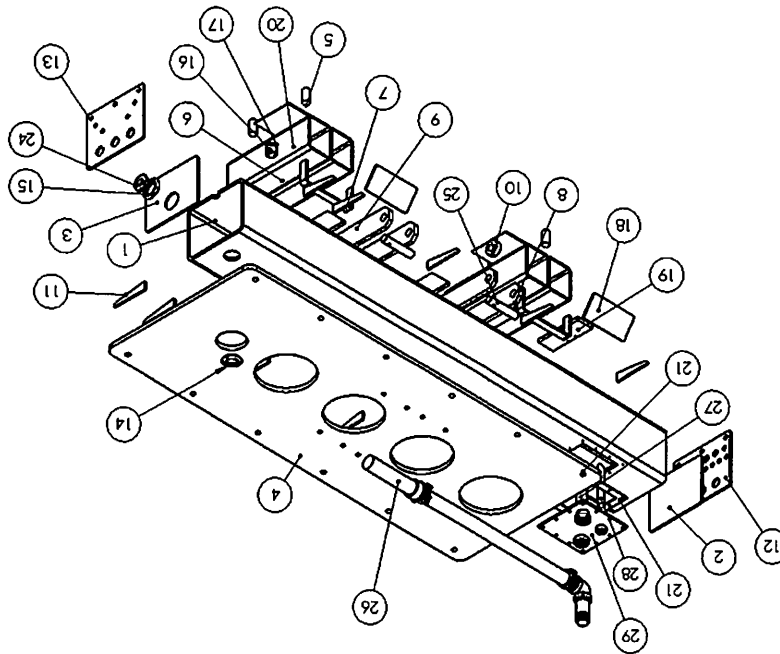
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	7701	LEFT PLATE	1
2	7702	OUTSIDE LEFT PLATE	1
3	7703	LEFT OUTER PLATE	1
4	7704	TRACK GUIDE	1
5	7705	GEAR MOUNT PLATE	1
6	7706	GUSSET (1)	2
7	7707	DRIVE MOTOR MOUNT PLATE	1
8	7774	DRIVE MOTOR	1
9	7708	GUSSET (2)	1
10	7721	2.5X3.5X6.75 SUPPORT TUBING	2
11	7722	1X1X9" TENSIONER GUIDE	2
12	7723	1X1X13" TENSIONER GUIDE	2
13	7724	TENSIONER SUPPORT L ANGLE	1
14	7709	TENSIONER SUPPORT PLATE	1
15	7710	TENSIONER SUPPORT RIB	2
16	7711	GUSSET (3)	2
17	7712	GUSSET (4)	2
18	7713	DRIVE MOTOR MOUNT HOUSING	1
19		5/8"-11 UNC BOLT	6
20		5/8"-11 UNC NUT	2
21	7715	GREASE RELIEF VALVE GUARD	1
22	7761	TENSIONER MOUNT PLATE GUSSET	1
23	7759	TRACK TENSIONER ASSEMBLY	1
24	7714	DRIVE SPROCKET	1
25		HEX M14X2.0X50 BOLT	1
26		HEX M14X2.0X30 BOLT	10
27	7778	IDLER BOGIE	5

7700-90" LEFT TRACK ASSEMBLY



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	7761	TENSIONER MOUNT PLATE GUSSET	1
2	7708	GUSSET (2)	1
3	7778	IDLER BOGIE	5
4	7774	DRIVE MOTOR	1
5	7721	2.5X3.5X6.75 SUPPORT TUBING	2
6	7723	1X1X13" TENSIONER GUIDE	2
7	7722	1X1X9" TENSIONER GUIDE	2
8	7724	TENSIONER SUPPORT L ANGLE	1
9		5/8"-11 UNC BOLT	6
10		5/8"-11 UNC NUT	2
11	7759	TRACK TENSIONER ASSEMBLY	1
12	7716	OUTSIDE RIGHT PLATE	1
13	7717	RIGHT PLATE	1
14	7718	RIGHT OUTER PLATE	1
15	7704	TRACK GUIDE	1
16	7705	GEAR MOUNT PLATE	1
17	7707	DRIVE MOTOR MOUNT PLATE	1
18	7711	GUSSET (3)	2
19	7706	GUSSET (1)	2
20	7709	TENSIONER SUPPORT PLATE	1
21	7710	TENSIONER SUPPORT RIB	2
22	7712	GUSSET (4)	2
23	7713	DRIVE MOTOR MOUNT HOUSING	1
24	7714	DRIVE SPROCKET	1
25	7715	GREASE RELIEF VALVE GUARD	1
26		HEX M14X2.0X30 BOLT	10
27		HEX M14X2.0X50	21

7720-90" RIGHT TRACK ASSEMBLY

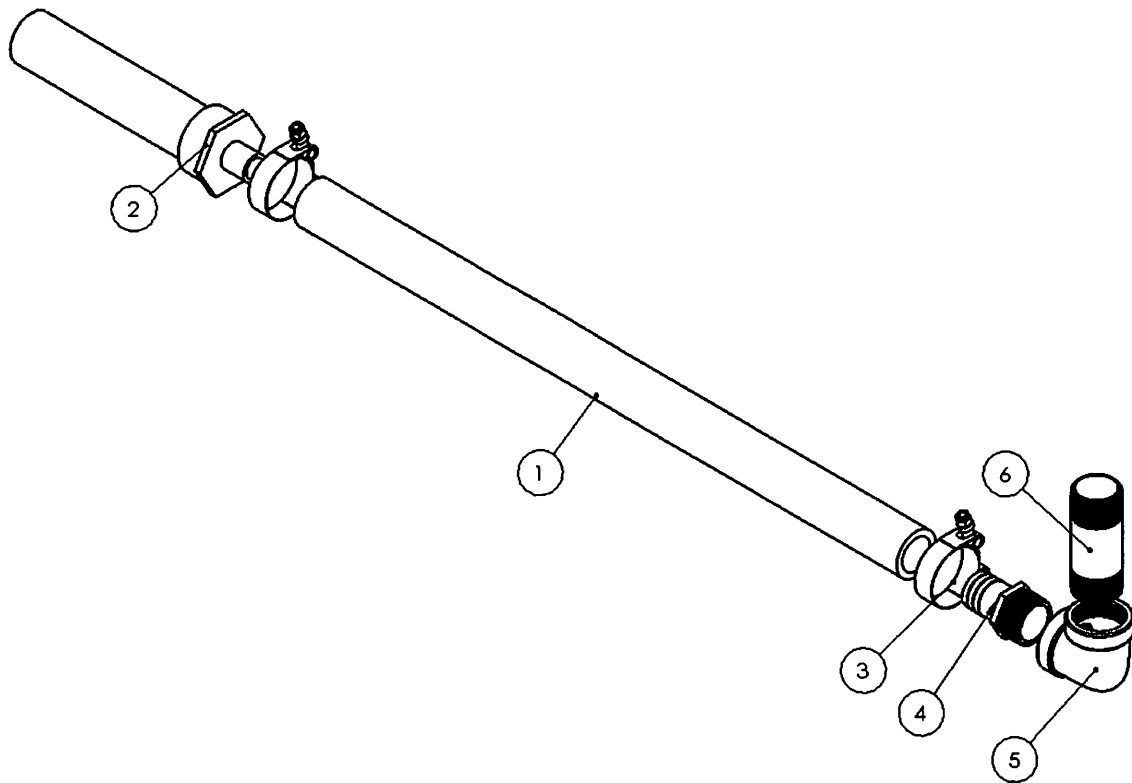


ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	7731	HYDRAULIC TANK	1
2	7732	REAR HYDRAULIC TANK CAP	1
3	7733	FRONT HYDRAULIC TANK CAP	1
4	7734	SLAB MOUNT PLATE	1
5	7735	SKID PLATE STANDOFF	4
6	7736	4X5X.25 TUBING	4
7	7737	4X5X.25 TUBING BRACE	4
8	7738	HYDRAULIC EXTEND/RETRACT CYLINDER MOUNT (1)	4
9	7739	HYDRAULIC EXTEND/RETRACT CYLINDER MOUNT (2)	2
10	7740	EXTEND/RETRACT CYLINDER BOSS	4
11	7741	SLAB MOUNT PLATE GUSSET	10
12	7742	REAR HYDRAULIC LINE MOUNT PLATE	1
13	7743	FRONT HYDRAULIC LINE MOUNT PLATE	1
14		1.25" BUNG	1
15		1.5" BUNG	1
16		DRAIN BUNG	1
17		DRAIN PLUG	1
18	7744	TUBING SUPPORT GUSSET	4
19	7746	FLOW DIVIDER MOUNT PLATE	1
20	7747	BOTTOM TUBING SUPPORT GUSSET	2
21	7748	TRACK TANK GASKET	1
22	7749	HYDRAULIC TANK BAFLE	1
23	7762	EXTEND CYLINDER MOUNT GUSSET	2
24	7769	HYDRAULIC TANK SIGHT GLASS	1
25	7752	EXTEND/RETRACT CYLINDER PIN (1)	4
26		SUCTION ASSEMBLY	1
27	7775	1.25" NPT MITER CUT 6" LONG	1
28	7776	0.75" NPT MITER CUT 6" LONG	1
29	7770	TANK UNION PLATE	1

7750-90" CENTER TRACK ASSEMBLY

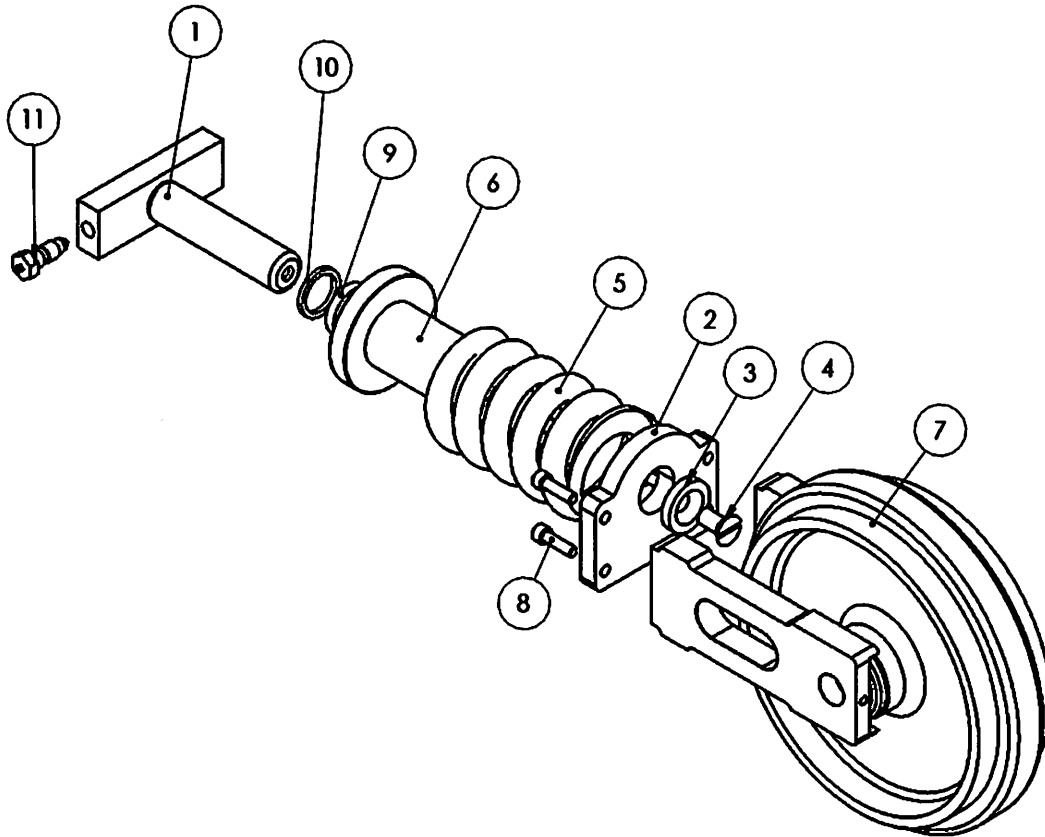
90" TRACK SUCTION ASSEMBLY

ITEM NO.	PART NO.	DESCRIPTION	QTY.
1	7771	SUCTION LINE	1
2	7768	SUCTION FILTER	1
3	CLAMP	1.75" T BOLT CLAMP	2
4	BARB	1.25" NPT BARB FITTING	1
5	ELBOW	1.25" NPT 90° ELBOW	1
6	NIPPLE	1.25" NPT 4" LONG NIPPLE	1



90" TRACK TENSIONER ASSEMBLY

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	7763	MALE TENSIONER ASSY	1
2	7757	TENSIONER MOUNT PLATE	1
3	7758	COUNTERSUNK RETAINER PLATE	1
4		COUNTERSUNK 5/8-11 UNC BOLT	1
5	7766	90" TRACK TENSIONER SPRING	1
6	7756	TRACK TENSIONER CYLINDER BODY	1
7	7767	13 INCH IDLER WHEEL W/ SLIDE BARS	1
8		SOCKET CAP M10X35 BOLT	4
9	7764	1.50 INCH U SEAL	1
10	7765	1.50" WIPER SEAL	1
11	7777	GREASE RELIEF VALVE	1



1 Production Outline

1. Pump	PVD Piston Pump
2. Model	PVD-0B-24-5778A
3. Applied machine	Digger Derrick
4. Customer	SKYLIFT

2 Pump Spec

1. Capacity	P1, P2 : $12 \times 2 \text{cm}^3/\text{rev}$
2. Pressure	P1, P2 : 20.6MPa (210kgf/cm ²)
3. Speed	Rated speed : 2400 min^{-1} Rotation Direction : Clockwise Max. speed : 2600 min^{-1}
4. Suction Pressure	-0.02 ~ +0.04 MPa (-0.2 ~ +0.4 kgf/cm ²)
5. Oil	ISO VG 32, 46, 68 Anti-Wear hydraulic fluid (JX Nippon Oil & Energy Corporation Superhyrando Equivalency Oil)
6. Oil temp	Temp range : $-20 \sim +80^\circ\text{C}$ Peak temperature within 100°C
7. Control	Constant torque control

3 Others

Pump Torque 48.0N·m

No.	REVISION	DATE	BY	APPD
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6. TROUBLE SHOOTING AND COUNTERMEASURE

No	Trouble	Possible cause	Countermeasure
1	Overload to engine	(1) Speed is higher than standard (2) Setting pressure is higher than specifications (3) Damage of internal parts of pump	(1) Readjust it as standard (2) Readjust it as spec (3) Repair or replace
2	Low pump flow or low pressure	(1) Speed down of engine (2) Wrong coupling (3) Damage of internal parts of pump	(1) Readjust of engine speed (2) Repair or replace (3) Repair or replace
3	Abnormal noise or abnormal vibration (Cavitations)	(1) The level of oil in the tank is low. (2) Air in the oil (3) Water in the oil (4) Clog of suction filter (5) High suction pressure (6) Damage of piston shoe (7) Installation condition is no good (8) Wrong coupling	(1) Replenish a tank with oil (2) Check piping Bleed the air in the hydraulic circuit. (3) Replace oil (4) Clean or replace (5) Correction (6) Replace (7) Correction (8) Replace
4	Oil leakage	(1) Damage of O ring or packing (2) Loosened plug (3) Leaking from oil seal	(1) Replace (2) Tight up (3) Replace Replace of oil seal

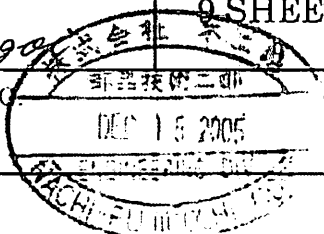
NACHI

PARTS LIST OF WHEEL MOTOR

MODEL : PHV-4B-60***-(P)-10

NOTE.
IN THE PARTS LIST,
·DIV."A" MEANS, STANDARD PART.
(AVAILABLE AS INDIVIDUAL PART.)
·DIV."B" MEANS, AVAILABLE AS INDIVIDUAL PART.
·DIV."C✳" MEANS, AVAILABLE AS KIT.
NOT AVAILABLE AS INDIVIDUAL PART.
·DIV."BLANK" MEANS, NOT AVAILABLE

CUSTOMER		APPD <i>N. Maeyama</i>	DATE Dec.15. 2005
		CHKD <i>K. Yamura</i>	
CONT NO.	WORKS NO.	CHKD <i>J. Yokota</i>	TOTAL SHEET
NACHI-FUJIKOSHI CORP.		BY <i>J. Kagawa</i>	9 SHEETS
JOB NO. PL-PHV4B-003		DOCUMENT NO.	



INTRODUCTION

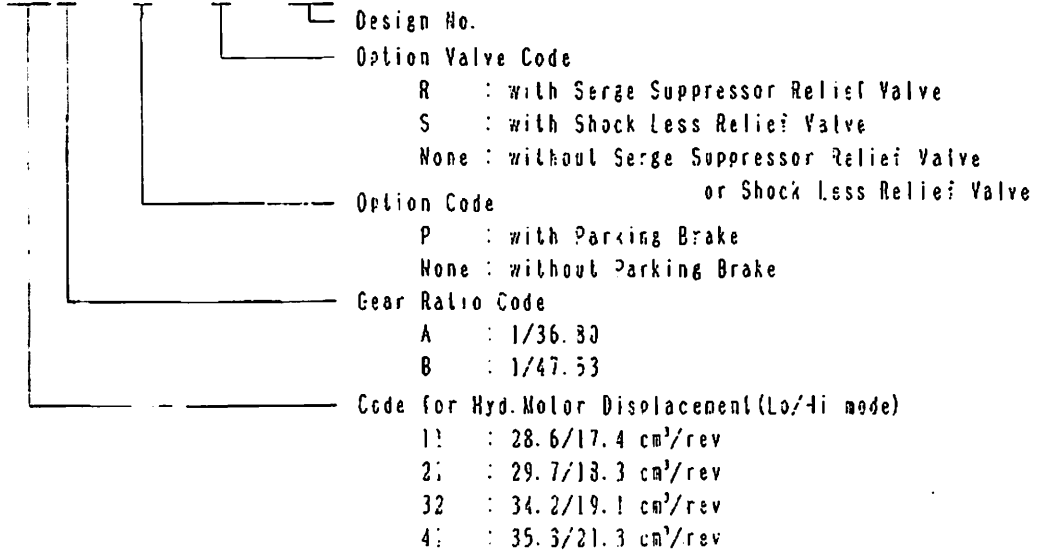
This parts list is shown the parts of model "PHV-4B-60***-10"

and "PHV-4B-60***-P-10".

The parts of other model aren't shown.

Model Code

PHV-4B-60***-(*) (*) -1 C



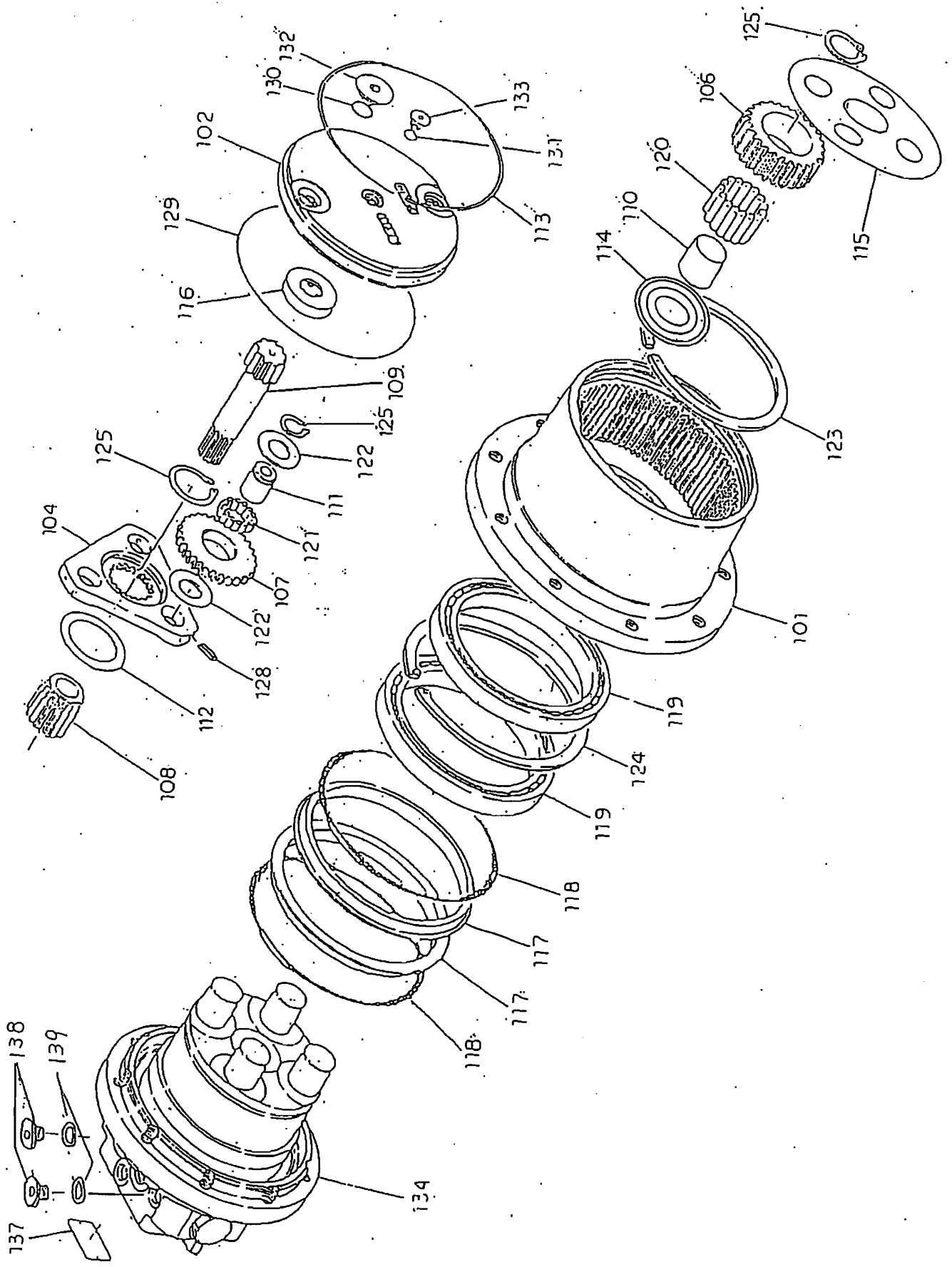
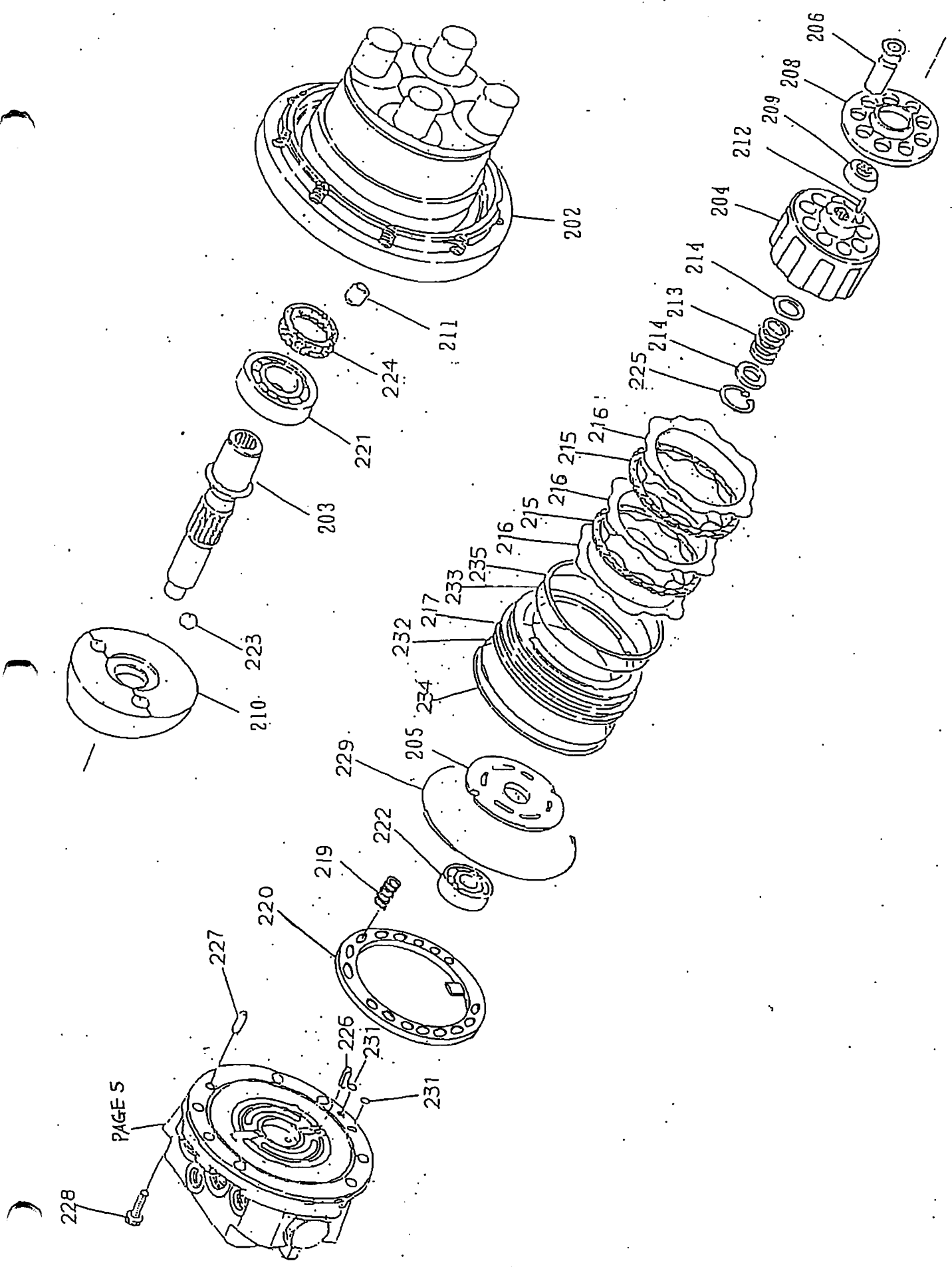


Table 1. REDUCTION GEAR GROUP

WHEEL MOTOR MODEL		PHV-4B-60**A-(P)-10		PHV-4B-60**B-(P)-10			
GEAR RATIO		1/36.80		1/47.53			
No.	DESCRIPTION	NACHI PART No.	Q'TY	NACHI PART No.	Q'TY	DIV.	REMARK
101	BODY		1		1	C1	
102	COVER	FZD-8322-1-02	1	FZD-8322-1-02	1	B	
104	CARRIER 2		1		1	C2	
106	B1 GEAR	FZD-8090-1-06	4	FZD-8090-1-06	4	B	
107	B2 GEAR		3		3	C2	
108	S1 GEAR		1		1	C2	
109	S2 GEAR	MV55-204037	1	FZD-8090-1-09	1	B	
110	RING	FZD-8090-1-10	4	FZD-8090-1-10	4	B	
111	B2 PIN		3		3	C2	
112	THRUST COLLAR	FZD-8090-1-12	1	FZD-8090-1-12	1	B	
113	O SNAP RING	FZD-8322-1-13	1	FZD-8322-1-13	1	B	
114	THRUST PLATE	FZD-8090-1-14	4	FZD-8090-1-14	4	B	
115	THRUST PLATE	FZD-8090-1-15	1	FZD-8090-1-15	1	B	
116	SLIDE RING	FZD-8322-1-16	1	FZD-8322-1-16	1	B	
117	FLOATING SEAT						
118	O RING	FZD-8322-1-17	2set	FZD-8322-1-17	2set	B	
119	BEARING		2		2	C1	
120	NEEDLE	FZD-8090-1-20	136	FZD-8090-1-20	136	B	
121	NEEDLE		72		72	C2	
122	THRUST WASHER		6		6	C2	
123	SNAP RING	FZD-8322-1-23	1	FZD-8322-1-23	1	B	4 PIECES / 1 SET
124	SNAP RING		1		1	C1	
125	SNAP RING	RA-35	8	RA-35	8	A, C2	JIS B 2804 SIZE CE35 FOR SHAFT
128	SPRING PIN		3		3	C2	
129	O RING		1		1	C9-1	
130	O RING		2		2	C9-1	
131	O RING		1		1	C9-1	
132	PLUG	FZD-8144-1-34	2	FZD-8144-1-34	2	B	
133	PLUG	GPF-1/8	1	GPF-1/8	1	B	
134	HYDRAULIC MOTOR		cf. table 4			C	
137	NAME PLATE		1		1		
138	PLUG	GPF-1/4	2	GPF-1/4	2	B	
139	O RING		2		2	C9-1	
<i>table C1.</i>							
BODY SUB ASSY							
C1	BODY SUB ASSY	GHB-4-8235	1set	GHB-4-8235	1set	C1	
(101)	BODY		(1)		(1)		
(119)	BEARING		(2)		(2)		
(124)	SNAP RING		(1)		(1)		
<i>table C2.</i>							
CARRIER 2 SUB ASSY							
C2	CARRIER 2 SUB ASSY	MVH-204037	1set	GHC-4B-2-8235	1set	C2	
(104)	CARRIER 2		(1)		(1)		
(107)	B2 GEAR		(3)		(3)		
(108)	S1 GEAR		(1)		(1)		
(111)	B2 PIN		(3)		(3)		
(121)	NEEDLE		(72)		(72)		
(122)	THRUST WASHER		(6)		(6)		
(125)	SNAP RING		(4)		(4)		
(128)	SPRING PIN		(3)		(3)		
<i>table C9-1.</i>							
SEAL KIT (REDUCTION GEAR)							
C9-1	SEAL KIT (REDUCTION GEAR)	GHS-500-1-8739	1set	GHS-500-1-8739	1set	C9-1	
(129)	O RING		(1)		(1)		
(130)	O RING		(2)		(2)		
(131)	O RING		(1)		(1)		
(139)	O RING		(2)		(2)		



PAGE 5

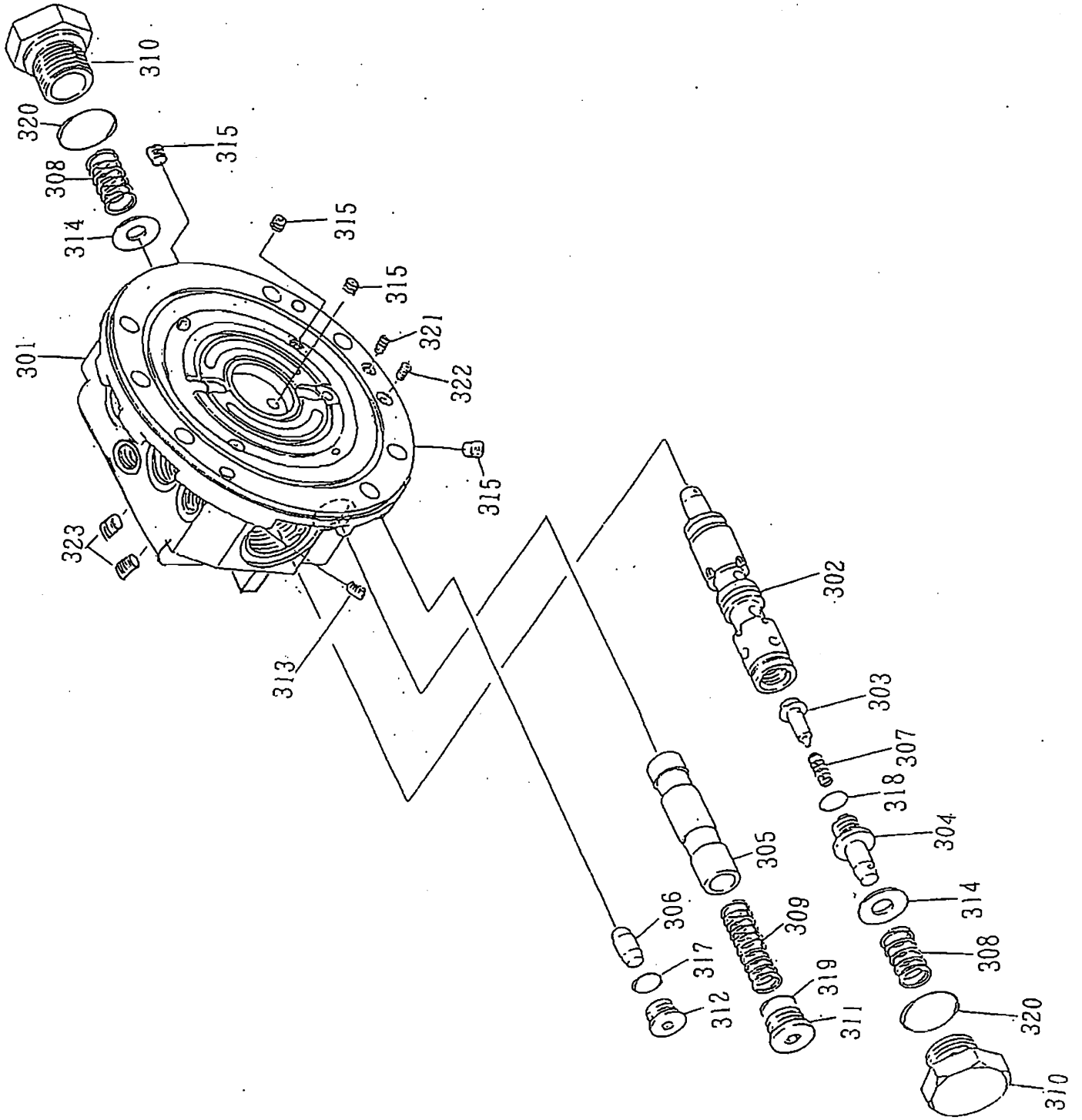


Table 2. HYDRAULIC MOTOR GROUP

WHEEL MOTOR MODEL		PHV-4B-60***-10		PHV-4B-60***-P-10		DIV.	REMARK	
OPTION		WITHOUT PARKING BRAKE		WITH PARKING BRAKE				
No.	DESCRIPTION	NACHI PART No.	Q'TY	NACHI PART No.	Q'TY			
202	BODY 2		1		1	C4		
203	SHAFT		1		1	C5		
204	CYLINDER BARREL		1		1	C6		
205	VALVE PLATE		1		1	C6		
206	PISTON ASSY		9		9	C6		
208	SHOE HOLDER		1		1	C6		
209	BARREL HOLDER		1		1	C6		
210	SWASH PLATE	<i>cf. table 4</i>					B	
211	CONTROL PISTON		1		1	C4		
212	PIN		3		3	C6		
213	SPRING C		1		1	C6		
214	RETAINER		2		2	C6		
215	DISK PLATE			FZD-4671-1-26	2	B		
216	STEEL PLATE			FZS-2632-27-2	3	B		
217	BRAKE PISTON			FZD-4954-1-17	1	B		
219	SPRING B			FZS-2817-29-B-1	8	B		
220	RETAINER			FZD-4954-1-20	1	B		
221	BEARING		1		1	C5		
222	BEARING		1		1	C3		
223	BALL	YB-5/8	2	YB-5/8	2	A	JIS B 1501 SIZE 5/8	
224	OIL SEAL		1		1	C4, C9-2		
225	SNAP RING		1		1	C6		
226	SPRING PIN		1		1	C3		
227	PIN	PP-h7-8×15	2	PP-h7-8×15	2	B		
228	SCREW	TH-10×25	7	TH-10×25	7	B		
229	O RING		1		1	C9-2		
231	O RING		2		2	C9-2		
232	O RING				1	C9-2		
233	O RING				1	C9-2		
234	BACK UP RING				1	C9-2		
235	BACK UP RING				1	C9-2		

Table 3. BODY 1 ASSY GROUP

WHEEL MOTOR MODEL		PHV-4B-60***-10		PHV-4B-60***-P-10		DIV.	REMARK
OPTION		WITHOUT PARKING BRAKE		WITH PARKING BRAKE			
No.	DESCRIPTION	NACHI PART No.	Q'TY	NACHI PART No.	Q'TY		
301	BODY 1		1		1	C3	
302	SPOOL		1		1	C3	
303	CHECK VALVE		2		2	C3	
304	SPRING GUIDE		2		2	C3	
305	SPOOL		1		1	C3	
306	SHUTTLE SPOOL		1		1	C3	
307	SPRING V1		2		2	C3	
308	SPRING V2		2		2	C3	
309	SPRING V3		1		1	C3	
310	PLUG		2		2	C3	
311	PLUG		2		2	C3	
312	PLUG		2		2	C3	
313	CHOKE		2		2	C3	
314	RING		2		2	C3	
315	PLUG		7		7	C3	
317	O RING		2		2	C3, C9-2	
318	O RING		2		2	C3	
319	O RING		2		2	C3, C9-2	
320	O RING		2		2	C3, C9-2	
321	CHOKE		1		1	C3	
322	CHOKE		1		1	C3	
323	PLUG		2		2	C3	

Table 4. HYDRAULIC MOTOR DISPLACEMENT

MODEL	HYDRAULIC MOTOR DISPLACEMENT Lo/Hi [cm ³ /rev]	HYDRAULIC MOTOR		SWASH PLATE	
		NACHI PART No.	Q'TY	NACHI PART No.	Q'TY
PHV-4B-6011*-10	28.6/17.4	PMV-2B-2917-EAH-8645A	1	FZD-4266-3-10	1
PHV-4B-6011*-P-10		PMV-2B-2917B8-EAH-8645A	1		
PHV-4B-6021*-10	29.7/18.3	PMV-2B-2918-EAH-8645A	1	FZD-4656-1-10-2918	1
PHV-4B-6021*-P-10		PMV-2B-2918B8-EAH-8645A	1		
PHV-4B-6032*-10	34.2/19.1	PMV-2B-3419-EAH-8645A	1	FZD-4660-1-10-3419	1
PHV-4B-6032*-P-10		PMV-2B-3419B8-EAH-8645A	1		
PHV-4B-6041*-10	35.3/21.3	PMV-2B-3521-EAH-8645A	1	FZD-4342-1-10-3521	1
PHV-4B-6041*-P-10		PMV-2B-3521B8-EAH-8645A	1		

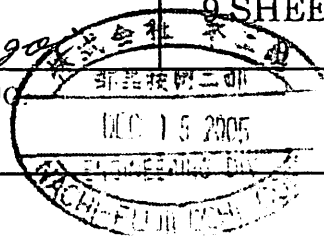
NACHI

PARTS LIST OF WHEEL MOTOR

MODEL : PHV-4B-60***-(P)-10

NOTE.
 IN THE PARTS LIST,
 ·DIV."A" MEANS, STANDARD PART.
 (AVAILABLE AS INDIVIDUAL PART.)
 ·DIV."B" MEANS, AVAILABLE AS INDIVIDUAL PART.
 ·DIV."C※" MEANS, AVAILABLE AS KIT.
 NOT AVAILABLE AS INDIVIDUAL PART.
 ·DIV."BLANK" MEANS, NOT AVAILABLE

CUSTOMER		APPD <i>N. Maeyama</i>	DATE
		CHKD <i>K. Yamura</i>	Dec.15. 2005
CONT NO.	WORKS NO.	CHKD <i>J. Yokota</i>	TOTAL SHEET
NACHI-FUJIKOSHI CORP.		BY <i>J. Kago</i>	9 SHEETS
JOB NO. PL-PHV4B-003		DOCUMENT NO.	



INTRODUCTION

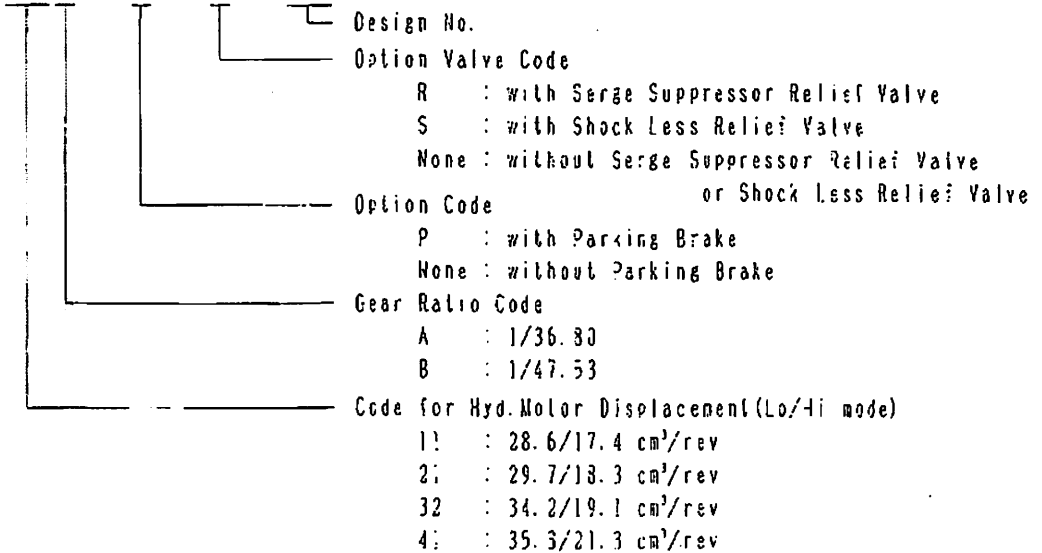
This parts list is shown the parts of model "PHV-4B-60***-10"

and "PHV-4B-60***-P-10".

The parts of other model aren't shown.

Model Code

PHV-4B-60***-(*) (*) -1 C



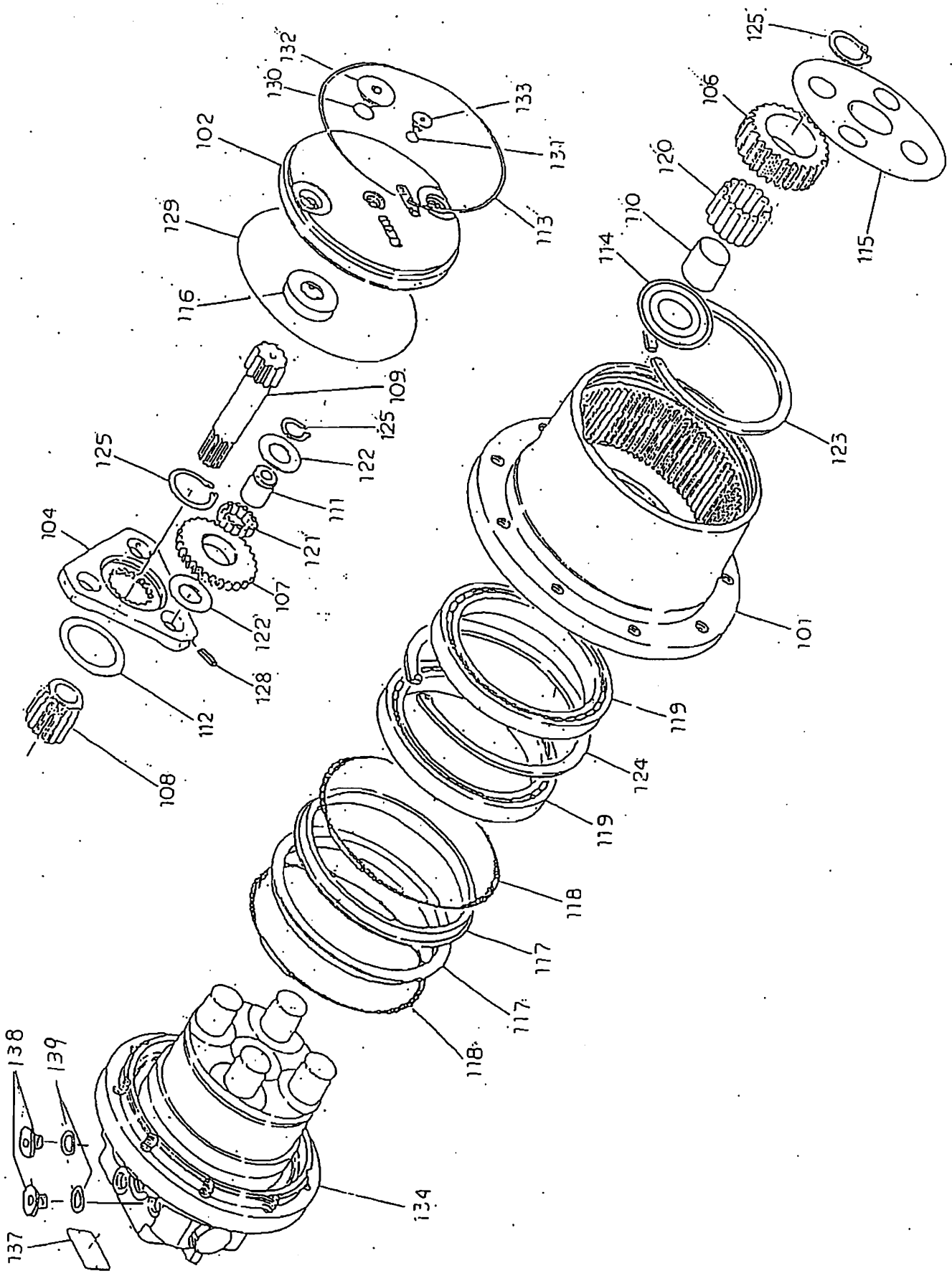
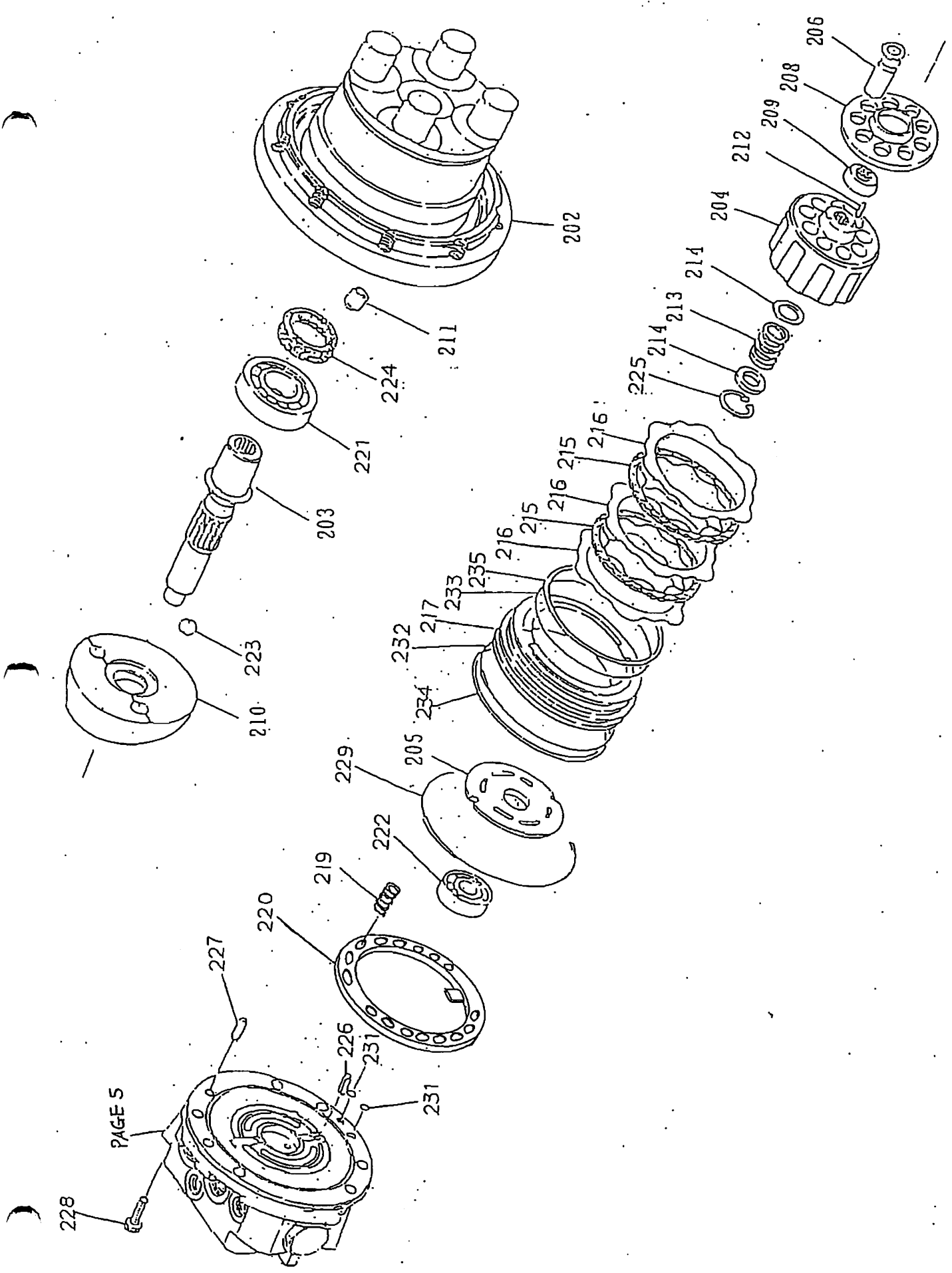


Table 1. REDUCTION GEAR GROUP

WHEEL MOTOR MODEL		MHV-4B-60**A-(P)-10		PIV-4B-60**B-(P)-10			
GEAR RATIO		1/36.80		1/47.53			
No.	DESCRIPTION	NACHI PART No.	Q'TY	NACHI PART No.	Q'TY	DIV.	REMARK
101	BODY		1		1	C1	
102	COVER	FZD-8322-1-02	1	FZD-8322-1-02	1	B	
104	CARRIER 2		1		1	C2	
106	B1 GEAR	FZD-8090-1-06	4	FZD-8090-1-06	4	B	
107	B2 GEAR		3		3	C2	
108	S1 GEAR		1		1	C2	
109	S2 GEAR	MV55-204037	1	FZD-8090-1-09	1	B	
110	RING	FZD-8090-1-10	4	FZD-8090-1-10	4	B	
111	B2 PIN		3		3	C2	
112	THRUST COLLAR	FZD-8090-1-12	1	FZD-8090-1-12	1	B	
113	O SNAP RING	FZD-8322-1-13	1	FZD-8322-1-13	1	B	
114	THRUST PLATE	FZD-8090-1-14	4	FZD-8090-1-14	4	B	
115	THRUST PLATE	FZD-8090-1-15	1	FZD-8090-1-15	1	B	
116	SLIDE RING	FZD-8322-1-16	1	FZD-8322-1-16	1	B	
117	FLOATING SEAT						
118	O RING	FZD-8322-1-17	2set	FZD-8322-1-17	2set	B	
119	BEARING		2		2	C1	
120	NEEDLE	FZD-8090-1-20	136	FZD-8090-1-20	136	B	
121	NEEDLE		72		72	C2	
122	THRUST WASHER		6		6	C2	
123	SNAP RING	FZD-8322-1-23	1	FZD-8322-1-23	1	B	4 PIECES / 1 SET
124	SNAP RING		1		1	C1	
125	SNAP RING	RA-35	8	RA-35	8	A, C2	JIS B 2804 SIZE CE35 FOR SHAFT
128	SPRING PIN		3		3	C2	
129	O RING		1		1	C9-1	
130	O RING		2		2	C9-1	
131	O RING		1		1	C9-1	
132	PLUG	FZD-8144-1-34	2	FZD-8144-1-34	2	B	
133	PLUG	GPF-1/8	1	GPF-1/8	1	B	
134	HYDRAULIC MOTOR		cf. table 4			C	
137	NAME PLATE		1		1		
138	PLUG	GPF-1/4	2	GPF-1/4	2	B	
139	O RING		2		2	C9-1	
<i>table C1.</i>							
BODY SUB ASSY							
C1	BODY SUB ASSY	GHB-4-8235	1set	GHB-4-8235	1set	C1	
(101)	BODY		(1)		(1)		
(119)	BEARING		(2)		(2)		
(124)	SNAP RING		(1)		(1)		
<i>table C2.</i>							
CARRIER 2 SUB ASSY							
C2	CARRIER 2 SUB ASSY	MVH-204037	1set	GHC-4B-2-8235	1set	C2	
(104)	CARRIER 2		(1)		(1)		
(107)	B2 GEAR		(3)		(3)		
(108)	S1 GEAR		(1)		(1)		
(111)	B2 PIN		(3)		(3)		
(121)	NEEDLE		(72)		(72)		
(122)	THRUST WASHER		(6)		(6)		
(125)	SNAP RING		(4)		(4)		
(128)	SPRING PIN		(3)		(3)		
<i>table C9-1.</i>							
SEAL KIT (REDUCTION GEAR)							
C9-1	SEAL KIT (REDUCTION GEAR)	GHS-500-1-8739	1set	GHS-500-1-8739	1set	C9-1	
(129)	O RING		(1)		(1)		
(130)	O RING		(2)		(2)		
(131)	O RING		(1)		(1)		
(139)	O RING		(2)		(2)		



PAGE 5

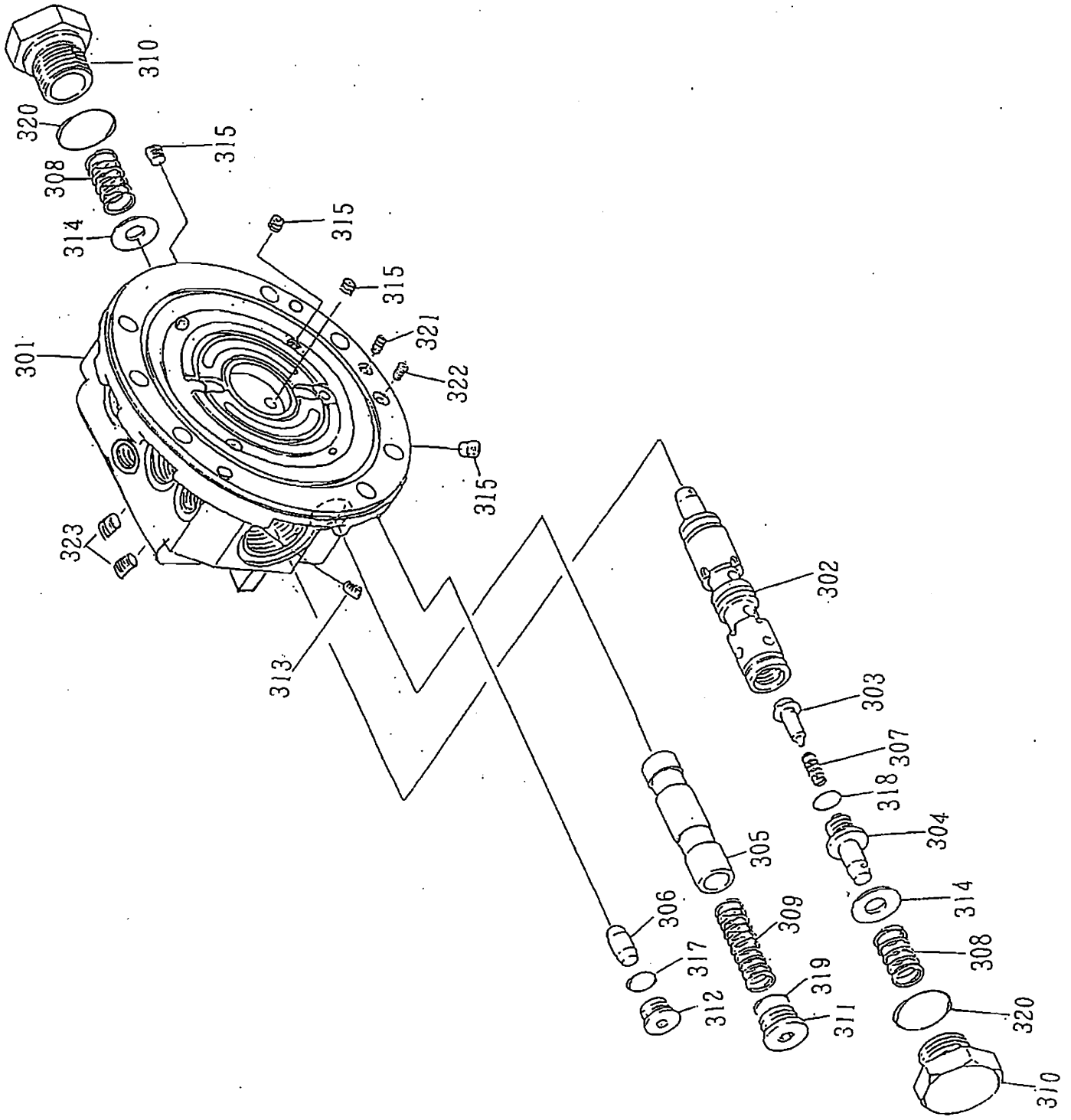


Table 2. HYDRAULIC MOTOR GROUP

WHEEL MOTOR MODEL		PHV-4B-60***-10		PHV-4B-60***-P-10		DIV.	REMARK
OPTION		WITHOUT PARKING BRAKE		WITH PARKING BRAKE			
No.	DESCRIPTION	NACHI PART No.	Q' TY	NACHI PART No.	Q' TY		
202	BODY 2		1		1	C4	
203	SHAFT		1		1	C5	
204	CYLINDER BARREL		1		1	C6	
205	VALVE PLATE		1		1	C6	
206	PISTON ASSY		9		9	C6	
208	SHOE HOLDER		1		1	C6	
209	BARREL HOLDER		1		1	C6	
210	SWASH PLATE		<i>cf. table 4</i>			B	
211	CONTROL PISTON		1		1	C4	
212	PIN		3		3	C6	
213	SPRING C		1		1	C6	
214	RETAINER		2		2	C6	
215	DISK PLATE			FZD-4671-1-26	2	B	
216	STEEL PLATE			FZS-2632-27-2	3	B	
217	BRAKE PISTON			FZD-4954-1-17	1	B	
219	SPRING B			FZS-2817-29-B-1	8	B	
220	RETAINER			FZD-4954-1-20	1	B	
221	BEARING		1		1	C5	
222	BEARING		1		1	C3	
223	BALL	YB-5/8	2	YB-5/8	2	A	JIS B 1501 SIZE 5/8
224	OIL SEAL		1		1	C4, C9-2	
225	SNAP RING		1		1	C6	
226	SPRING PIN		1		1	C3	
227	PIN	PP-h7-8×15	2	PP-h7-8×15	2	B	
228	SCREW	TH-10×25	7	TH-10×25	7	B	
229	O RING		1		1	C9-2	
231	O RING		2		2	C9-2	
232	O RING				1	C9-2	
233	O RING				1	C9-2	
234	BACK UP RING				1	C9-2	
235	BACK UP RING				1	C9-2	

Table 3. BODY 1 ASSY GROUP

WHEEL MOTOR MODEL		PHV-4B-60***-10		PHV-4B-60***-P-10		DIV.	REMARK
OPTION		WITHOUT PARKING BRAKE		WITH PARKING BRAKE			
No.	DESCRIPTION	NACHI PART No.	Q' TY	NACHI PART No.	Q' TY		
301	BODY 1		1		1	C3	
302	SPOOL		1		1	C3	
303	CHECK VALVE		2		2	C3	
304	SPRING GUIDE		2		2	C3	
305	SPOOL		1		1	C3	
306	SHUTTLE SPOOL		1		1	C3	
307	SPRING V1		2		2	C3	
308	SPRING V2		2		2	C3	
309	SPRING V3		1		1	C3	
310	PLUG		2		2	C3	
311	PLUG		2		2	C3	
312	PLUG		2		2	C3	
313	CHOKE		2		2	C3	
314	RING		2		2	C3	
315	PLUG		7		7	C3	
317	O RING		2		2	C3, C9-2	
318	O RING		2		2	C3	
319	O RING		2		2	C3, C9-2	
320	O RING		2		2	C3, C9-2	
321	CHOKE		1		1	C3	
322	CHOKE		1		1	C3	
323	PLUG		2		2	C3	

Table 4. HYDRAULIC MOTOR DISPLACEMENT

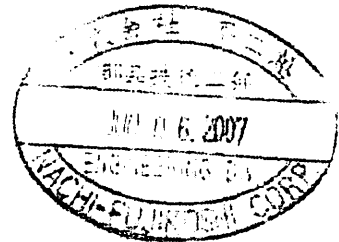
MODEL	HYDRAULIC MOTOR DISPLACEMENT Lo/Hi [cm ³ /rev]	HYDRAULIC MOTOR		SWASH PLATE	
		NACHI PART No.	Q'TY	NACHI PART No.	Q'TY
PHV-4B-6011*-10	28.6/17.4	PMV-2B-2917-EAH-8645A	1	FZD-4266-3-10	1
PHV-4B-6011*-P-10		PMV-2B-2917B8-EAH-8645A	1		
PHV-4B-6021*-10	29.7/18.3	PMV-2B-2918-EAH-8645A	1	FZD-4656-1-10-2918	1
PHV-4B-6021*-P-10		PMV-2B-2918B8-EAH-8645A	1		
PHV-4B-6032*-10	34.2/19.1	PMV-2B-3419-EAH-8645A	1	FZD-4660-1-10-3419	1
PHV-4B-6032*-P-10		PMV-2B-3419B8-EAH-8645A	1		
PHV-4B-6041*-10	35.3/21.3	PMV-2B-3521-EAH-8645A	1	FZD-4342-1-10-3521	1
PHV-4B-6041*-P-10		PMV-2B-3521B8-EAH-8645A	1		

NACHI

WHEEL MOTOR INSTRUCTION MANUAL

MACHINE : _____

MODEL : PHV-4B-60***-P-10



CUSTOMER	APPD	<i>M. Ejiri</i>	DATE
	CHKD	<i>H. Kunomura</i>	06. Jun. 2007
CONT NO.	WORKS NO.	CHKD	TOTAL SHEET
		<i>K. Maruyama</i>	16 SHEETS
NACHI-FUJIKOSHI CORP.		BY	
JOB NO.	DOCUMENT NO.		
<i>IM-PH-0045</i>			

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PRECAUTIONS

Thank you very much for buying the NACHI products.

This Instruction Manual is describing the installation • driving precautions and the operational principle of the PHV series wheel motors.

Please read this manual before using the product and keep preciously.

For safety usage (Obey surely)

With this instruction manual, to protect the accident by mis-usage, precautions are described as follows.

■By ignoring the precautions, the degree of danger or damage with incorrect handling are described below.



Danger This type of precaution indicates a condition in which incorrect handling creates the immediate risk of death or serious personal injury.



Warning This type of precaution indicates a condition in which incorrect handling creates the risk of death or serious personal injury.



Caution This type of precaution indicates a condition in which incorrect handling creates the risk of personal injury or material damage.

Request

This type of precaution indicates a condition in which understanding creates the safety usage of motor.

■Obeying items are showing following drawings.



Mark is prohibition



Mark shows prohibition action.



Within this mark or near to this mark shows concrete prohibition content.



Mark is caution



Mark shows leading caution content.



Within this mark or near to this mark shows concrete caution content.

For safety caution (Obey surely)



Warning : To avoid clip accident



- Touching a moving motor makes injury.
Don' t insert a finger or tool from opening space.



Warning : Prevention fire



- Hydraulic equipment uses hydraulic oil. Usual hydraulic oil is inflammability (Flash point is 210°C), it is dangerous if there is a fire or high temperature object near by. Especially fog situation hydraulic oil easily ignite, it is necessary pay caution.
- Use the suitable hydraulic oil, and confirm no overflow and no leakage of hydraulic oil.



Warning : Caution for breakage or burst under high pressure



[Following usage leads the hydraulic equipment breakage or burst and blowing up high pressure oil etc, very dangerous situation. Don' t do absolutely.]

- All hydraulic equipment are not used exceeding max. operating pressure which is designating in the catalogue and instruction manual.
- Select the suitable piping and coupling which is fit the system.
- Use the designated seal and bolt.
- Don' t install in the abnormal vibration and acceleration deceleration place.



Caution : Usage suitable hydraulic oil



Confirm

- The hydraulic oil effects big influence about the hydraulic equipment operation, efficiency and reliability.
Use the high quality petroleum hydraulic oil ISO VG 46 or equivalent.
- Use the hydraulic oil within the suitable range of temperature coefficient of viscosity.

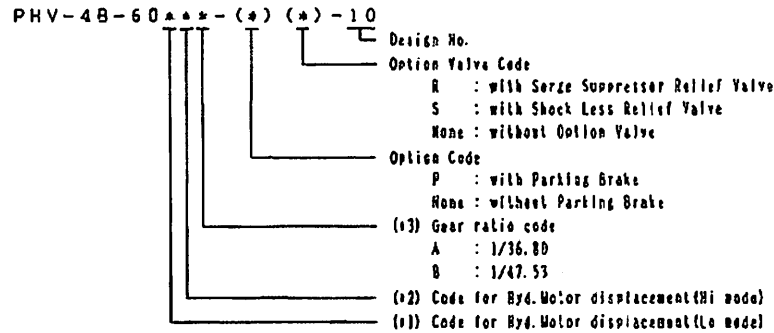
Request : Protection for environment

- Pay attention carefully not to drain the oil to outside.
- By any change the oil drain to outside, not to leave it, wipe up immediately.
- Discharging the oil to the sewage makes the cause of environment pollution and fire. And draining to the floor makes slippery and very dangerous.

Request : Unpacking tenderly

- The hydraulic equipment is generally heavy and precision parts. Taking out from package treats carefully and do not hit and drop, this is the cause of breakage and damage.
- Don' t life up by hand the products weight over 20kgf. It may the cause of injury or accident.

1. MODEL CODE



2. SPECIFICATIONS

Model No.	SPECIFICATION (THEORETICAL)				(Note3)	(Note4)	(Note5)	(Note6)		(Note7)							
	Code for Hyd. Motor Displacement		Code for Gear Ratio		Max. Pressure	Max. Output Torque (Theoretical, Lo mode)		Max. Flow	Max. Output Speed (Theoretical, Hi mode)		Option Parking Brake Torque						
	Lo mode	Hi mode	code:13	ratio		Lo mode, Hi mode	Intermittent		Continuous	Wheel Motor	Hyd. Motor	Wheel Motor	Hyd. Motor				
	code:s1	cm ³ /rev			code:s2			cm ³ /rev		min ⁻¹	min ⁻¹	N·m	N·m				
PHV-4B-6011A-(P)-10	1	28.6	1	17.4	24.5	A 11/36.80	1052.51	640.3	60	65	(2392)	3176	86.3				
PHV-4B-6011B-(P)-10						B 1/47.53	1359.4	227.0						(5301)	(3089)	4102	
PHV-4B-6021A-(P)-10	2	29.7	1	18.3		A 11/36.80	1093.01	673.4									(43.0)
PHV-4B-6021B-(P)-10						B 1/47.53	1411.6	269.2						(5504)	(3089)	4102	
PHV-4B-6032A-(P)-10	3	34.2	2	19.1		A 11/36.80	1258.61	782.1									(4902)
PHV-4B-6032B-(P)-10						B 1/47.53	1625.5	307.8						(6338)	(3089)	4102	
PHV-4B-6041A-(P)-10	4	35.3	1	21.3		A 11/36.80	1299.01	783.2									(5065)
PHV-4B-6041B-(P)-10						B 1/47.53	1677.8	1012.4						(6542)	40.0	151.31	

Note1 : Use this wheel motor within the hereinbefore "SPECIFICATION".

Note2 : The hereinbefore "SPECIFICATION" is theoretical value. Real Torque at 10min⁻¹(Lo) should be approximate 85% of Theoretical Torque. Real Speed at Hi(P<10.3MPa) should be approximate 96% of Theoretical Speed.

Note3 : Max. Pressure is 24.5 MPa.

Note4 : Max. Output Torque is 6893 N·m. However, the value in () is limited by Max. Pressure. "Intermittent" means less than 7% of operating time.

Note5 : Max. flow is 60 L/min. However, the value in () is limited by Max. Output Speed(Wheel Motor or Hyd. Motor).

Note6 : Max. Output Speed is 65 min⁻¹(Wheel Motor), 3500 min⁻¹(Hyd. Motor). However, the value in () is limited by Max. Flow or Max. Output Speed(Wheel Motor or Hyd. Motor).

Note7 : Parking Brake Torque(Hyd. Motor) is 86.3 N·m. Therefore, Parking Brake Torque(Wheel Motor) is different value between Gear Ratio "A(1/36.80)" and "B(1/47.53)".

Note8 : You can select "Option Valve". However, this drawing is shown the wheel motor without Option Valve.

3. CROSS SECTIONAL DRAWING

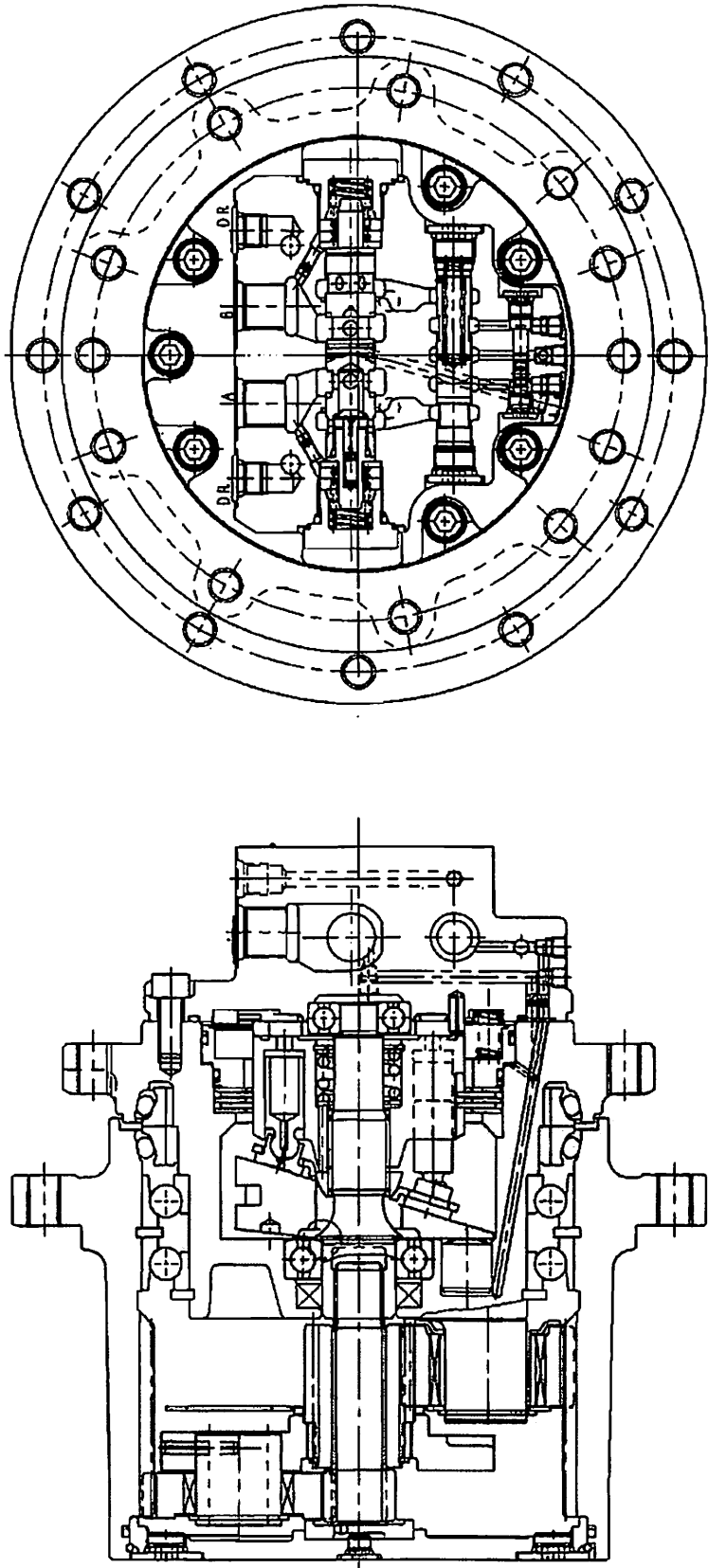


Fig. 1

4. DRAWING OF OPERATIONAL PRINCIPLE

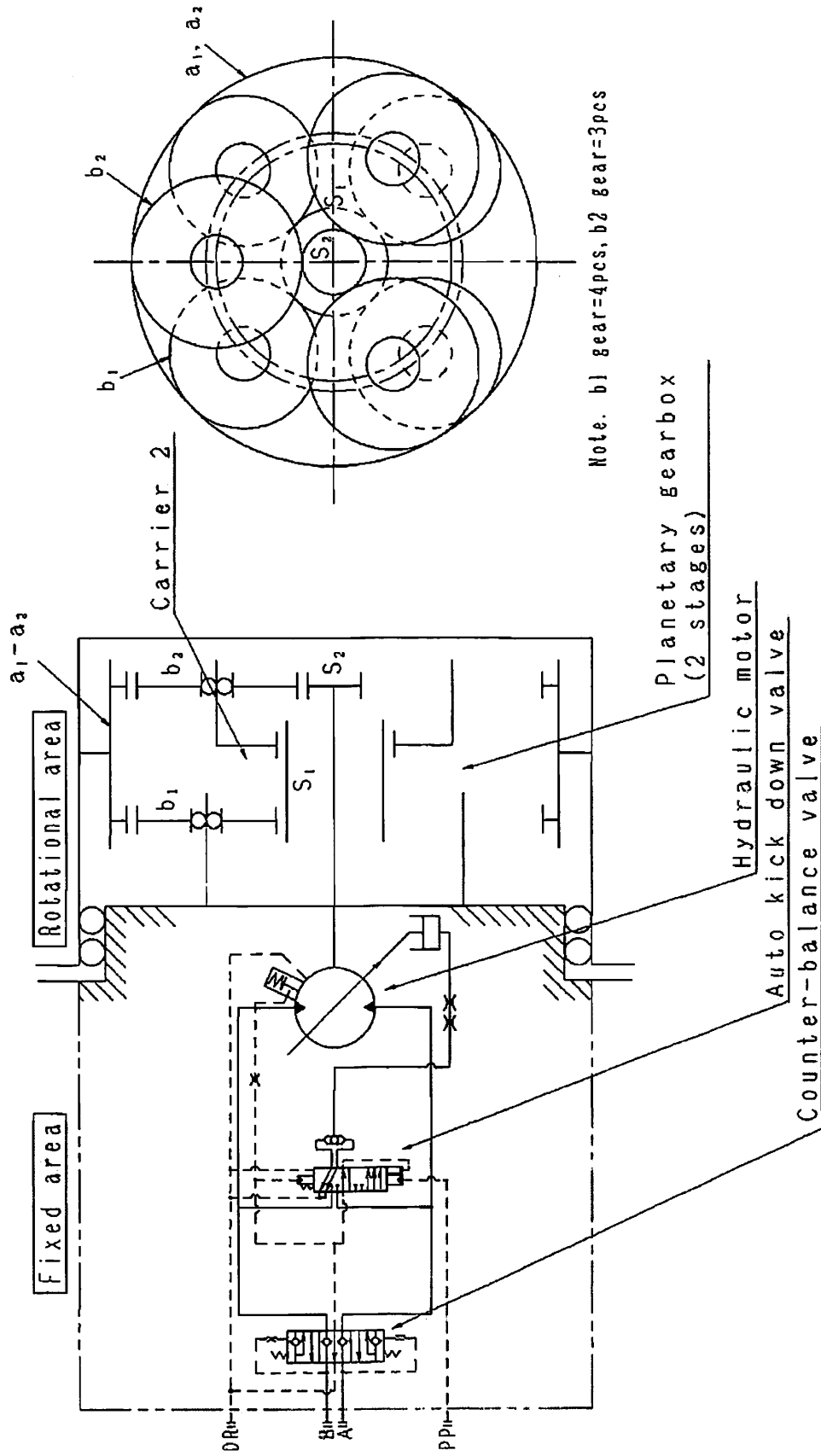


Fig. 2

5. OPERATION

PHV series wheel motors consist of a hydraulic motor "Fixed parts" and a planetary gear speed reducer "Rotating parts."

5.1 REDUCTION GEAR SECTION

1). Function

The speed reducer of PHV series wheel motor is a simple planetary gear type with two stages. The high output speed of the hydraulic motor is reduced to low speed with high torque.

2). Operation

The s_2 gear is attached to the hydraulic motor shaft, and the s_2 output speed is reduced between the gears (s_2, b_2, a_2) as a first stage speed reducer. The reduced output speed of this first stage is reduced again between the gears (s_1, b_1, a_1) which are connected to the carrier₂ with the spline. This reduced output speed of the second stage is transmitted to the body case "Rotating parts" through the inner gears (a_1, a_2) and drives the machine.

The gear ratio of 2 stage simple planetary speed reducer is calculated using the following formula.

$$R = \frac{Z_{s_1}}{Z_{s_1} + Z_{a_1}} \times \frac{Z_{s_2}}{Z_{s_2} + Z_{a_2}}$$

Note Z_{**} : Number of teeth

With the PHV series wheel motor, the body case rotating, so the gear ratio is:

$$R' = \frac{1}{1 \cdot 1/R}$$

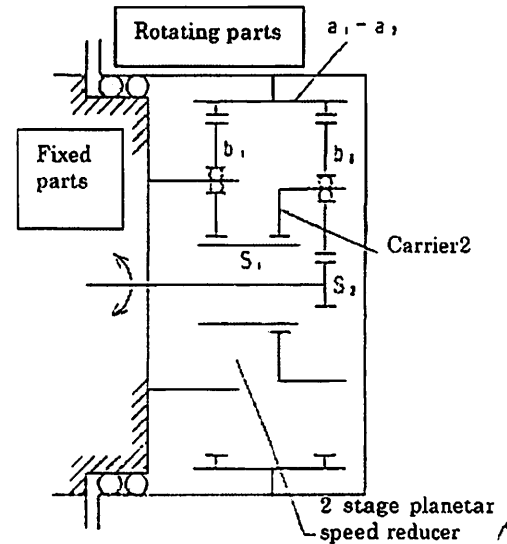


Fig.3

5.2 HYDRAULIC MOTOR SECTION

1). Function

This hydraulic motor is an axial piston type, and changes the hydraulic energy supplied from the pump to the rotary motion.

2). Structure

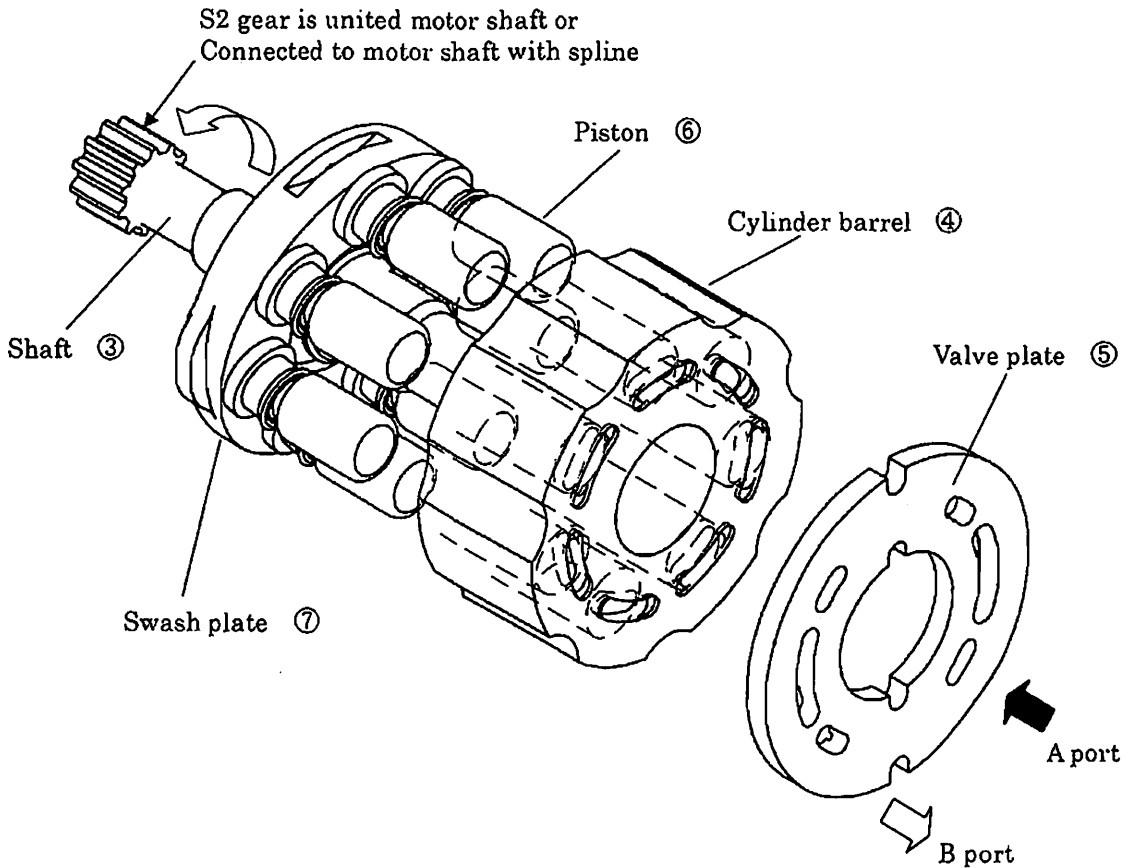


Fig.4

Through a hydraulic valve, the pressurized oil is supplied to the valve plate ⑤. When the pressurized oil is supplied to the (A) port, this pressurized oil pushes the piston ⑥ in the cylinder barrel ④. This pushing force is changed to the rotational power by the swash plate ⑦ and transmitted to the shaft ③ which is connected to the cylinder barrel ④ with the spline. The return flow from the cylinder port is going out through the (B) port of the valve plate ⑤. To reverse rotation, pressurized oil is supplied to the (B) port and returning oil exits through the (A) port.

3). 2 speed motor operation

The swash plate, which has I and II surface in the opposite side to the shoe sliding surface, is supported by the 2 balls which are fixed to the body 2.

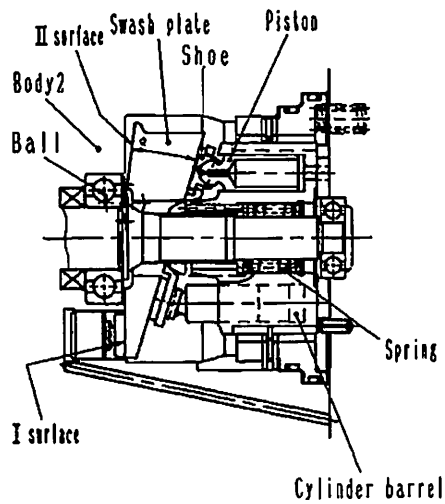
Since the balls are located in the eccentric position, in the low speed range, the I surface is faced to the body 2 by the oil pressure in the piston and the spring force in the cylinder barrel. The swash plate angle is α (Max. capacity).

When the speed change lever is changed, the pressurized oil is led to the control chamber which is made by the stopper ring and the control cylinder.

The control cylinder moves forward until the II surface of swash plate is in contact with the body 2, and the swash plate angle becomes β .

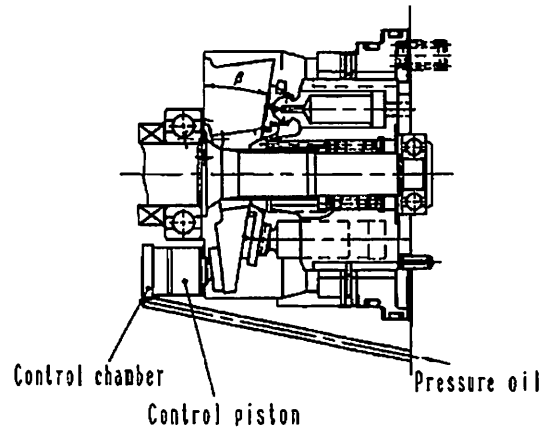
The motor capacity is made small.

When an engine is stopped, the control chamber is led to the tank port and the swash plate position comes to the low speed one by the spring force. Startling position is always in the low speed.



Low speed

Fig.5



High speed

Fig.6

5.3 HYDRAULIC VALVE SECTION

1). Counter-balance valve

When the pressurized oil is supplied from the (A) port, the pressurized oil opens the check valve ③ and flows into the hydraulic motor inlet (A') port. At the same time, the pressurized oil goes through the orifice (C) into the chamber (D), pushes the spring ④ and moves the spool ② to right. Then the returned oil from the hydraulic motor flows into the (B) port, goes through area (E) and drives the hydraulic motor. When the pressurized oil is supplied from the (B) port, the hydraulic motor rotates in reverse. Even the pressurized oil of the (A) port is shut off, the hydraulic motor tries to rotate by inertia force. When the pressurized oil from the (A) port is shut off, the spool ② tries to return to left by the spring ④ force. At this time, the oil in the chamber (D) tries to go out to the (A) port through the orifice (C), but due to the throttle effect of orifice (C), the spool ② speed is reduced. With the orifice and notches on the spool, the returned oil is controlled gradually and the hydraulic motor stops smoothly.

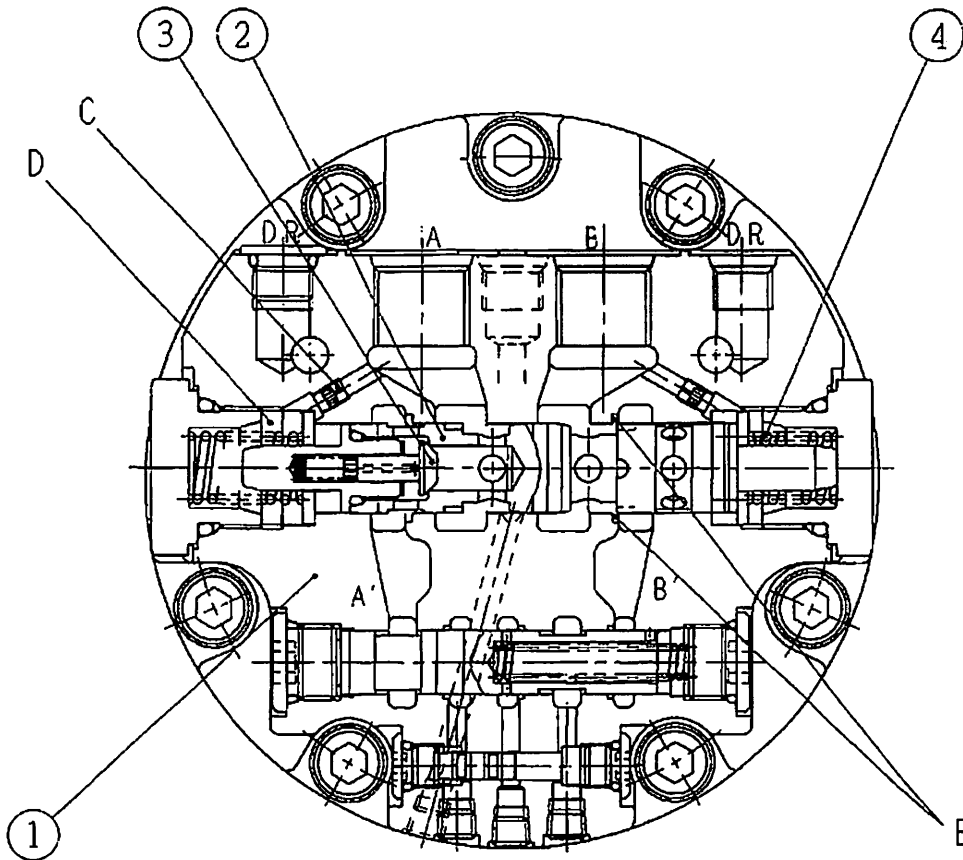


Fig.7

5.4 PARKING BRAKE SECTION

1). Structure

The parking brake fixes the output shaft of hydraulic motor mechanically while the wheel motor is stopped. And it is applied automatically in the following fashion. When A and B ports are not pressurized, the brake piston ① is pressed in the direction (shown as arrow:Fig.7) by the spring ②. Then the disk plate ④ which is fixed to the cylinder barrel ③ is held between the steel plate ⑥ which are fixed to the body 2 ⑤ and the body 2 ⑤. As a result, with the friction of these plates, the cylinder barrel ③ and the hydraulic motor are unable to rotate. (Fig.7)

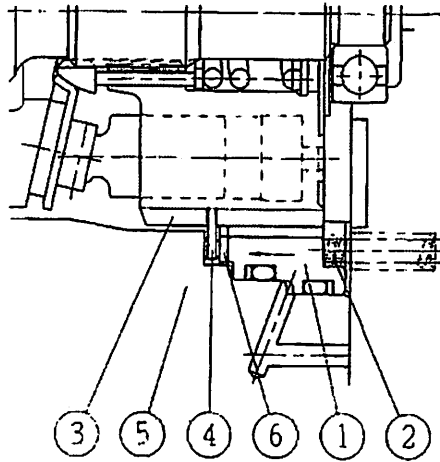


Fig.7

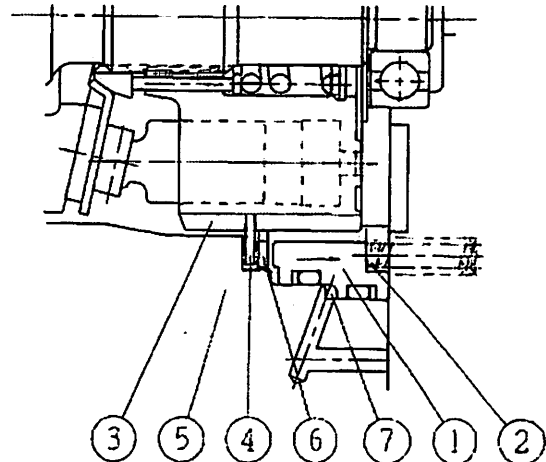


Fig.8

When A or B ports are pressurized, the oil is lead to chamber ⑦ shown in Fig.8. Then the brake piston ① is moved to the direction (shown as arrow:Fig.8) against the force of spring ②. As a result, the disk plate ④ is released from the steel plate ⑥ and the body 2 ⑤, and the cylinder barrel ③ can be rotated. (Fig.8)

6. HANDLING

6.1 MOUNTING

1). Sprocket pilot dimension A

Body pilot dimension B

$\phi 230 h8 - \frac{0}{-0.072}$

$\phi 180 h8 - \frac{0}{-0.063}$

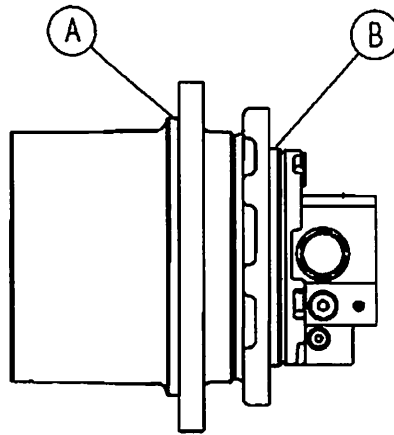


Fig.9

- 2). When installing the motor to the machine and/or attaching the sprocket to the motor, do not force the sections and/or strike them with a heavy object as damage may result. The best method is to use the mounting bolts as a guide and slowly slide it into place.
- 3). Use the specified bolts (equivalent grade 12.9 or higher) for mounting the motor and the sprocket, and tighten using the following torque.

Bolt size	Torque
M14	147 to 176 N · m (15 to 18 kgf · m)

6.2 PIPING

- 1). The installation drawing shows the motor piping. Pay attention to the rotating direction and piping.
- 2). When shipped, rubber plugs (or steel plugs for drain ports) are attached to the piping ports. When piping, pay attention as not to introduce dirt or welding scale into the ports.
- 3). One of two drain ports is used as a drain line. Use the upper side port, and fill with 100cm³ of hydraulic oil, then connect the piping.
- 4). The permissible drain pressure is limited by the oil seal. Therefore, pay attention to the size of drain piping so that the drain pressure does not exceed the limit especially in a low temperature environment. The permissible drain pressure is 0.3 MPa { 3 kgf/cm² } (Rated) and 1.0 MPa { 10 kgf/cm² } (Peak).
- 5). Fine filtration prolongs the hydraulic system life and ensures high reliability. Install a 10 μ m filter, or better in the circuit.

6.3 GEAR LUBRICATING OIL

- 1). Use diesel engine oil SAE-30-CD or equivalent as gear lubricating oil.
(When shipped, Idemitsu Apolol Diesel Motive S-330 is used.)
- 2). Any recommended gear oil can be used, but drain old oil completely, and do not mix.
- 3). When shipped, gear box is pre-filled. Take the following steps to refill. All plugs are sealed by O ring.
 - a) Remove the oil supply, discharge port plugs and the level check port plug.
 - b) Fill the oil from the oil supply port up to the "LEVEL." (about 1000cm³)
 - c) Screw the oil supply, discharge port plugs and the level check port plug.

	tightening torque
oil supply, discharge port plugs	46~51 N·m
level check port plug	12~18 N·m

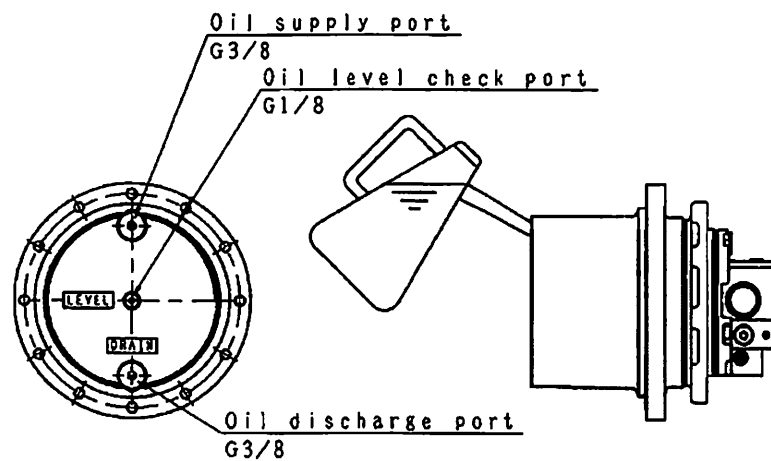


Fig.10

- 4). Gear oil amount: 1000 cm³
- 5). Gear oil change period
 - First change: 200 hours or 2 months
 - Second and after: 1000 hours or 1 year

6.4 GENERAL PRECAUTIONS

- 1). Always pay attention to oil leaks and loose bolts, detect and correct these problems as soon as possible to prevent damage to the motor or machine. Making a check sheet is recommended.

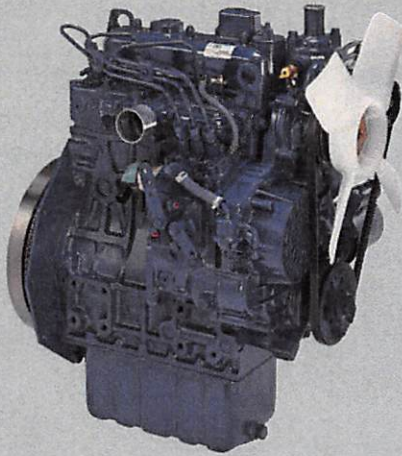
INDUSTRIAL DIESEL ENGINE

KUBOTA 05 SERIES (3-cylinder)

D1105-E4B

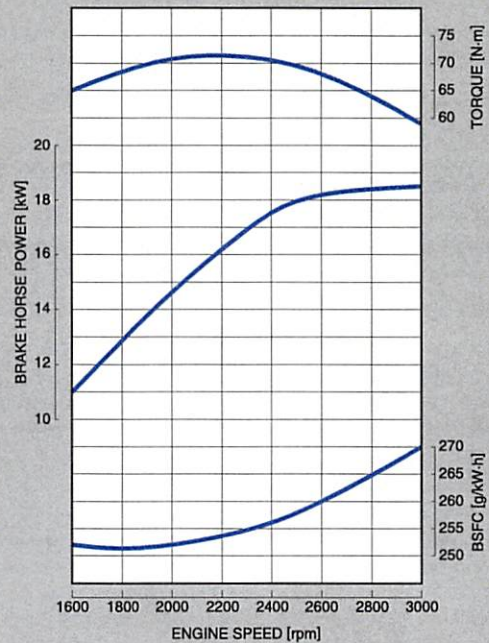
RATED POWER

18.5kW @ 3000rpm



Photograph may show non-standard equipment.

PERFORMANCE CURVE



FEATURES and BENEFITS

Emissions

Kubota 05 Series, the compact multi-cylinder liquid cooled industrial diesel engines, complies with EPA Tier 4 emissions regulations. These are most stringent emissions regulations in the world in this class.

Kubota engine less than 19kW meets emission standards over the NRTC and also meets the NTE requirements.

Clean and Quiet Power

Kubota's original E-TVCS(Three Vortex Combustion System) has been further improved for better emissions.

Option

A variety of engine accessory options is also available.

Durable Power

The Kubota 05 Series is an established leader in its horsepower range and has been the preferred power source of various industrial equipment manufactures.

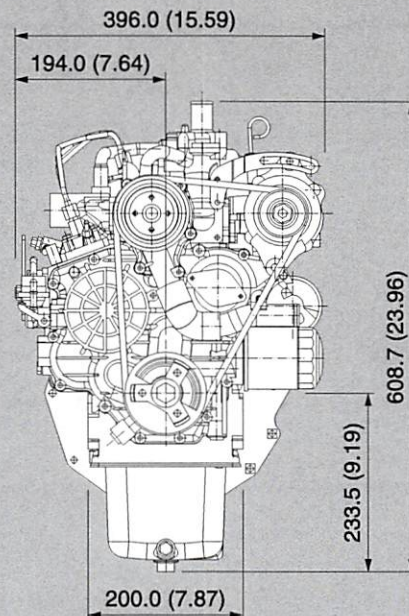
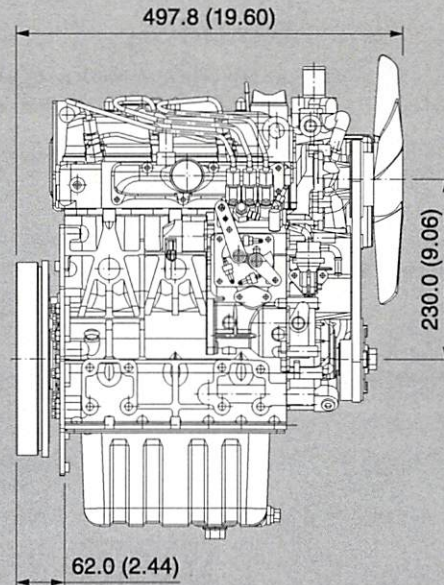
KUBOTA 05 SERIES D1105-E4B

GENERAL SPECIFICATION

Model		D1105-E4B
Emission Regulation		Tier 4
Type		Vertical 4-cycle Liquid Cooled Diesel
Number of Cylinders		3
Bore	mm (in)	78.0 (3.07)
Stroke	mm (in)	78.4 (3.09)
Displacement	L (cu.in)	1.123 (68.53)
Combustion System		IDI
Intake System		Naturally Aspirated
Maximum Speed	rpm	3000
Output: Gross Intermittent	kW	18.5
	hp	24.8
Direction of Rotation		Counterclockwise Viewed on Flywheel
Oil Pan Capacity	L (gal)	5.1 (1.35)
Starter Capacity	V-kW	12-1.2
Alternator Capacity	V-A	12-40
Length	mm (in)	497.8 (19.60)
Width	mm (in)	396.0 (15.59)
Height (1)	mm (in)	608.7 (23.96)
Height (2)	mm (in)	233.5 (9.19)
Dry Weight	kg (lb)	93.0 (205.0)

*Specification is subject to change without notice.
 *Output: Gross Intermittent SAE J1995
 *Dry weight is according to Kubota's standard specification.
 When specification varies, the weight will vary accordingly.

DIMENSIONS



PARTS LIST (ADD ONS) D1105-E4B-KEA-1

1	SRF	79000436	Radiator Kit
1	ENG	2FW-E2	Air Cleaner
1	MIS	68378	2 In Cobra 90
1	SRF	23000272	Mounting Kit
1	SRF	81500001	Overflow Bottle
1	KP	66706-55120	Key Switch
1	DON	M045193	Muffler
1	MPY	760-AF30-12V	Tattletale-30 Sec Delay
1	MPY	EN204SG12	Enuciator
1	KP	15876-74152	Spacer
1	KP	51601-37670	Temperature Switch
1	MIS	CEC-SKYLIFT-HARN	Engine Harness
2	MIS	39050-2	Cable Stop
2	KP	15371-11252	Band, Muffler
1	CAR	AFK102	Ex Flange
3	KP	16271-03450	Cylinder Bolt
1	KP	16616-11620	Air Cleaner Hose
1	CAR	TTK-S5-ET	Ex Tube, 90
1	TP	50756	Isolator for Radiator Support Bracket
1	LOF	550-1000-35	Tach
4	SRF	68980218	Overflow Hose
1	KTR	KTR-B1-S5	Drive Flange
1	KTR	KTR-HSG-B1-S5B	Housing
1	KTR	KTR-42-A-2-S37	Drive Hub
1	SUP	PAL-40-40	Pallet

1	SRF	22100075	Rear Legs
1	STN	36691BP	Fuel Filter
1	CAR	K05-SLSFB-001	Fuel Filter Brkt
1	CAR	TTK-S5-ER	EXH. RING
1	KP	15852-52850	Cover Plate
1	KP	1G662-52030	ELEC. FUEL PUMP
1	MIS	POWERED-BY-KUBOTA	DECAL
1	STN	38564	ONE SHOT
1	KP	800DECAL	DECAL

D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 13/09/2016

**ILLUSTRATED PARTS LIST
LISTA DE PIEZAS
LISTE DES PIECES**

KUBOTA

MODEL
MODELO **D1105-E4B-KEA-1**
MODELE

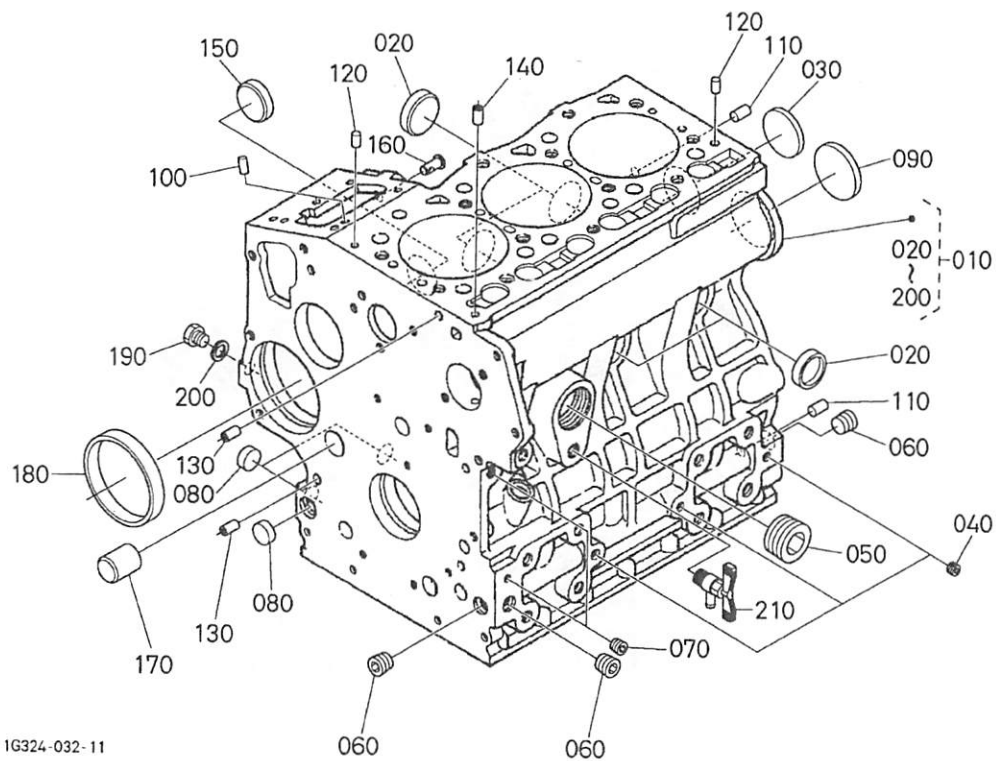
**DIESEL ENGINE
MOTOR DIESEL
MOTEUR DIESEL**

Kubota

97898-84410
SEPT.
SEPTIEMBRE 2013
SEPTEMBRE

D1105-E4B-KEA-1 -> ENGINE -> 000100 CRANKCASE ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



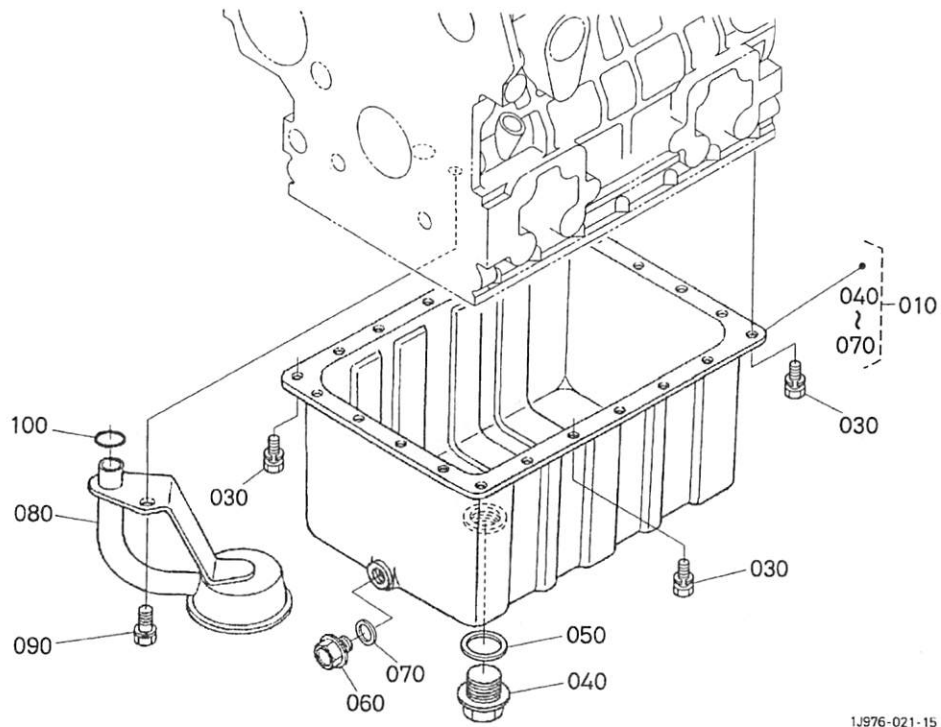
1G324-032-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1G694-01012	COMP.CRANKCASE	1				31.0
020	15451-96270	CAP,SEALING	4				0.01
030	15221-03490	CAP,SEALING	1				0.02
040	15261-96010	PLUG	3				0.002
050	16683-96020	PLUG	1				0.088
060	16241-96010	PLUG	3				0.007
070	15521-96020	PLUG	2				0.003
080	17391-96160	PLUG,EXPANSION	3				0.003
090	16271-96160	PLUG,EXPANSION	1				0.025
100	05012-00508	PIN,STRAIGHT	2				0.001
110	05012-00814	PIN,STRAIGHT	2				0.006
120	05012-00610	PIN,STRAIGHT	2				0.003
130	15231-33960	PIN,PIPE	2				0.001
140	16241-33650	PIN,PIPE	1				0.002
150	16241-96262	PLUG,FUEL CAMSHAFT	1				0.007
160	16261-56280	PIN(START SPRING)	1				0.004
170	16282-96010	PLUG	1				0.09
180	16271-55350	BUSHING(GEAR,GOBER NOR)	1				0.06
190	1G896-33610	PLUG	1				0.008
200	15021-33660	PACKING	1				0.001
210	16871-73020	COCK,ASSY(DRAIN)	1				0.034

D1105-E4B-KEA-1 -> ENGINE -> 000200 OIL PAN ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



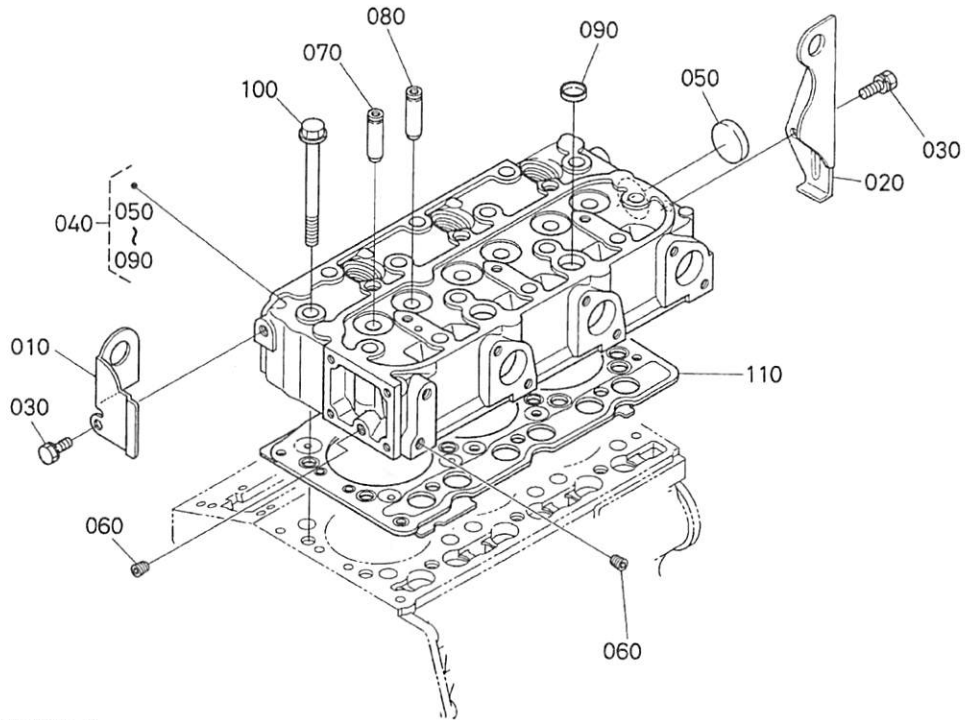
1J976-021-15

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16613-01605	KIT OIL PAN	1				1.7
030	01023-50614	BOLT,SEMS	22				0.005
040	15707-33750	PLUG(DRAIN)	1				0.095
050	16265-96670	PACKING	1				0.005
060	13901-33750	PLUG,DRAIN	1				0.025
070	6C090-58960	GASKET	1				0.005
080	16226-32114	FILTER,OIL	1				0.28
090	01123-50816	BOLT,SEMS	1				0.011
100	04814-00160	O RING	1				0.001

D1105-E4B-KEA-1 -> ENGINE -> 000300 CYLINDER HEAD ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016

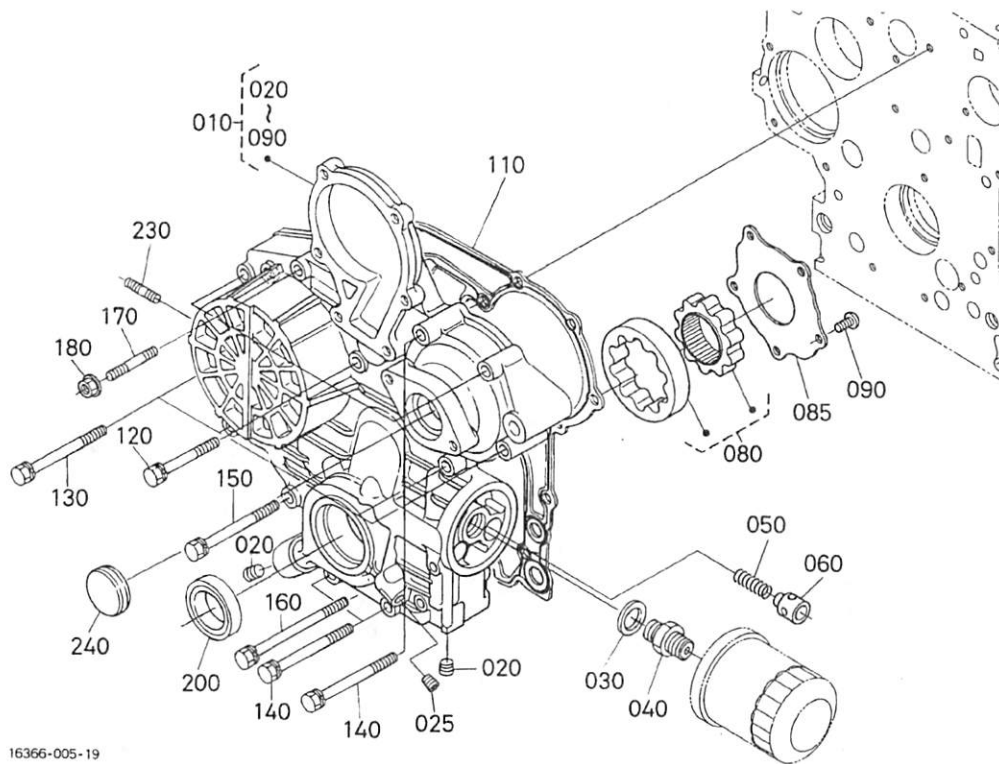


1G662-012-33

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16241-01753	HOOK,ENGINE	1				0.14
020	16241-01770	HOOK,ENGINE	1				0.175
030	01123-50814	BOLT,SEMS	2				0.01
040	1J096-03040	HEAD,CYL,COMP	1				9.3
050	15321-96260	CAP,SEALING	1				0.014
060	15261-03370	CAP,SEALING	2				0.005
070	16261-13540	GUIDE,INLET VALVE	3				0.02
080	16261-13560	GUIDE,EXHAUST VALVE	3				0.019
090	15261-96010	PLUG	2				0.002
100	16241-03450	BOLT,HEAD(CYLINDER)	14				0.05
110	1G063-03310	GASKET(HEAD,CYL)	1				0.16

Update Date: 01/06/2016, Printing Date: 14/09/2016



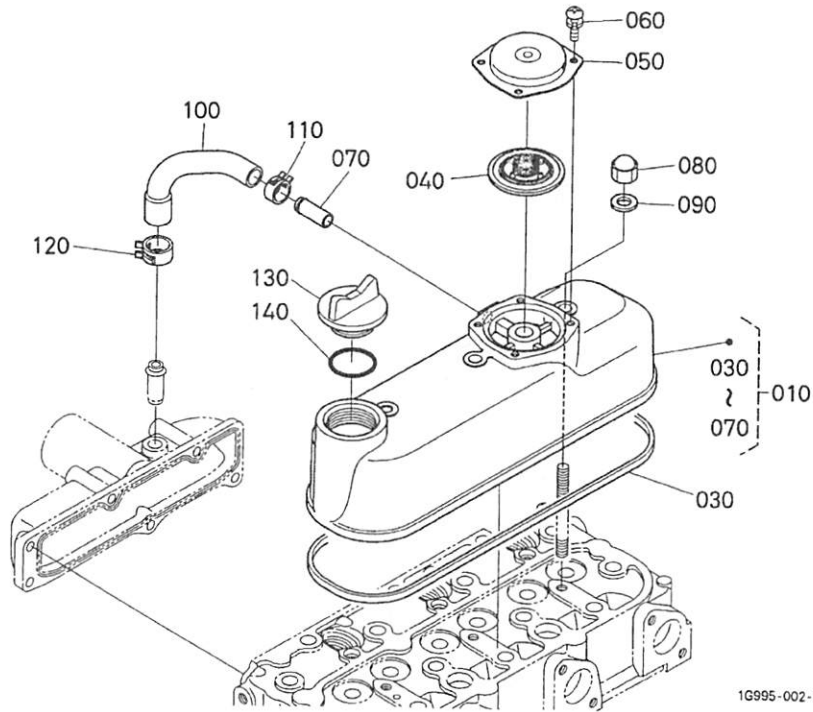
16366-005-19

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No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16252-04024	COMP.CASE,GEAR	1				2.46
020	16241-96020	PLUG	2				0.015
025	15521-96020	PLUG	1				0.003
030	04011-50180	WASHER,PLAIN	1				0.012
040	15241-32290	JOINT,PIPE	1				0.053
050	1J050-36950	SPRING	1				0.004
060	1J050-36930	VALVE(RELIEF)	1				0.005
080	1J050-35070	ROTOR,ASSY(OIL PUMP)	1				0.244
085	1J050-35132	COVER(OIL PUMP)	1				0.085
090	03017-50614	SCREW,BINDING(PHILLIPS)	5				0.005
110	16264-04132	GASKET,GEAR CASE	1				0.01
120	01023-50645	BOLT,SEMS	3				0.01
130	01023-50650	BOLT,SEMS	4				0.012
140	01023-50655	BOLT,SEMS	4				0.012
150	01023-50665	BOLT,SEMS	1				0.015
160	16241-91040	BOLT	1				0.015
170	16245-91530	STUD	1				0.01
180	02751-50060	NUT,FLANGE	1				0.005
200	16241-04212	SEAL,OIL	1				0.012
230	16245-91540	STUD	2				0.005
240	16264-83342	COVER,GEAR CASE	1				0.01

D1105-E4B-KEA-1 -> ENGINE -> 000500 HEAD COVER ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



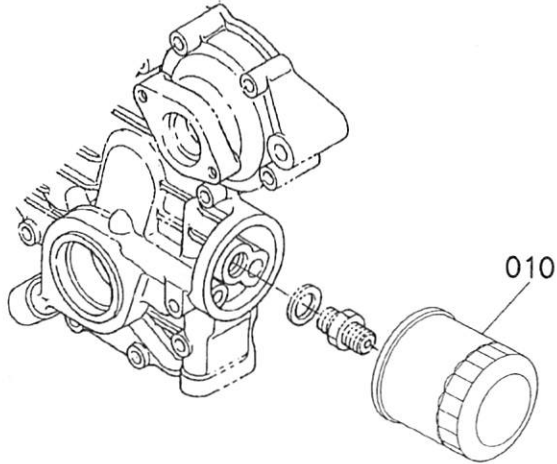
1G995-002-22

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1G032-14507	ASSY COVER,CYL.HEAD	1		<=1FHZ999		0.75
010	1G032-14508	ASSY COVER,CYL.HEAD	1	>>	>=1FJ0001		0.75
030	16261-14524	GASKET,HEAD COVER	1				0.01
040	1G911-05203	COMP VALVE,BREATHER	1				0.01
050	1G801-05120	COVER,BREATHER	1				0.035
060	03024-50510	SCREW,SEMS(PAN HEAD)	4				0.002
070	17331-73342	PIPE,WATER RETURN	1				0.01
080	15952-92330	NUT,CAP	3				0.01
090	15951-96660	PACKING	3				0.001
100	1G032-05510	TUBE,BREATHER	1				0.017
110	09318-88150	CLAMPHOSE	1				0.004
120	16259-05580	BAND,PIPE	1				0.03
130	E9151-33140	PLUG(OIL FILLER)	1				0.017
140	1J001-96770	O RING	1				0.001

D1105-E4B-KEA-1 -> ENGINE -> 000600 OIL FILTER ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



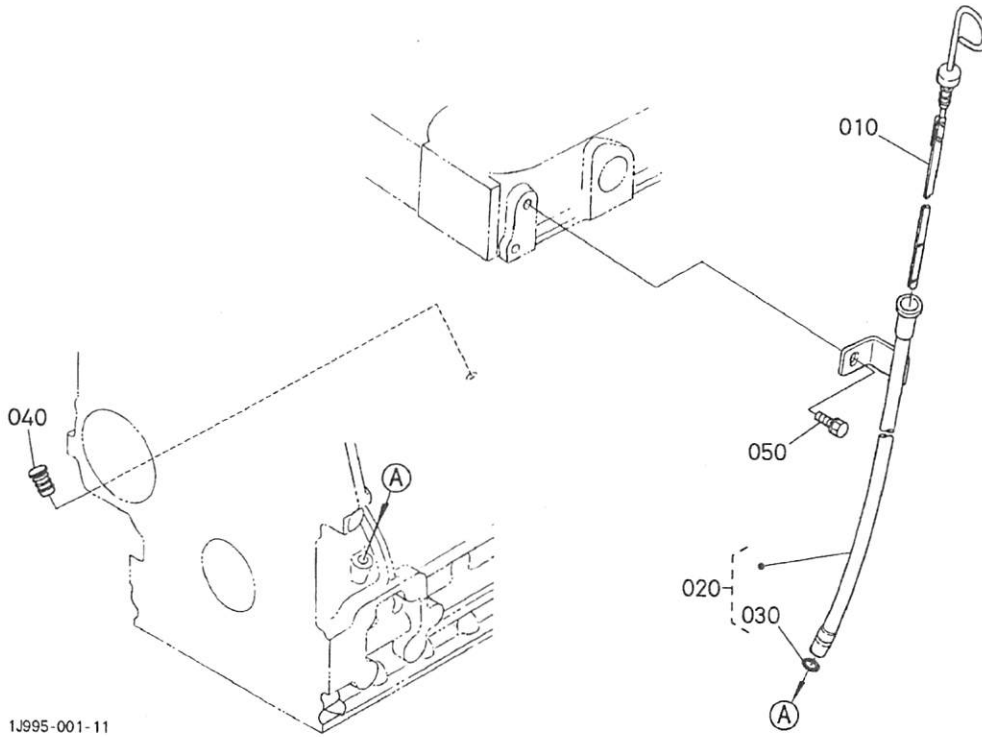
16615-003-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	HH160-32093	CARTRIDGE OIL FILTER	1				0.36

D1105-E4B-KEA-1 -> ENGINE -> 000700 DIPSTICK AND GUIDE ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016

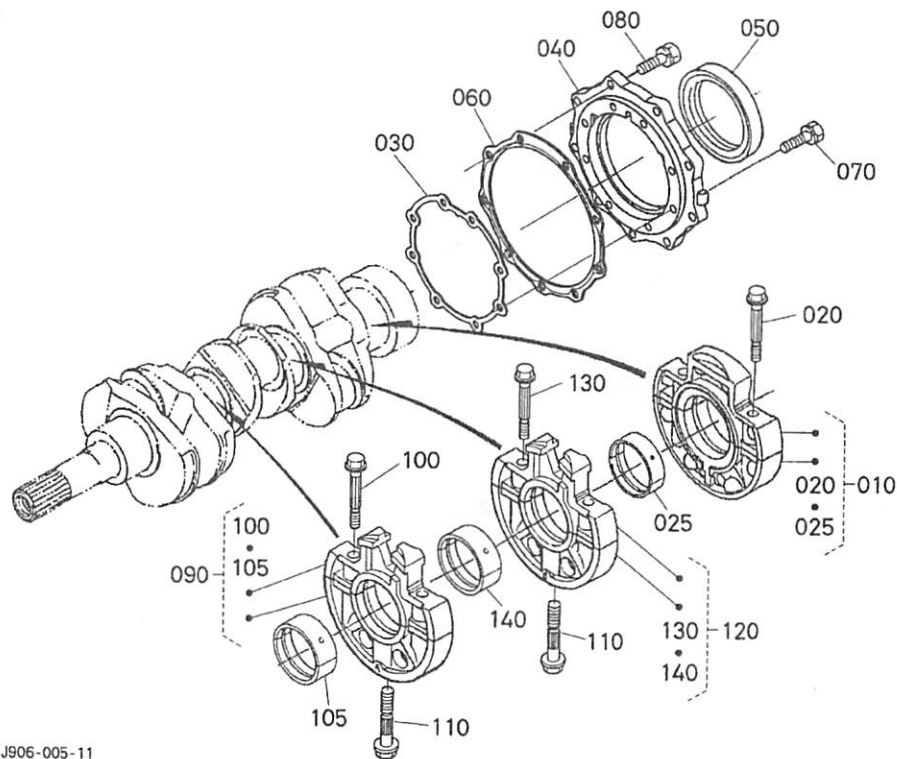


Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16611-36413	GAUGE,OIL	1				0.028
020	16282-36500	ASSY GUIDE,OIL GAUGE	1				0.11
030	04814-00090	O RING	1				0.001
040	1G513-36550	PLUG,OIL GAUGE	1				0.004
050	01123-50814	BOLT,SEMS	1				0.01

D1105-E4B-KEA-1 -> ENGINE -> 010000 MAIN BEARING CASE ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



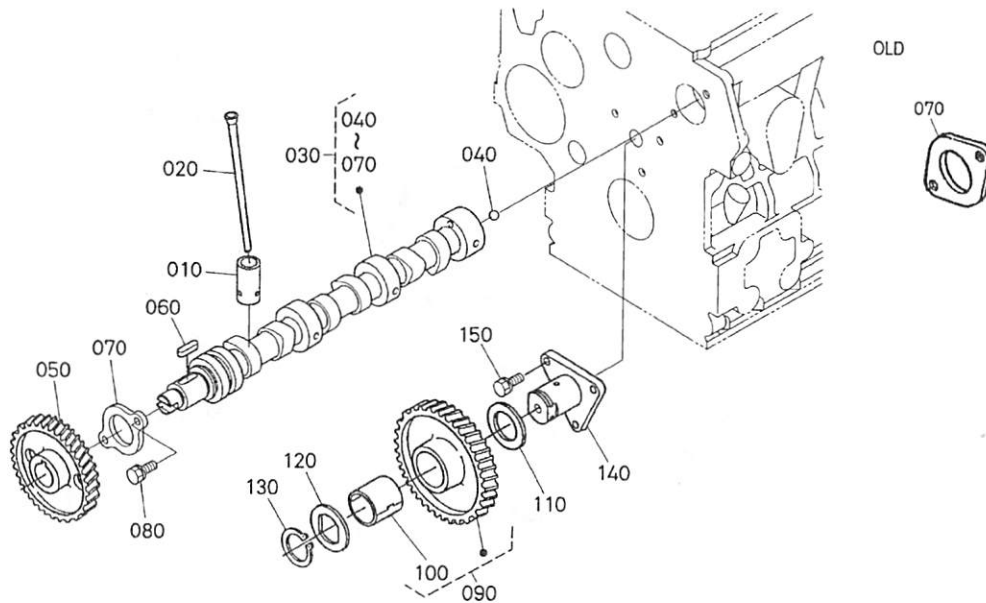
1J906-005-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16292-07095	CASE,BRG,ASSY(WHEEL)	1				1.1
020	16241-04540	BOLT(CASE,BRG)	2				0.02
025	16292-23494	METAL,CRANKSHAFT	1			STD SET	0.07
025	16292-23864	METAL,CRANKSHAFT	1			-0.20mm SET	0.05
025	16292-23874	METAL,CRANKSHAFT	1			-0.40mm SET	0.05
030	1J095-04360	GASKET(BRG.CASE)	1				0.006
040	16241-04815	COVER(CASE,BRG)	1				0.22
050	16285-04460	SEAL,OIL	1				0.003
060	16264-04822	GASKET	1				0.008
070	1G679-91010	BOLT	8				0.007
080	1G679-91020	BOLT	9				0.006
090	16261-07047	ASSY BRG.CASE,MAIN	1				0.86
100	16241-04540	BOLT(CASE,BRG)	2				0.02
105	16292-23483	METAL,CRANKSHAFT	1			STD SET	0.05
105	16292-23933	METAL,CRANKSHAFT	1			-0.20mm SET	0.05
105	16292-23943	METAL,CRANKSHAFT	1			-0.40mm SET	0.05
110	16241-04560	BOLT(CASE,BRG)	2				0.03
120	16261-07057	ASSY BRG.CASE,MAIN	1				0.8
130	16241-04540	BOLT(CASE,BRG)	2				0.02
140	16292-23483	METAL,CRANKSHAFT	1			STD SET	0.05
140	16292-23933	METAL,CRANKSHAFT	1			-0.20mm SET	0.05
140	16292-23943	METAL,CRANKSHAFT	1			-0.40mm SET	0.05

D1105-E4B-KEA-1 -> ENGINE -> 010100 CAMSHAFT AND IDLE GEAR SHAFT ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



1J976-036-16

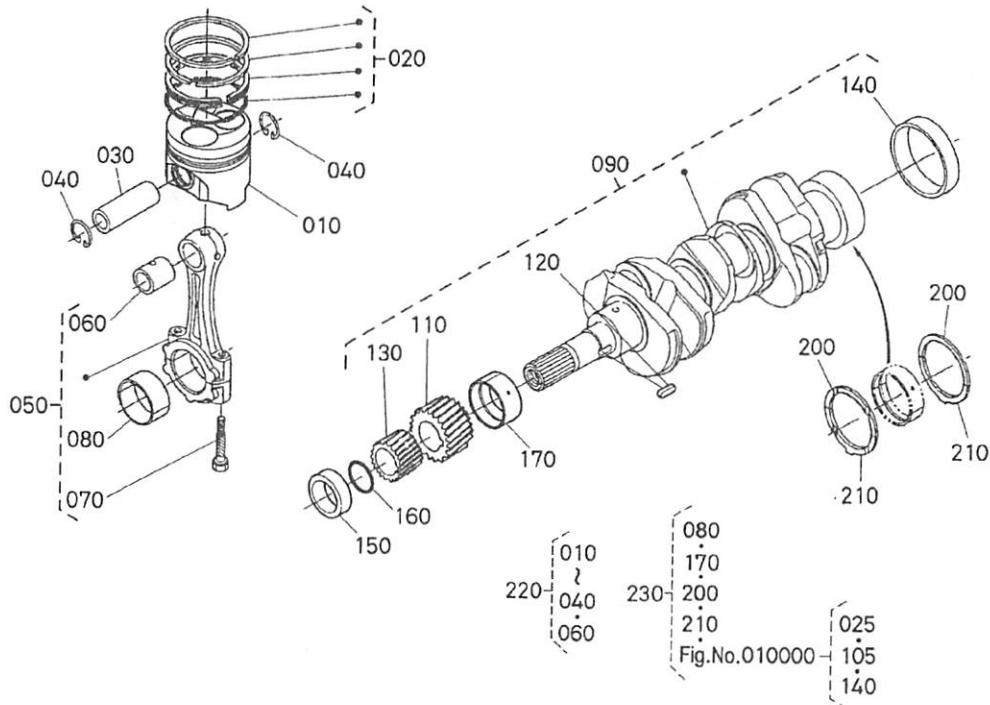
10324-828-10

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1G673-15550	TAPPET	6				0.035
020	16241-15114	PUSH ROD	6				0.028
030	1J096-16010	ASSY CAMSHAFT	1				1.55
040	07715-00401	BALL 1/4	1				0.001
050	16241-16510	GEAR,CAM	1				0.45
060	05712-00518	FEATHER KEY	1				0.003
070	16241-16270	STOPPER(CAMSHAFT)	1		<=1EKZ999		0.04
070	1J097-16270	STOPPER(CAMSHAFT)	1	>>	>=1EL0001		0.03
080	01023-50616	BOLT,SEMS	2				0.006
090	16271-24012	COMP GEAR,IDLE	1				0.6
100	16271-24982	BUSH,IDLE GEAR	1				0.02
110	16241-24360	COLLAR,IDLE GEAR	1				0.01
120	16241-24370	COLLAR,IDLE GEAR	1				0.012
130	16241-24320	CIR CLIP,IDLE GEAR	1				0.003
140	16241-24250	SHAFT,IDLE GEAR	1				0.255
150	01023-50616	BOLT,SEMS	3				0.006

D1105-E4B-KEA-1 -> ENGINE -> 010200 PISTON AND CRANKSHAFT ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



1J905-026-12

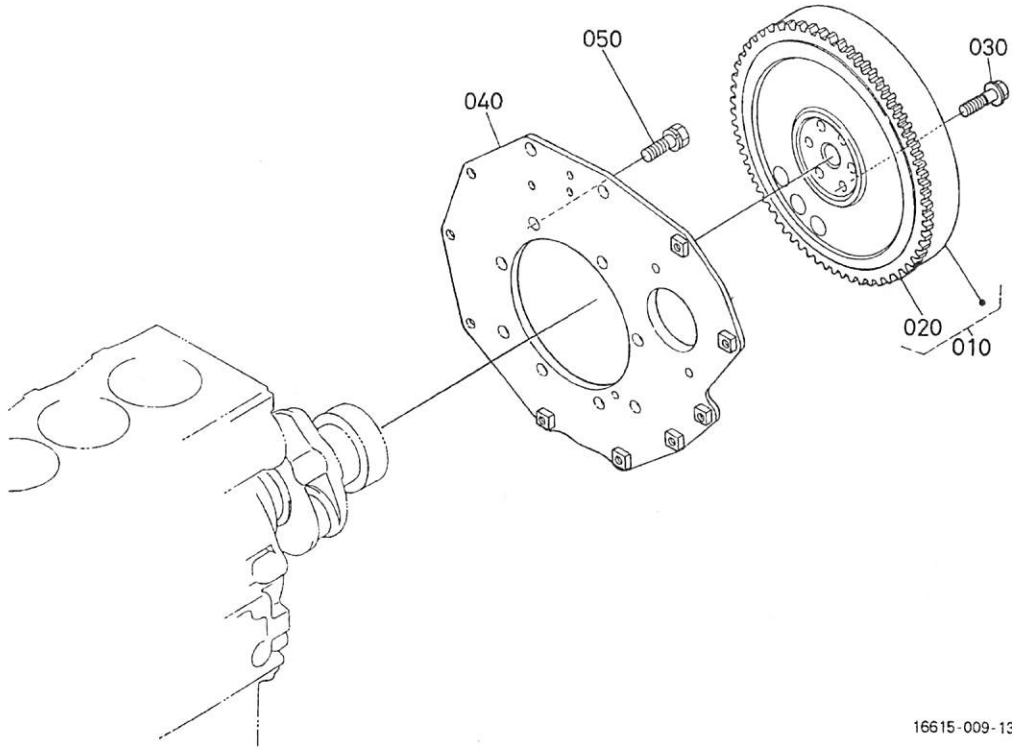
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1J097-21110	PISTON	3			STD	0.414
010	1J097-21910	PISTON(05)	3			+0.50mm	0.425
020	1J050-21050	RING,PISTON,ASSY	3			STD	0.04
020	1J050-21090	RING,PISTON,ASSY 05	3			+0.50mm	0.032
030	16241-21310	PIN,PISTON	3				0.135
040	16241-21330	CIRCLIP(PIN,PISTON)	6				0.002
050	16292-22016	ROD,CONNECTING,ASSY	3				0.526
060	1G700-21980	BUSH,PISTON PIN	3				0.01
070	16241-22142	BOLT(CONNECTING ROD)	6				0.024
080	16292-22310	METAL(PIN,CRANK)	3			STD SET	0.04
080	16292-22972	METAL,CRANKPIN	3			-0.20mm SET	0.033
080	16292-22982	METAL,CRANKPIN	3			-0.40mm SET	0.034
090	1G065-23013	COMP.CRANKSHAFT	1				8.61
110	1A055-24110	GEAR(CRANKSHAFT)	1				0.142
120	16271-95230	KEY	1				0.005
130	1J050-35630	GEAR(OIL PUMP DRIVE)	1				0.09
140	16241-23280	SLEEVE,CRANKSHAFT	1				0.06
150	1J050-23250	COLLAR(CRANKSHAFT)	1				0.047
160	04814-10280	RING	1				0.001
170	16292-23473	METAL(CRANKSHAFT)	1			STD	0.046
170	16292-23913	METAL(CRANKSHAFT)	1			-0.20mm	0.005

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
170	16292-23923	METAL(CRANKSHAFT)	1			-0.40mm	0.05
200	15521-23533	METAL,SIDE	2			STD	0.01
200	15521-23953	METAL,SIDE	2			+0.20mm	0.01
200	15521-23963	METAL,SIDE	2			+0.40mm	0.01
210	19202-23543	METAL,SIDE	2			STD	0.01
210	19202-23973	METAL,SIDE	2			+0.20mm	0.01
210	19202-23983	METAL,SIDE	2			+0.40mm	0.01
220	1J097-21770	PISTON,KIT(STD)	3			STD	0.658
220	1J097-21790	PISTON,KIT(050)	3			+0.50mm	0.668
230	1G995-23755	METAL,KIT(ENGINE)	1			STD	0.325
230	1G993-23765	METAL,KIT(ENGINE)	1			-0.20mm/+0.20mm	0.32
230	1G993-23775	METAL,KIT(ENGINE)	1			-0.40mm/+0.40mm	0.49

D1105-E4B-KEA-1 -> ENGINE -> 010300 FLYWHEEL ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016

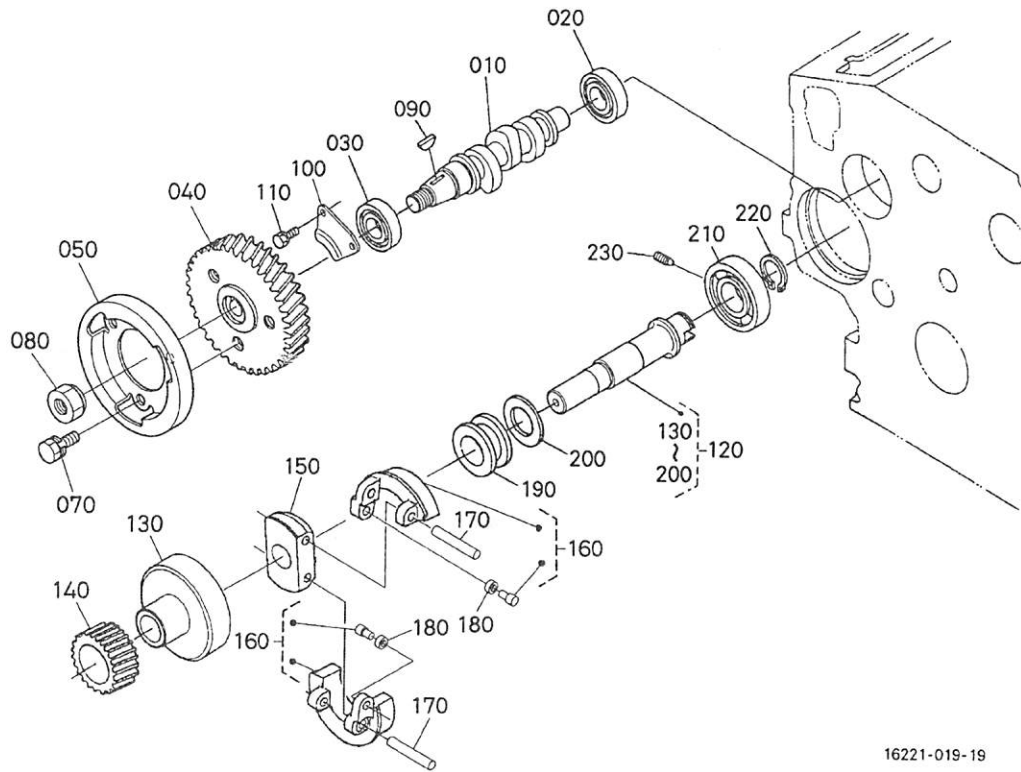


16615-009-13

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16692-25013	COMP.FLYWHEEL	1				13.1
020	1G081-63820	GEAR,RING	1				0.63
030	16241-25160	BOLT,FLYWHEEL	6				0.03
040	16241-04620	PLATE,REAR END	1				2.77
050	15261-91190	BOLT	8				0.03

Update Date: 01/06/2016, Printing Date: 14/09/2016



16221-019-19

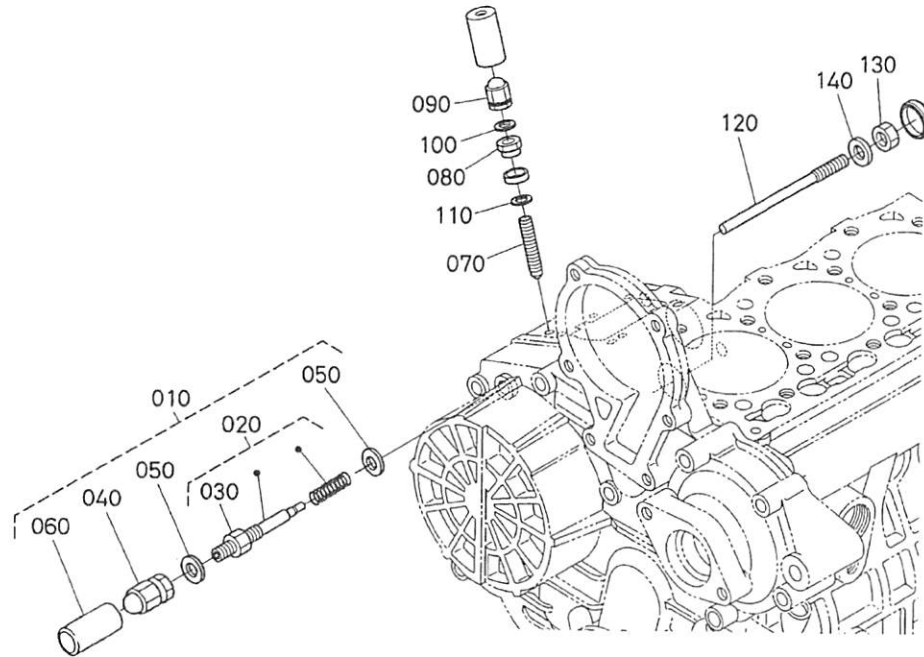
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16020-16170	CAMSHAFT,FUEL	1				0.38
020	16261-97300	BEARING,BALL	1				0.044
030	16261-97310	BEARING,BALL	1				0.1
040	16272-51150	GEAR,INJECTION PUMP	1				0.49
050	16241-51114	CAM,FUEL	1				0.196
070	01023-50612	BOLT,SEMS	3				0.005
080	1J050-92330	NUT	1				0.021
090	16241-95230	KEY,WOODRUFF	1				0.001
100	16241-16320	STOPPER,FUEL.C/SHAF T	1				0.04
110	01023-50616	BOLT,SEMS	2				0.006
120	16265-55019	ASSY SHAFT,GOVERNOR	1				1.12
130	16241-55392	HOLDER,GOVERNOR GEAR	1				0.34
140	16282-55320	GEAR,GOVERNOR	1				0.24
150	16241-55270	HOLDER,GOV.WEIGHT	1				0.085
160	16241-55064	COMP.WEIGHT,GOVER NOR	2				0.085
170	16241-55260	SHAFT,GOV. WEIGHT	2				0.013
180	19484-55440	ROLLER	2				0.005
190	16241-55450	SLEEVE,GOVERNOR	1				0.04
200	16241-55463	WASHER,THRUST	1				0.005
210	16261-97320	BALL BEARING	1				0.14

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
220	16271-55410	CIR CLIP,GOV.SHAFT	1				0.005
230	16241-55554	SCREW,SET	1				0.007

D1105-E4B-KEA-1 -> ENGINE -> 018000 IDLE APPARATUS ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



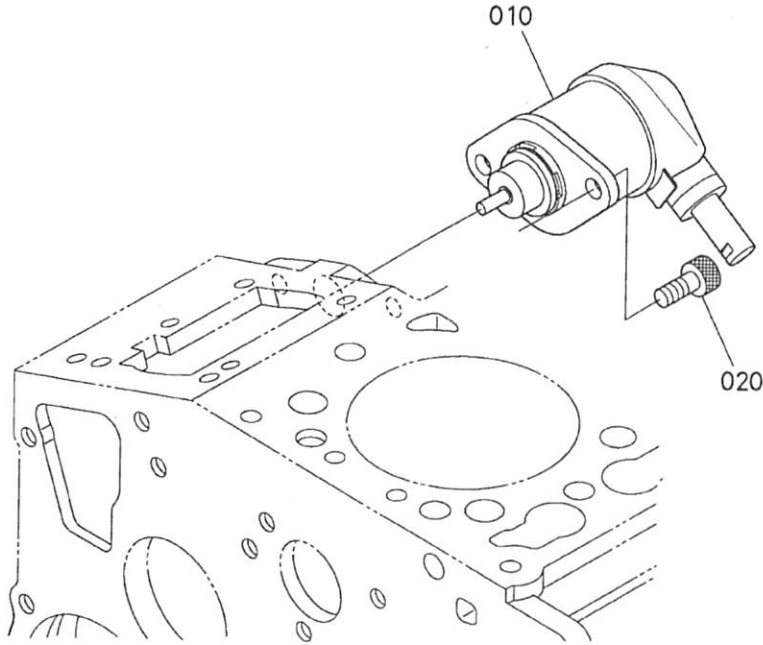
1J995-073-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16285-54093	ASSY APPARATUS,IDLE	1				0.02
020	16285-54103	ASSY BOLT,ADJUSTING	1				0.007
030	15841-92020	NUT	1				0.004
040	15852-92330	NUT,CAP	1				0.005
050	15601-96650	PACKING	2				0.001
060	16221-54420	CAP	1				0.001
070	16241-54122	BOLT,ADJUSTING	1				0.005
080	1G031-54210	NUT(LOCK)	1				0.003
090	15852-92330	NUT,CAP	1				0.005
100	15601-96650	PACKING	1				0.001
110	1G021-96650	GASKET	1		<=1FZZ999		0.001
110	15601-96650	PACKING	1	NI	>=1GA0001		0.001
120	1G053-54150	BOLT	1				0.009
130	02056-50060	HEX.NUT	1				0.002
140	15601-96650	PACKING	1				0.001

D1105-E4B-KEA-1 -> ENGINE -> 020100 STOP SOLENOID ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



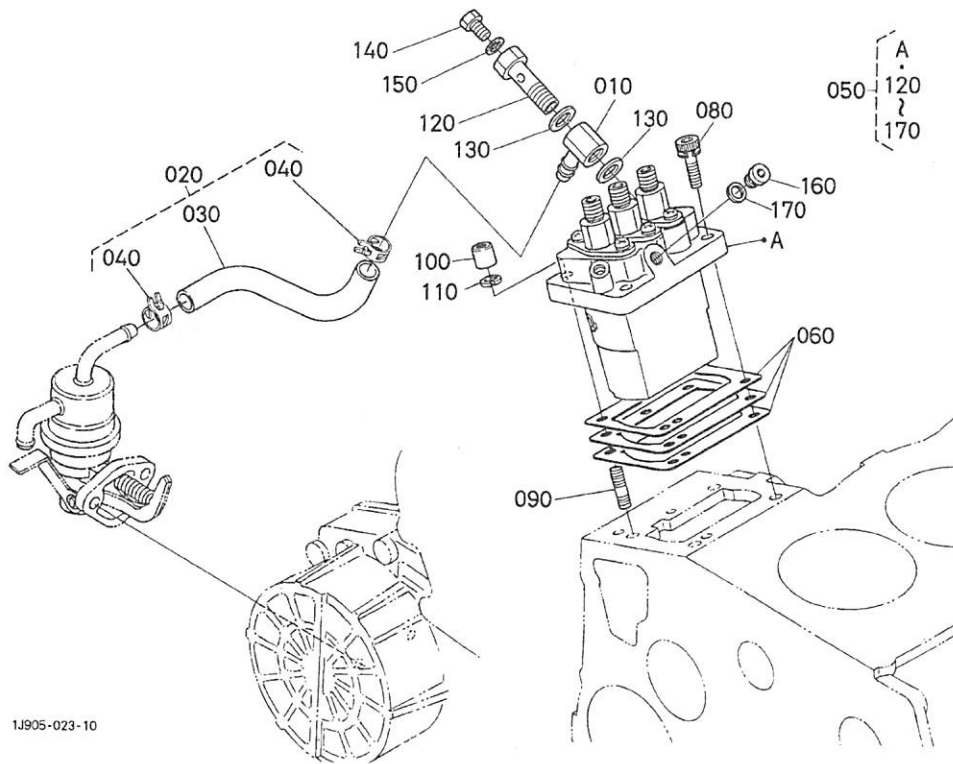
1J401-030-13

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	17208-60016	ASSY SOLENOID,STOP	1				0.2
020	01311-10612	BOLT,SOCKET HEAD	2				0.005

D1105-E4B-KEA-1 -> ENGINE -> 020200 INJECTION PUMP ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016

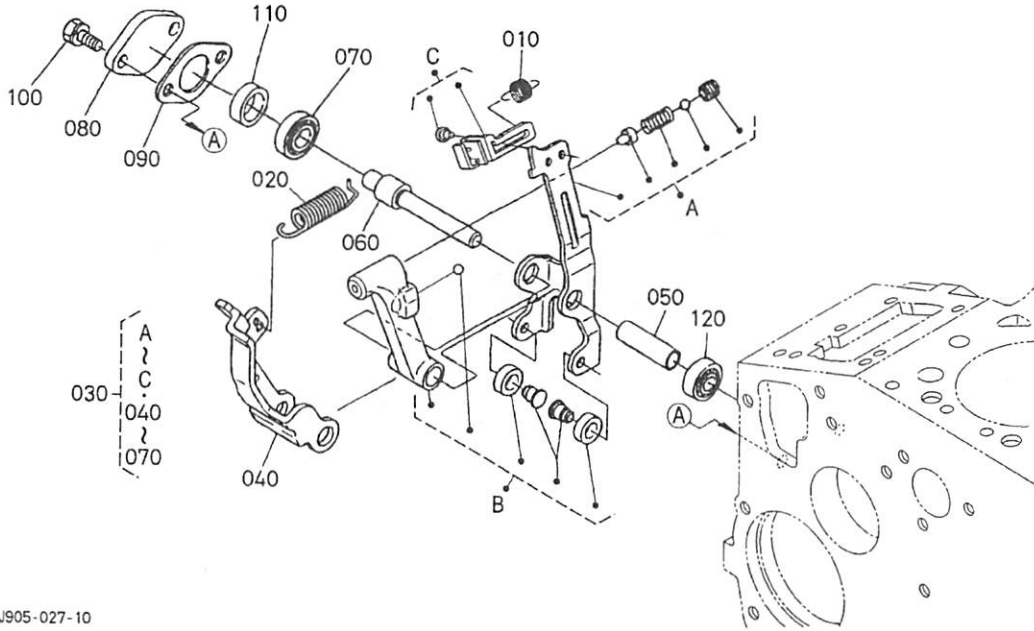


1J905-023-10

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16241-95690	JOINT,EYE	1				0.05
020	16032-42010	TUBE,FUEL,ASSY	1				0.012
030	09661-80075	TUBE,FUEL	1				0.01
040	14911-42750	CLIP,PIPE	2				0.002
050	16030-51013	ASSY PUMP,INJECTION	1				1.0
060	1G700-52200	SHIM,INJECTION	1		0.175mm		0.005
060	16006-52092	SHIM,INJECTION	1		0.200mm		0.004
060	16006-52112	SHIM(INJECTION PUMP)	1		0.250mm		0.004
060	16006-52122	SHIM(INJECTION PUMP)	1		0.300mm		0.006
060	1G700-52160	SHIM,INJECTION PUMP	1		0.350mm		0.004
080	16871-91060	BOLT,SOCKET HEAD	2				0.007
090	15841-91500	STUD	2				0.02
100	15841-92320	NUT,CAP	2				0.01
110	04512-50060	WASHER,SPRING LOCK	2				0.001
120	16030-51320	BOLT,JOINT	1				0.07
130	15841-96650	GASKET	2				0.001
140	15841-51350	SCREW	1				0.005
150	15841-96660	GASKET	1				0.001
160	16030-96010	PLUG	1				0.008
170	15861-96650	GASKET	1				0.001

Update Date: 01/06/2016, Printing Date: 14/09/2016



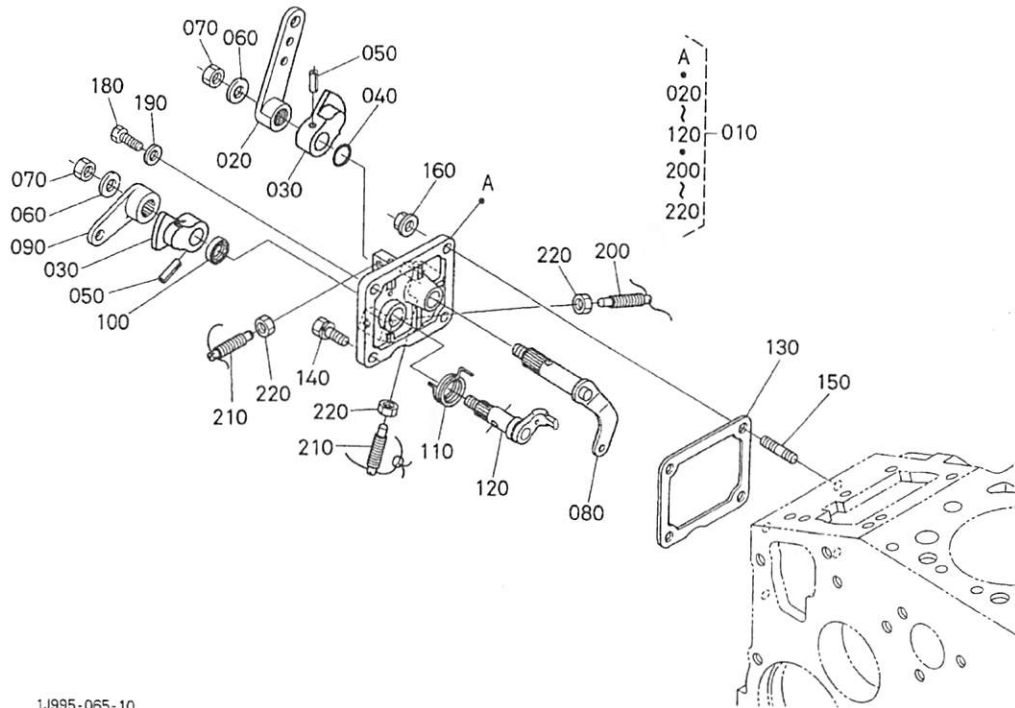
1J905-027-10

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16261-56480	SPRING,START	1				0.002
020	16285-56412	SPRING,GOVERNOR	1				0.022
030	1G673-56010	ASSY LEVER,FORK	1				0.25
040	1G032-56130	LEVER,FORK	1				0.08
050	1G032-56150	SHAFT,FORK LEVER	1				0.007
060	1G032-56470	SHAFT,FORK LEVER	1				0.04
070	16241-56330	BEARING,MINIATURIZE	1				0.007
080	16241-56253	COVER,FORK LEV.SHAFT	1				0.025
090	16299-56260	GASKET	1				0.002
100	01023-50612	BOLT,SEMS	2				0.005
110	16241-56210	COLLAR	1				0.008
120	16241-56340	BEARING,MINIATURIZE	1				0.007

D1105-E4B-KEA-1 -> ENGINE -> 020500 SPEED CONTROL PLATE ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



1J995-065-10

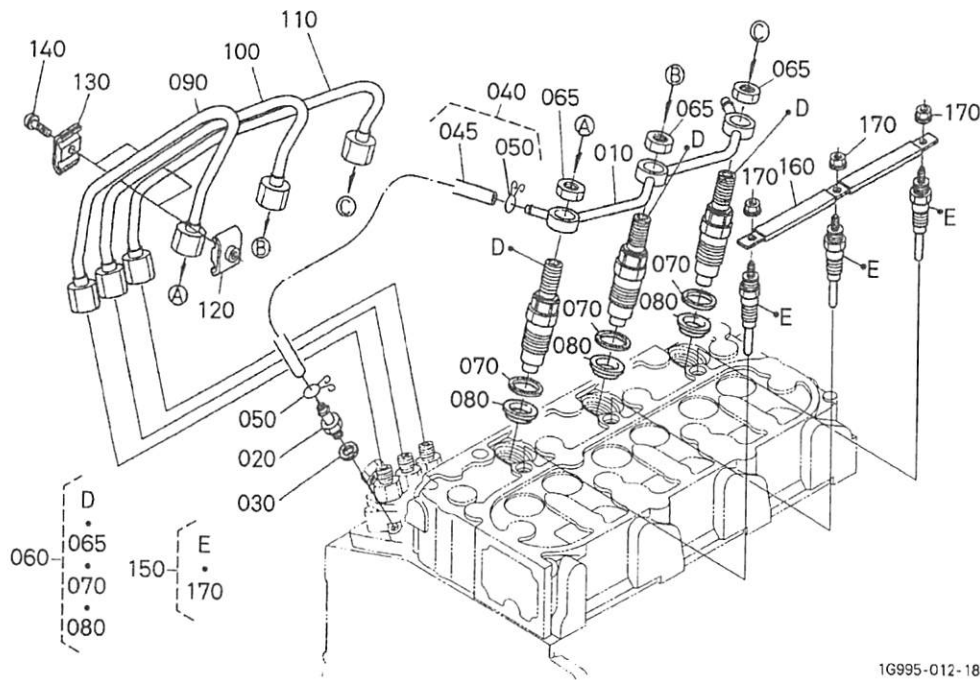
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16299-57015	PLATE,ASSY(CONTROL)	1				0.32
020	16271-57150	LEVER,SPEED CONTROL	1				0.05
030	16241-57160	LEVER,SPEED CONTROL	2				0.02
040	04814-00100	O RING	1				0.001
050	05411-00420	PIN,SPRING	2				0.001
060	16241-94020	WASHER,PLAIN	2				0.002
070	16241-92020	NUT	2				0.002
080	16271-56023	COMP.LEVER,GOVERNOR	1				0.05
090	16271-57720	LEVER,ENGINE STOP	1				0.03
100	15471-57980	SEAL,OIL	1				0.001
110	16222-57510	SPRING,RETURN	1				0.01
120	16271-57740	SHAFT,STOP LEVER	1				0.039
130	16264-57210	GASKET	1				0.002
140	01023-50616	BOLT,SEMS	1				0.006
150	16245-91540	STUD	2				0.005
160	02751-50060	NUT,FLANGE	2				0.005
180	01053-50616	HEX,BOLT	1				0.005
190	15601-96650	PACKING	1				0.001
200	1G263-57630	BOLT,ADJUSTING	1				0.005
210	16241-57632	BOLT(ADJUSTING)	2				0.005

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
220	02056-50060	HEX.NUT	3				0.002

D1105-E4B-KEA-1 -> ENGINE -> 020600 NOZZLE HOLDER AND GLOW PLUG ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



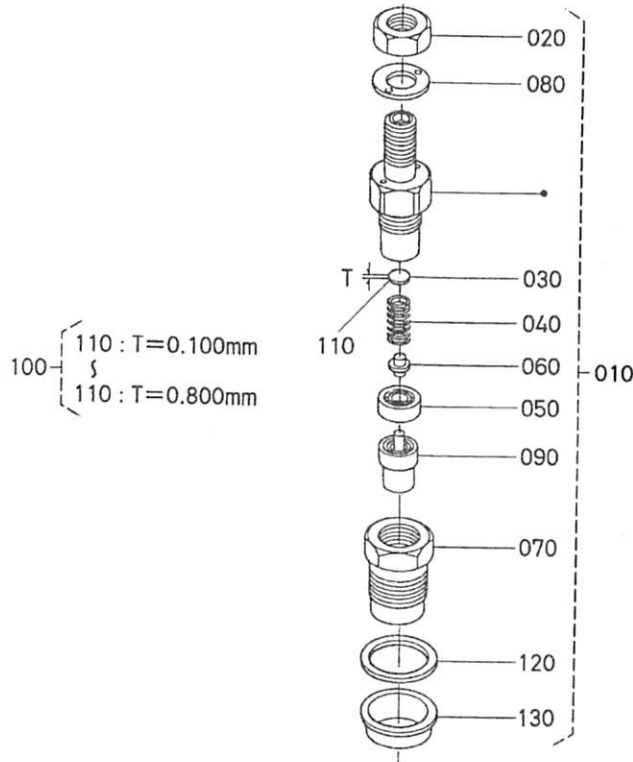
1G995-012-18

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16261-42502	ASSY PIPE,OVER FLOW	1				0.04
020	15841-51360	SCREW, BLEATHER	1				0.008
030	15601-96650	PACKING	1				0.001
040	15841-42500	ASSY PIPE,OVER FLOW	1				0.01
045	15841-42520	PIPE,FUEL OVER FLOW	1				0.006
050	14971-42750	CLIP,PIPE	2				0.001
060	1G677-53903	KIT HOLDER,NOZZLE	3				0.152
065	1G826-92032	NUT	3				0.004
070	15841-53622	GASKET	3				0.002
080	19077-53650	SEAL HEAT	3				0.002
090	16271-53712	PIPE,INJECTION	1				0.12
100	16271-53722	PIPE,INJECTION	1				0.12
110	16271-53732	PIPE,INJECTION	1				0.118
120	15841-53850	CLAMP,PIPE	2				0.008
130	15841-53860	CLAMP,PIPE	2				0.008
140	03024-50520	SCREW,SEMS(PAN HEAD)	2				0.004
150	1G679-65512	PLUG,GLOW	3				0.016
160	16261-65560	CORD,GLOW PLUG	1				0.01
170	02761-50040	NUT,FLANGE	3				0.002

D1105-E4B-KEA-1 -> ENGINE -> 020700 NOZZLE HOLDER (COMPONENT PARTS) ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



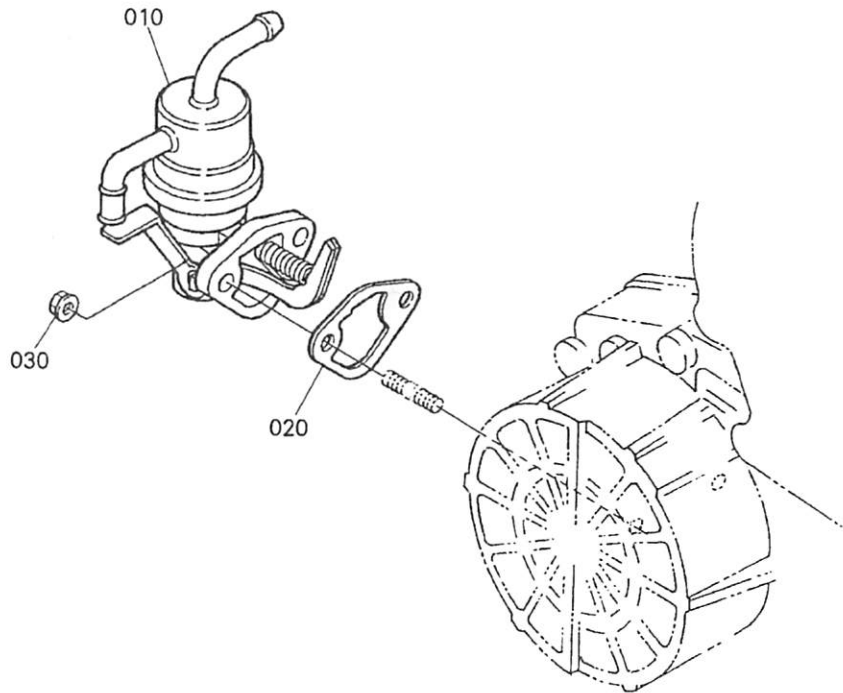
1G347-015-12

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1G677-53903	KIT HOLDER,NOZZLE	3				0.152
020	1G826-92032	NUT	3				0.004
030	16032-53230	WASHER,ADJUSTING	3				0.001
040	16032-53170	SPRING,NOZZLE	3				0.007
050	16032-53350	SPACER,DISTANCE	3				0.02
060	16032-53160	PUSH ROD	3				0.001
070	16032-53280	NUT,NOZZLE	3				0.037
080	16032-94040	WASHER,PLAIN	3				0.002
090	1G677-53612	PIECE,NOZZLE	3				0.019
100	16032-98100	ASSY WASHER,ADJUST	3			OPTION	0.016
110	16032-98500	WASHER,ADJUSTING	3			0.100mm	0.001
110	16032-98510	WASHER,ADJUSTING	3			0.200mm	0.001
110	16032-98520	WASHER,ADJUSTING	3			0.300mm	0.001
110	16032-98530	WASHER,ADJUSTING	3			0.400mm	0.001
110	16032-98540	WASHER,ADJUSTING	3			0.500mm	0.001
110	16032-98550	WASHER,ADJUSTING	3			0.520mm	0.001
110	16032-98560	WASHER,ADJUSTING	3			0.540mm	0.001
110	16032-98570	WASHER,ADJUSTING	3			0.560mm	0.001
110	16032-98580	WASHER,ADJUSTING	3			0.580mm	0.001
110	16032-98590	WASHER,ADJUSTING	3			0.800mm	0.001
120	15841-53622	GASKET	3				0.002
130	19077-53650	SEAL HEAT	3				0.002

D1105-E4B-KEA-1 -> ENGINE -> 030100 FUEL PUMP (MECHANICAL) ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



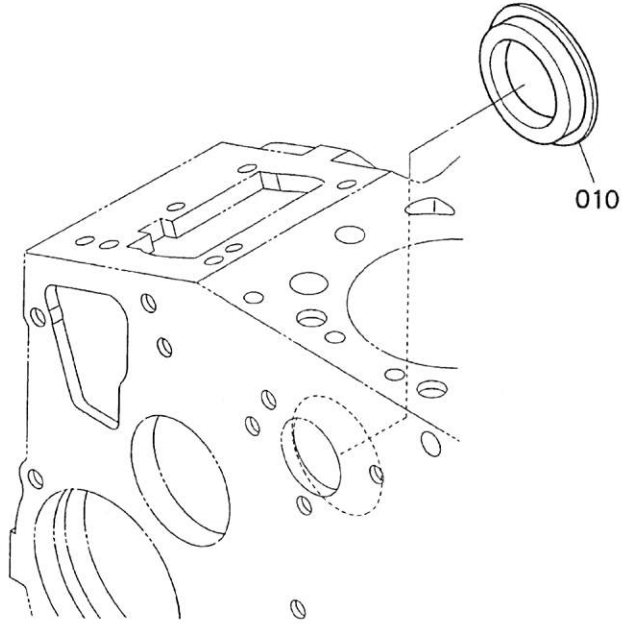
16615-012-21

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No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16285-52032	ASSY PUMP,FUEL	1				0.14
020	16261-52140	GASKET,FUEL PUMP	1				0.001
030	02751-50060	NUT,FLANGE	2				0.005

D1105-E4B-KEA-1 -> ENGINE -> 030500 COVER ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



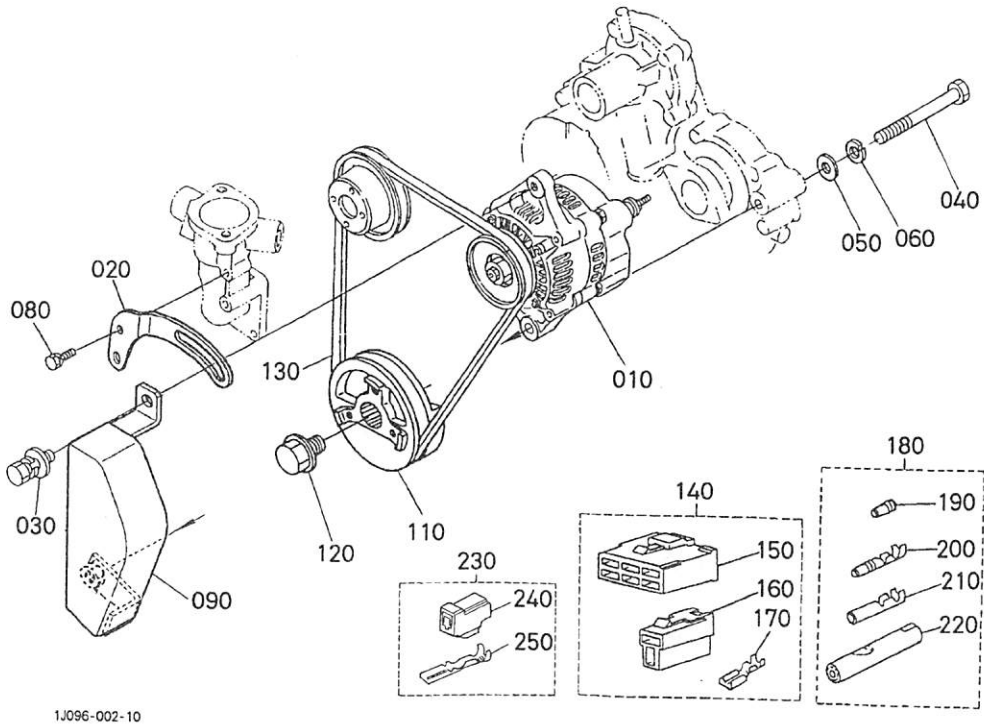
1J401-040-10

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16264-83153	COVER, HYDRAULIC PUMP	1				0.028

D1105-E4B-KEA-1 -> ENGINE -> 040200 ALTERNATOR AND PULLEY ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



1J096-002-10

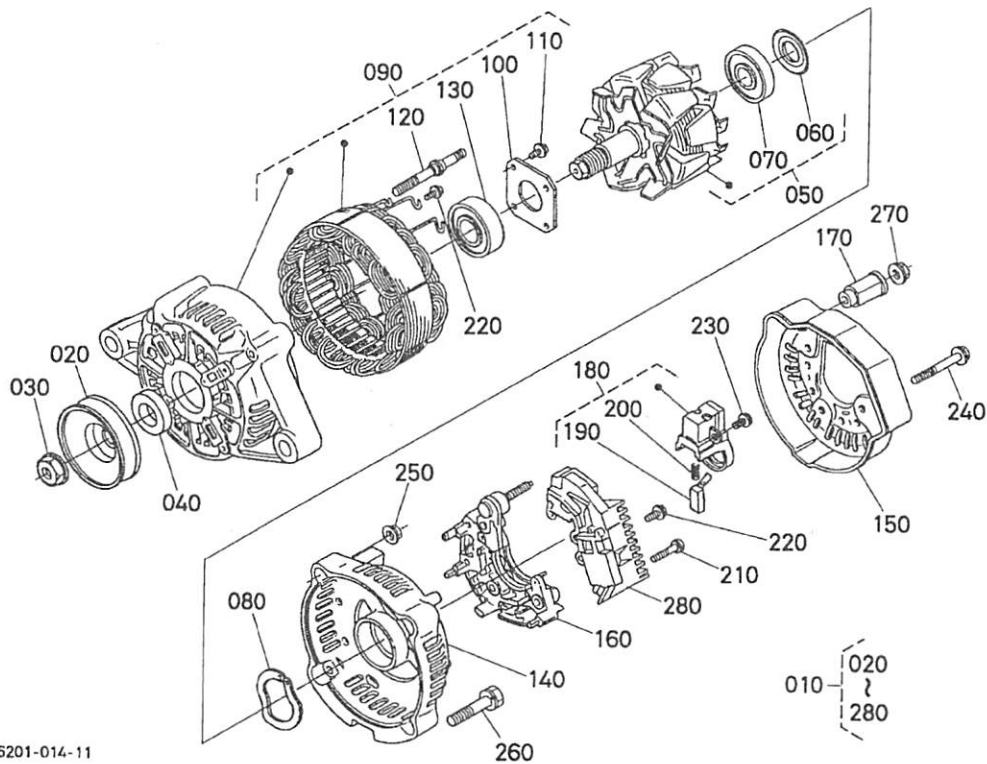
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16241-64012	ASSY ALTERNATOR	1		<=1EMZ999	12V 40A ORDER BY REF.No.010 NEW PART	3.0
010	16241-64013	ASSY ALTERNATOR	1	>>	>=1EN0001	12V 40A	3.0
020	16241-64422	STAY,DYNAMO	1				0.095
030	01127-50830	BOLT,W SEMS(LARGE WASHER)	1				0.023
040	01173-51085	HEX.BOLT	1				0.051
050	04011-50100	WASHER,PLAIN	1				0.002
060	04512-50100	WASHER,SPRING LOCK	1				0.003
080	01023-50616	BOLT,SEMS	1				0.006
090	16616-13860	COVER,BELT	1				0.2
110	16229-74280	PULLEY,FAN DRIVE	1				1.19
120	16241-91020	BOLT(FAN DRIVE)	1				0.1
130	16282-97013	V BELT	1			37.5in	0.072
140	19883-65830	ASSY COUPLER	1				0.013
150	19872-65840	CONNECTOR	1				0.006
160	19872-65880	CONNECTOR	1				0.001
170	19237-65910	TERMINAL	7				0.001
180	19268-65780	ASSY TERMINAL	1				0.003
190	68271-65920	SLEEVE	1				0.001
200	68271-65910	TERMINAL	1				0.003
210	19268-65930	TERMINAL	1				0.001
220	19268-65870	SLEEVE	1				0.001

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
230	1C010-65830	ASSY COUPLER,SOLENO.	1				0.005
240	1C010-65880	CONNECTOR	1				0.005
250	1C010-65910	TERMINAL	2				0.001

D1105-E4B-KEA-1 -> ENGINE -> 040300 ALTERNATOR (COMPONENT PARTS) ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



16201-014-11

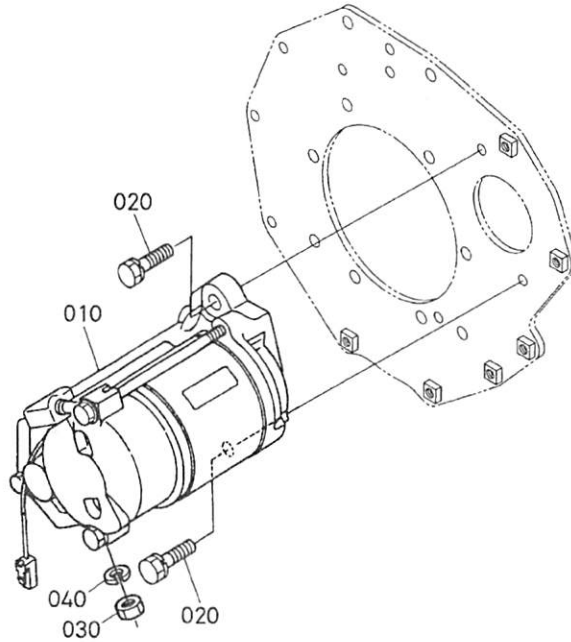
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16241-64012	ASSY ALTERNATOR	1		<=1EMZ999	ORDER BY REF.No.010 NEW PART	3.0
010	16241-64013	ASSY ALTERNATOR	1	>>	>=1EN0001		3.0
020	15881-64110	PULLEY,DYNAMO	1				0.16
030	15881-92010	NUT	1				0.02
040	15881-64150	COLLAR	1				0.004
050	66436-64040	ROTOR	1				1.2
060	15881-64800	COVER, BEARING	1				0.001
070	16652-64770	BEARING BALL	1				0.045
080	15881-64810	WASHER,THRUST	1				0.002
090	66436-64020	FRAME,ASSY(DRIVE END)	1		<=1EMZ999	ORDER BY REF.No.090 NEW PART	1.1
090	66436-64022	FRAME,DRIVE END	1	>>	>=1EN0001		1.1
100	15881-64710	PLATE, RETAINER	1				0.01
110	15881-93010	SCREW, ROUND HEAD	4				0.003
120	15881-64260	BOLT, THROUGH	2				0.01
130	16652-64780	BRG,BALL	1		<=1EMZ999	ORDER BY REF.No.130 NEW PART	0.05
130	16652-64782	BEARING BALL	1	>>	>=1EN0001		0.05
140	16231-64060	FRAME,END	1				0.17
150	16231-64230	COVER,END	1				0.035
160	16241-64850	ASSY RECTIFIER	1				0.16
170	16241-64900	BUSH INSULATION	1				0.007
180	16652-64310	HOLDER BRUSH	1				0.025
190	15881-64090	BRUSH	2				0.002

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
200	15881-64330	SPRING, BRUSH	2				0.002
210	15881-93020	SCREW, ROUND HEAD	2				0.005
220	15881-93030	SCREW, ROUND HEAD	6				0.003
230	15881-93040	SCREW, ROUND HEAD	1				0.003
240	15881-91040	BOLT	3				0.005
250	15881-92020	NUT	2				0.02
260	15881-91050	BOLT	2				0.01
270	14182-92030	NUT	1				0.003
280	1K531-64602	ASSY REGULATOR	1				0.08

D1105-E4B-KEA-1 -> ENGINE -> 040400 STARTER ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



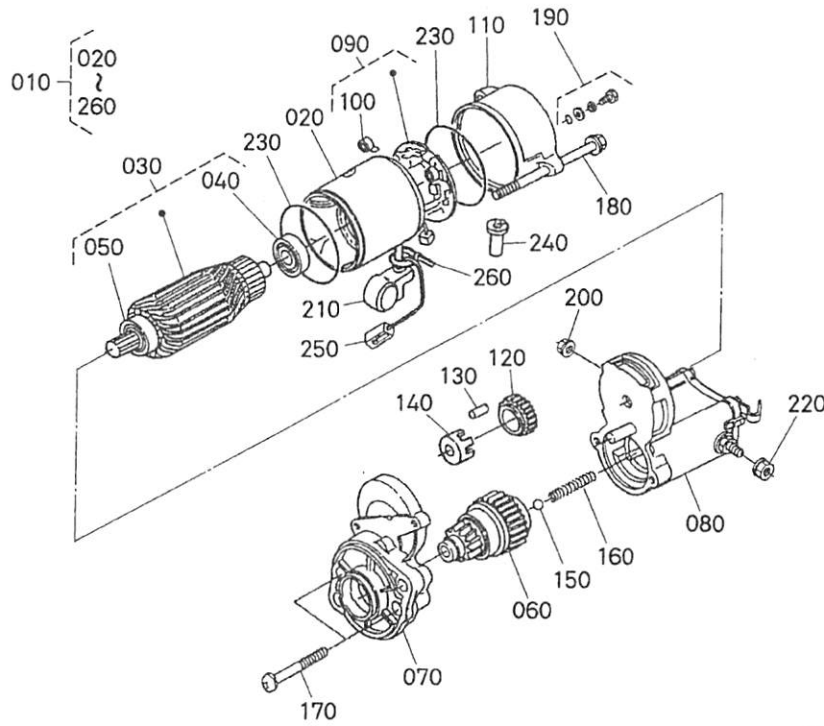
1J996-012-10

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	37560-63010	ASSY STARTER	1			12V 1.2kW	3.45
020	01123-50830	BOLT,SEMS	2				0.015
030	02114-50080	HEX.NUT	1				0.005
040	04512-50080	WASHER,SPRING LOCK	1				0.002

D1105-E4B-KEA-1 -> ENGINE -> 040500 STARTER (COMPONENT PARTS) ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



37560-013-27

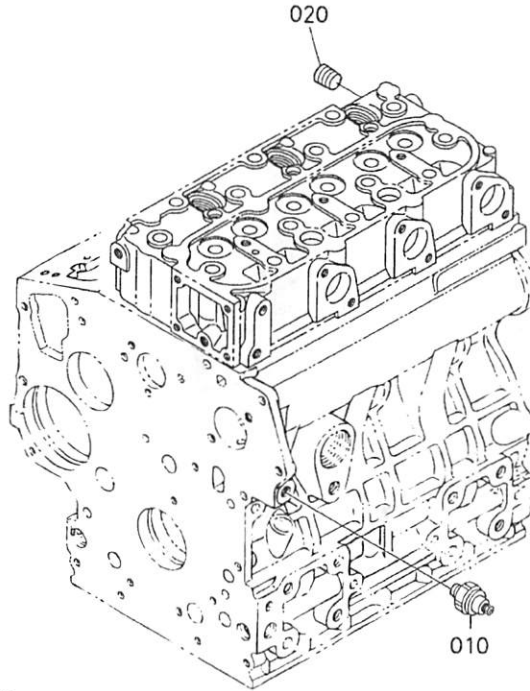
Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	37560-63010	ASSY STARTER	1				3.45
020	37560-63080	YOKE	1				0.83
030	11460-63070	ARMATURE	1				0.05
040	11460-63530	BEARING	1				0.02
050	11460-63500	BEARING	1				0.03
060	16285-63040	ASSY CLUTCH	1				0.55
070	16285-63030	ASSY HOUSING	1				0.43
080	16611-63020	ASSY SWITCH, MAGNETIC	1				0.91
090	11470-63380	ASSY HOLDER, BRUSH	1				0.3
100	11460-63390	SPRING, BRUSH	4				0.01
110	16285-63200	ASSY FRAME, END	1				0.103
120	11460-63270	GEAR	1				0.04
130	19212-63100	ROLLER	5				0.002
140	11460-63110	RETAINER	1				0.01
150	19212-97130	BALL	1				0.003
160	11460-63120	SPRING	1				0.01
170	11460-93310	BOLT	2				0.01
180	11460-63320	BOLT, THROUGH	2				0.02
190	15511-63760	ASSY BOLT	2				0.005
200	16285-92010	NUT, HEXAGON	1				0.005
210	16611-63450	COVER	1				0.03
220	16611-92020	NUT, HEXAGON	1				0.005

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
230	15511-96660	O RING	2				0.005
240	16285-63570	PIPE,DRAIN	1				0.005
250	16611-63660	CORD,STOP SOLENOID	1				0.005
260	16612-63100	BAND,COVER	1				0.01

D1105-E4B-KEA-1 -> ENGINE -> 040600 OIL SWITCH AND PLUG ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



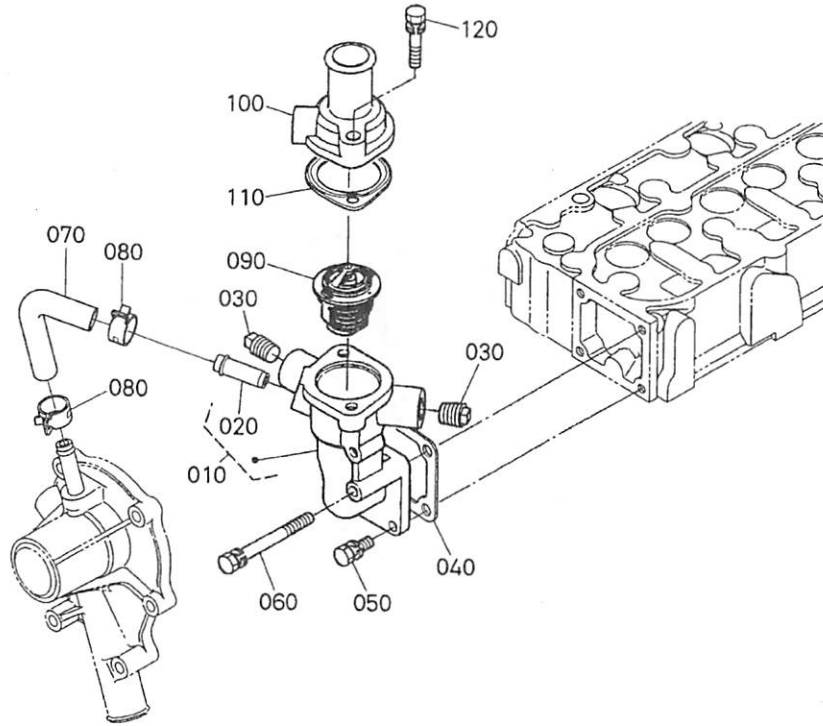
1G383-081-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	15841-39010	SWITCH,OIL	1		<=1FZZ999		0.03
010	15841-39013	SWITCH,OIL	1	>>	>=1GA0001		0.03
020	15841-96020	PLUG	1				0.02

D1105-E4B-KEA-1 -> ENGINE -> 050000 WATER FLANGE AND THERMOSTAT ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



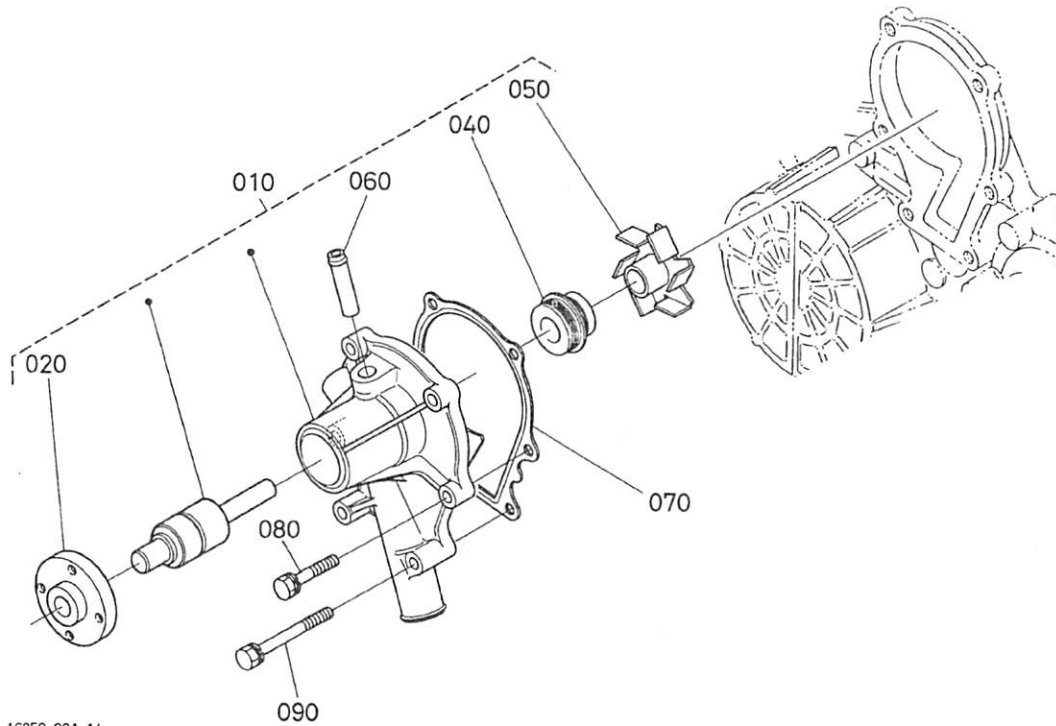
16614-024-24

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16613-72700	COMP FLANGE, WATER	1				0.266
020	16241-73370	PIPE, WATER RETURN	1				0.007
030	19071-96020	PLUG	2				0.022
040	16264-72920	GASKET, WATER FLANGE	1				0.001
050	01023-50616	BOLT, SEMS	3				0.006
060	01023-50655	BOLT, SEMS	1				0.012
070	16241-73350	PIPE, WATER RETURN	1				0.015
080	1G687-73362	CLAMP, HOSE	2				0.002
090	19434-73014	ASSY THERMOSTAT	1				0.07
100	16219-73260	COVER(THERMOSTAT)	1				0.099
110	16221-73270	GASKET, THERMOSTAT	1				0.001
120	01123-50835	BOLT, SEMS	2				0.02

D1105-E4B-KEA-1 -> ENGINE -> 050100 WATER PUMP ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



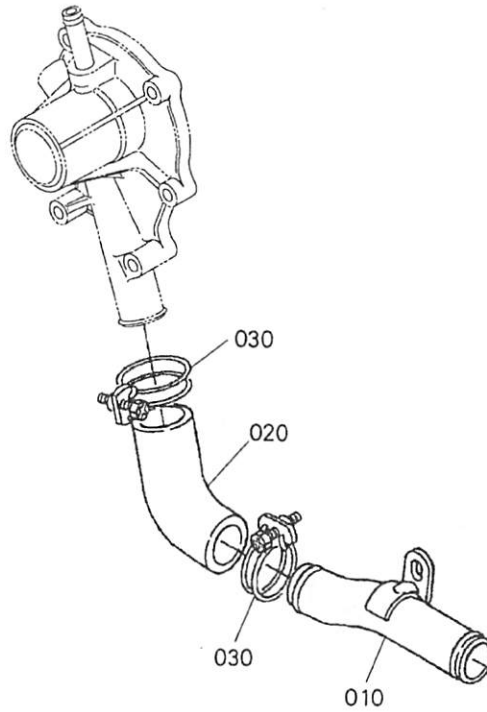
16259-001-14

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16251-73034	PUMP,WATER,ASSY	1				0.8
020	16259-73520	FLANGE,WATER PUMP	1				0.15
040	16642-73050	ASSY SEAL,MECHANICAL	1				0.03
050	16259-73512	IMPELLER,WATER PUMP	1				0.09
060	15852-73340	PIPE,WATER RETURN	1				0.02
070	16239-73430	GASKET,WATER PUMP	1				0.007
080	01023-50630	BOLT,SEMS	4				0.008
090	01023-50685	BOLT,SEMS	2				0.018

D1105-E4B-KEA-1 -> ENGINE -> 050300 WATER PIPE ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



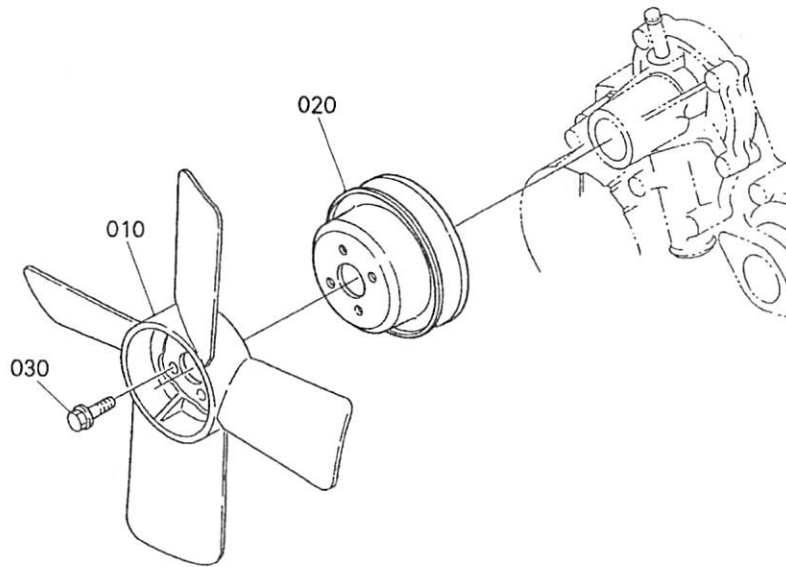
1J401-025-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	17203-72860	PIPE,WATER	1				0.16
020	1G680-72870	PIPE,WATER	1				0.053
030	1G677-72960	CLAMP,HOSE	2				0.024

D1105-E4B-KEA-1 -> ENGINE -> 050400 COOLING FAN ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



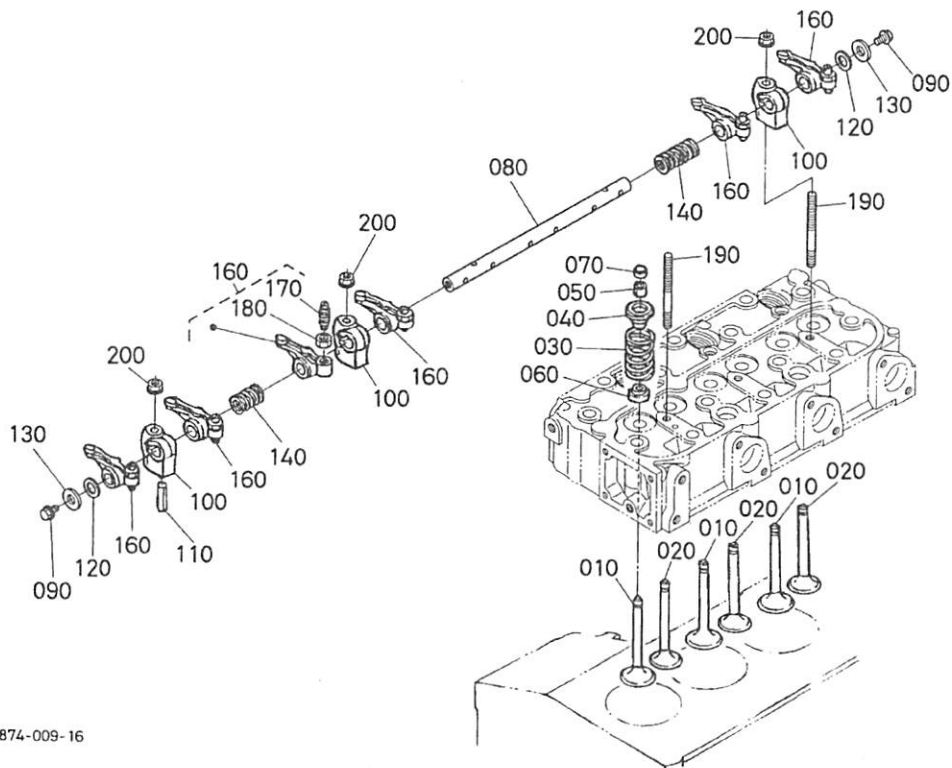
16235-003-11

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	16265-74110	FAN	1				0.24
020	16241-74250	PULLEY,FAN	1				0.24
030	01754-50610	BOLT,FLANGE	4				0.006

D1105-E4B-KEA-1 -> ENGINE -> 060000 VALVE AND ROCKER ARM ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



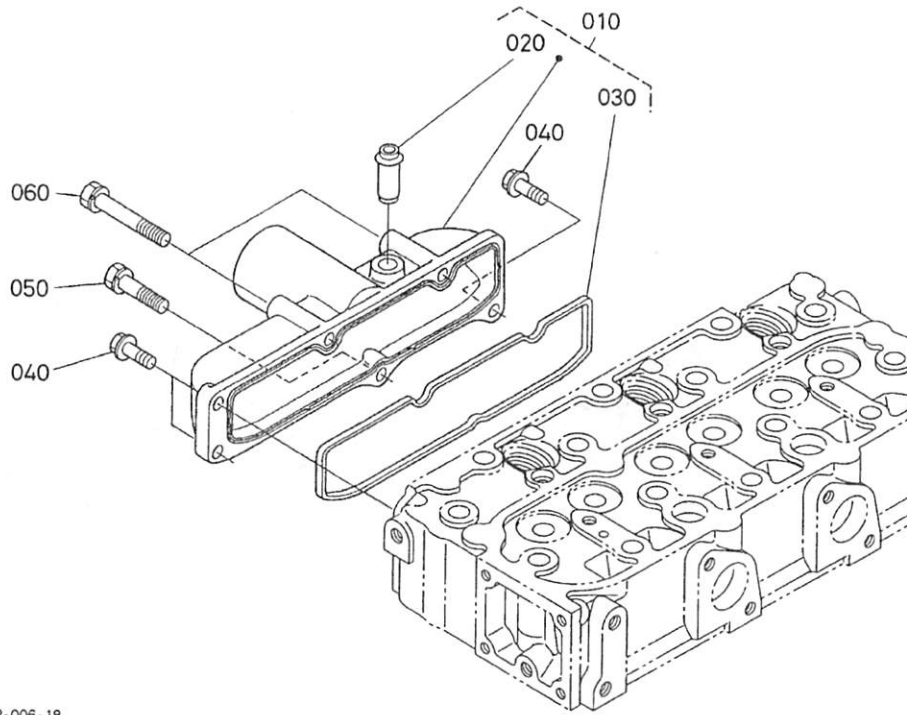
1G874-009-16

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	1G673-13110	VALVE,INLET	3				0.043
020	1G673-13120	VALVE,EXHAUST	3				0.043
030	16271-13240	SPRING,VALVE	6				0.015
040	16261-13330	RETAINER,VALVE SP.	6				0.015
050	15261-13360	COLLET,VALVE SPRING	6		SET		0.001
060	1C010-13150	SEAL,VALVE STEM	6				0.002
070	16241-13280	CAP,VALVE	6				0.005
080	16261-14266	SHAFT,ROCKER ARM	1				0.16
090	01754-50610	BOLT,FLANGE	2				0.006
100	16241-14350	BRACKET(ARM,ROCKE R)	3				0.04
110	05411-00428	PIN,SPRING	1				0.002
120	16241-14430	WASHER(R- ARM.SHAFT)	2				0.002
130	15841-94022	WASHER,PLAIN	2				0.005
140	16241-14310	SPRING(ARM,ROCKER)	2				0.004
160	16241-14032	ARM,ROCKER,ASSY	6				0.052
170	16241-14230	SCREW,ADJUSTING	6				0.008
180	16241-14240	NUT	6				0.004
190	16241-14410	STUD	3				0.022
200	1J095-92010	NUT,FLANGE	3				0.005

D1105-E4B-KEA-1 -> ENGINE -> 060100 INLET MANIFOLD ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016



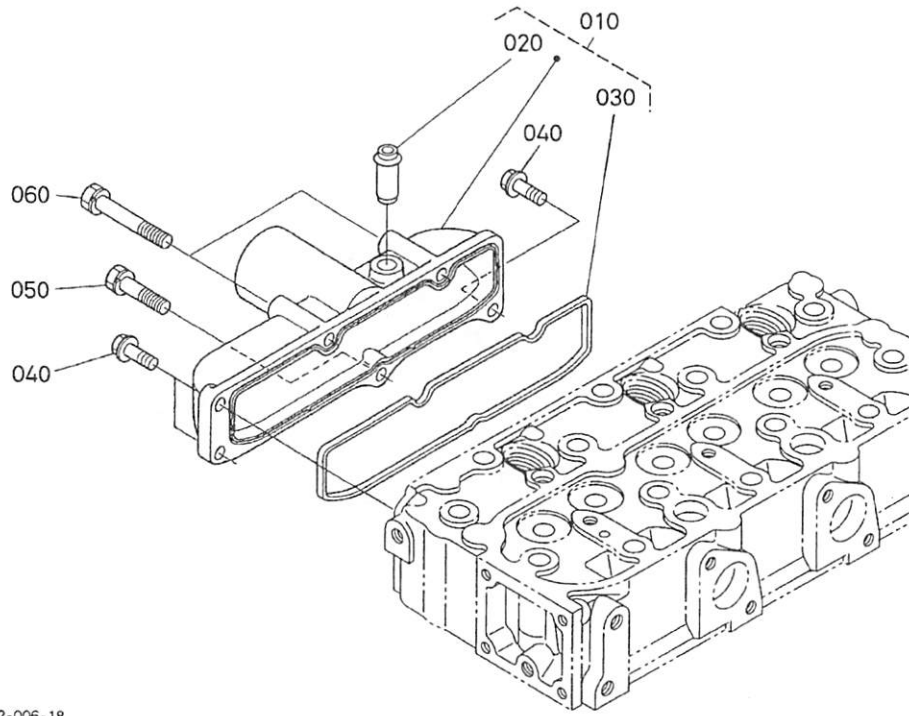
1G062-006-18

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	17407-11770	ASSY MANIFOLD,INLET	1		<=1FMZ999		0.3
010	17407-11773	ASSY MANIFOLD,INLET	1	>>	>=1FN0001		0.284
020	16241-05550	JOINT,BREATHER PIPE	1				0.02
030	16261-11822	GASKET(IN-MANIFOLD)	1				0.01
040	01754-50616	BOLT,FLANGE	3				0.006
050	01023-50630	BOLT,SEMS	1				0.008
060	01023-50650	BOLT,SEMS	2				0.012

D1105-E4B-KEA-1 -> ENGINE -> 060100 INLET MANIFOLD ## D1105-E4B-KEA-1

Update Date: 01/06/2016, Printing Date: 14/09/2016

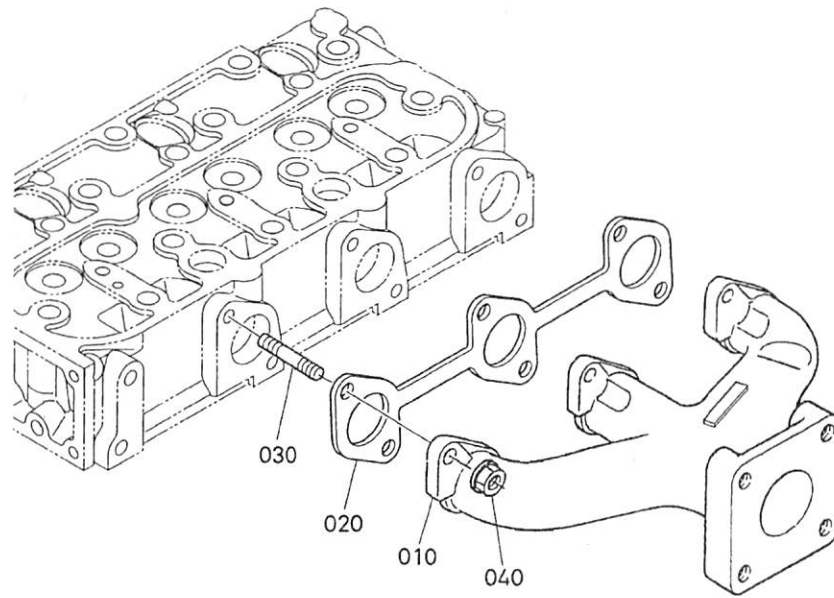


1G062-006-18

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	17407-11770	ASSY MANIFOLD,INLET	1		<=1FMZ999		0.3
010	17407-11773	ASSY MANIFOLD,INLET	1	>>	>=1FN0001		0.284
020	16241-05550	JOINT,BREATHER PIPE	1				0.02
030	16261-11822	GASKET(IN-MANIFOLD)	1				0.01
040	01754-50616	BOLT,FLANGE	3				0.006
050	01023-50630	BOLT,SEMS	1				0.008
060	01023-50650	BOLT,SEMS	2				0.012

Update Date: 01/06/2016, Printing Date: 14/09/2016



16611-028-16

Interchangeable =, Not Interchangeable NI, New for Old >>, Old for New <<

No	Part Number	Part Name	Qty	IC	S/N	Remarks	Kg
010	17213-12312	MANIFOLD,EXHAUST	1				1.47
020	16261-12350	GASKET,EX-MANIFOLD	1				0.019
030	16241-91490	STUD	6				0.005
040	16271-92010	NUT	6				0.004

- Oil used in the engine should have API classification and Proper SAE Engine Oil according to the ambient temperatures as shown below:

Above 25°C (77°F)	SAE30, SAE10W-30 or 15W-40
-10 to 25°C (14°F to 77°F)	SAE10W-30 or 15W-40
Below -10°C (14°F)	SAE10W-30

- Recommended API classification
Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used : (Ultra Low Sulfur or High Sulfur Fuels).

Fuel type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	CF (If the "CF-4, CG-4, CH-4 or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	---
Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	CF, CF-4, CG-4, CH-4 or CI-4	CF or CI-4 (Class CF-4, CG-4 and CH-4 engine, oils cannot be used on EGR type engines.)

EGR: Exhaust Gas Re-circulation

ENGLISH

PERIODIC SERVICE

FUEL

Fuel is flammable and can be dangerous. You should handle fuel with care.



CAUTION

To avoid personal injury:

- Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.
- Be careful not to spill fuel during refueling. If fuel should spill, wipe it off at once, or it may cause a fire.
- Do not fail to stop the engine before refueling. Keep the engine away from the fire.
- Be sure to stop the engine while refueling or bleeding and when cleaning or changing fuel filter or fuel pipes. Do not smoke when working around the battery or when refueling.
- Check the fuel systems at a well ventilated and wide place.
- When fuel and lubricant are spilled, refuel after letting the engine cool off.
- Always keep spilled fuel and lubricant away from engine.

Fuel level check and refueling

1. Check to see that the fuel level is above the lower limit of the fuel level gauge.
2. If the fuel is too low, add fuel to the upper limit. Do not overfill.

Flash Point, °C (°F)	Water and Sediment, volume %	Carbon Residue on, 10 percent Residuum, %	Ash, weight %
Min	Max	Max	Max
52 (125)	0.05	0.35	0.01

Distillation Temperatures, °C(°F) 90% Point		Viscosity Kinematic cSt or mm ² /s at 40°C		Viscosity Saybolt, SUS at 37.8°C(100°F)	
Min	Max	Min	Max	Min	Max
282 (540)	338 (640)	1.9	4.1	32.6	40.1

Sulfur, weight %	Copper Strip Corrosion	Cetane Number
Max	Max	Min
0.50	No. 3	40

- Cetane Rating : The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below -20 °C (-4 °F) or elevations above 1500 m (5000 ft).
- Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half).
- DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).
- Diesel fuels specified to EN 590 or ASTM D975 are recommended.
- No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S15 diesel fuel as an alternative to No.2-D, and use No.1-D S15 diesel fuel as an alternative to No.1-D for ambient temperatures below -10 °C (14 °F).
 - 1) SAE : Society of Automotive Engineers
 - 2) EN : European Norm
 - 3) ASTM : American Society of Testing and Materials
 - 4) US EPA : United States Environmental Protection Agency
 - 5) No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt. %

IMPORTANT :

- Be sure to use a strainer when filling the fuel tank, or dirt or sand in the fuel may cause trouble in the fuel injection pump.
- For fuel, always use diesel fuel. You are required not to use alternative fuel, because its quality is unknown or it may be inferior in quality. Kerosene, which is very low in cetane rating, adversely affects the engine. Diesel fuel differs in grades depending on the temperature.
- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.

■ Air bleeding the fuel system

CAUTION

To avoid personal injury;

- Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

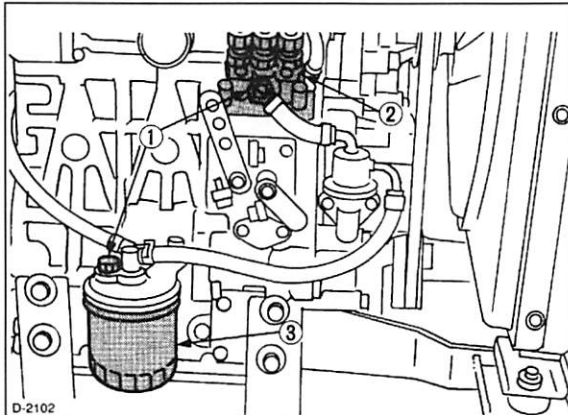
Air bleeding of the fuel system is required if;

- after the fuel filter and pipes have been detached and refitted;
- after the fuel tank has become empty; or
- before the engine is to be used after a long storage.

[PROCEDURE (A)] (gravity feed fuel tanks only)

1. Fill the fuel tank to the fullest extent. Open the fuel filter lever.
2. Loosen air vent plug of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent plug on top of the fuel injection pump.
5. Retighten the plug when bubbles do not come up any more.

[GRAVITY FEED SYSTEM]



- (1) Air vent plug
- (2) Injection pump
- (3) Fuel filter

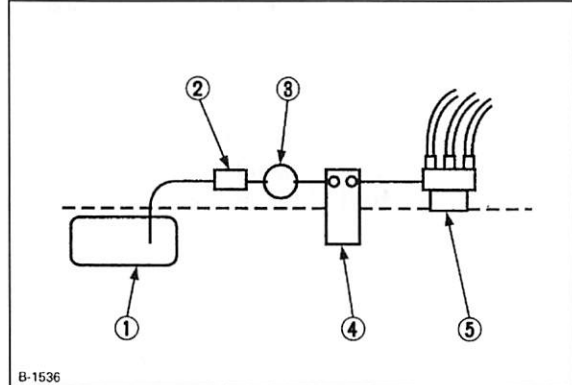
[PROCEDURE (B)] (fuel tanks lower than injection pump)

1. For fuel tanks that are lower than the injection pump. The fuel system must be pressurized by the fuel system electric fuel pump.
2. If an electric fuel pump is not used, you must manually actuate the pump by lever to bleed.
3. The primary fuel filter (3) must be on the pressure side of the pump if the fuel tank is lower than the injection pump.
4. To bleed follow (2) through (5) above. (PROCEDURE (A))

IMPORTANT :

- Tighten air vent plug of the fuel injection pump except when bleeding, or it may stop the engine suddenly.

[TANK BELOW INJECTION PUMP SYSTEM]



- (1) Fuel tank below injection pump
- (2) Pre-filter
- (3) Electric or Mechanical pump
- (4) Main Filter
- (5) Injection pump

■ Checking the fuel pipes

CAUTION

To avoid personal injury;

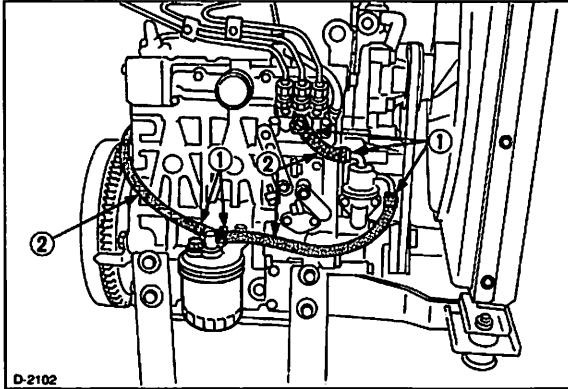
- Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.

Check the fuel pipes every 50 hours of operation. When if;

1. If the clamp band is loose, apply oil to the screw of the band, and tighten the band securely.
2. If the fuel pipes, made of rubber, became worn out, replace them and clamp bands every 2 years.
3. If the fuel pipes and clamp bands are found worn or damaged before 2 years' time, replace or repair them at once.
4. After replacement of the pipes and bands, air-bleed the fuel system.

IMPORTANT :

- When the fuel pipes are not installed, plug them at both ends with clean cloth or paper to prevent dirt from entering. Dirt in the pipes can cause fuel injection pump malfunction.

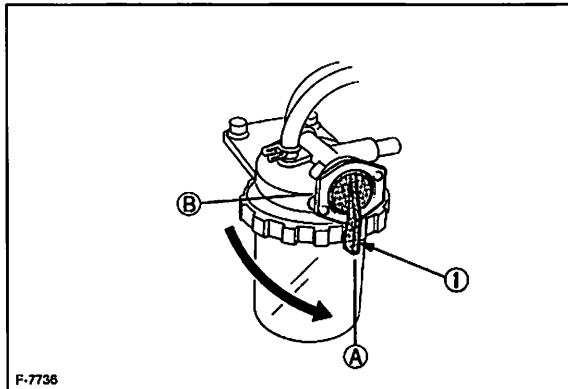


(1) Clamp band
(2) Fuel pipe

■Cleaning the fuel filter pot

Every 100 hours of operation, clean the fuel filter in a clean place to prevent dust intrusion.

1. Close the fuel filter lever.

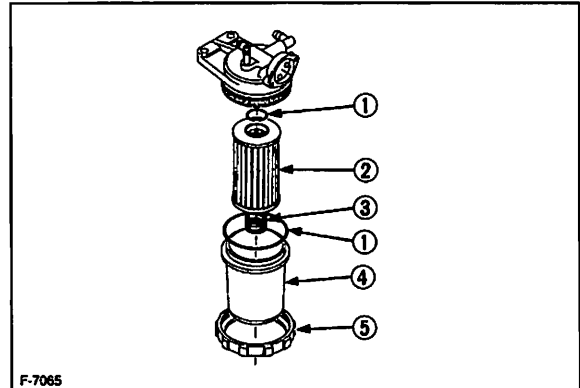


(1) Fuel filter lever
(2) Fuel filter pot
(A) "OFF"
(B) "ON"

2. Remove the top cap, and rinse the inside with diesel fuel.
3. Take out the element, and rinse it with diesel fuel.
4. After cleaning, reinstall the fuel filter, keeping out of dust and dirt.
5. Air-bleed the injection pump.

IMPORTANT :

- Entrance of dust and dirt can cause a malfunction of the fuel injection pump and the injection nozzle. Wash the fuel filter cup periodically.



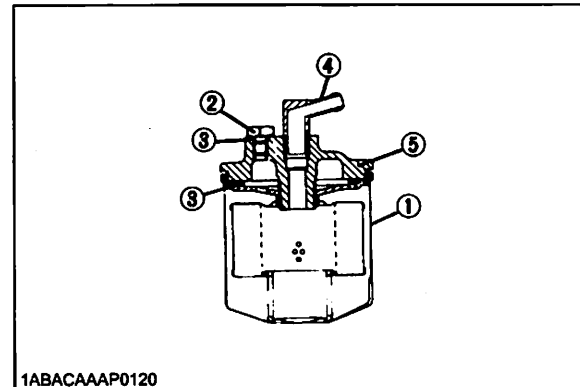
(1) O ring
(2) Filter element
(3) Spring
(4) Filter bowl
(5) Screw ring

■Fuel filter cartridge replacement

1. Replace the fuel filter cartridge with a new one every 400 operating hours.
2. Apply fuel oil thinly over the gasket and tighten the cartridge into position by hand-tightening only.
3. Finally, vent the air.

IMPORTANT :

- Replace the fuel filter cartridge periodically to prevent wear of the fuel injection pump plunger or the injection nozzle, due to dirt in the fuel.



(1) Fuel filter cartridge
(2) Air vent plug
(3) O ring
(4) Pipe joint
(5) Cover

ENGINE OIL

CAUTION

To avoid personal injury:

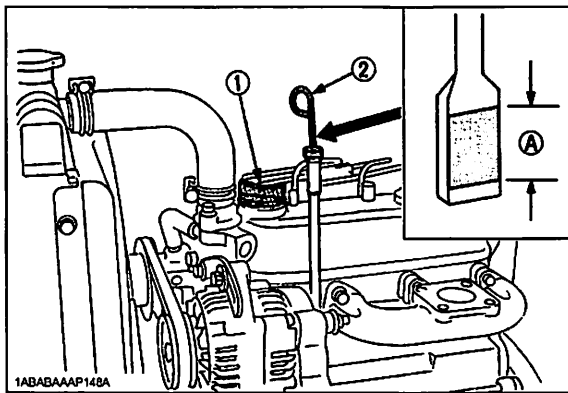
- Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.
- Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning procedure.
- Contact with engine oil can damage your skin. Put on gloves when using engine oil. If you come in contact with engine oil, wash it off immediately.

NOTE :

- Be sure to inspect the engine, locating it on a level place. If placed on gradients accurately, oil quantity may not be measured.

■ Checking oil level and adding engine oil

1. Check the engine oil level before starting or more than 5 minutes after stopping the engine.
2. Remove the oil level gauge, wipe it clean and reinstall it.
3. Take the oil level gauge out again, and check the oil level.



(1) Oil filler plug
(2) Oil level gauge

[Lower end of oil level gauge]
(A) Engine oil level within this range is proper.

4. If the oil level is too low, remove the oil filler plug, and add new oil to the prescribed level.
5. After adding oil, wait more than 5 minutes and check the oil level again. It takes some time for the oil to drain down to the oil pan.

Engine oil quantity

Model	Quantity
D1005-E4, D1105-E4	5.1 L (1.35 U.S. gals.)
D1305-E4	5.7 L (1.51 U.S. gals.)
V1505-E4	6.0 L (1.59 U.S. gals.)

Oil quantities shown are for standard oil pans.

IMPORTANT :

- Engine oil should be MIL-L-2104C or have properties of API classification CF or higher. Change the type of engine oil according to the ambient temperature.

above 25°C (77°F)	SAE30 or SAE10W-30 SAE15W-40
-10°C to 25°C (14°F to 77°F)	SAE10W-30 or SAE15W-40
below -10°C (14°F)	SAE10W-30

- When using oil of different brands from the previous one, be sure to drain all the previous oil before adding the new engine oil.

■ Changing engine oil

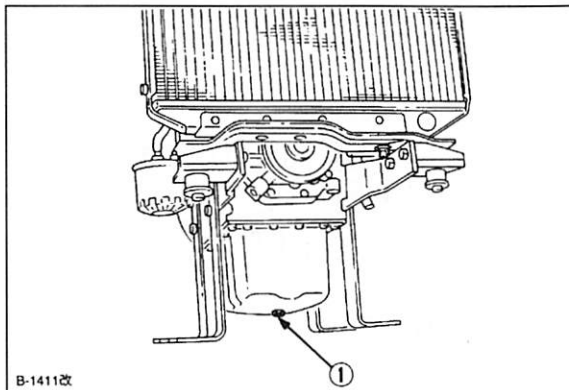


CAUTION

To avoid personal injury:

- Be sure to stop the engine before draining engine oil.
- When draining engine oil, place some container underneath the engine and dispose it according to local regulations.
- Do not drain oil after running the engine. Allow engine to cool down sufficiently.

1. Change oil after the initial 50 hours of operation and every 200 hours thereafter.
2. Remove the drain plug at the bottom of the engine, and drain all the old oil. Drain oil will drain easier when the oil is warm.



(1) Oil drain plug

3. Add new engine oil up to the upper limit of the oil level gauge.

■ Replacing the oil filter cartridge

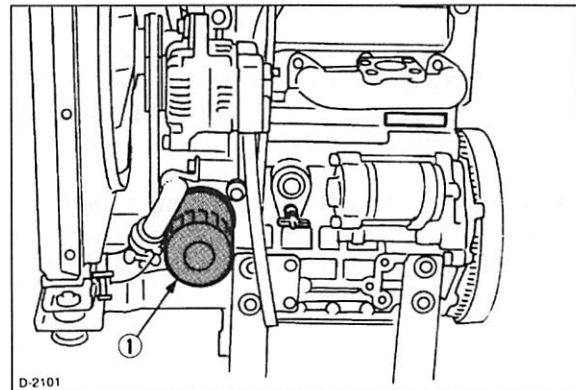


CAUTION

To avoid personal injury:

- Be sure to stop the engine before changing the oil filter cartridge.
- Allow engine to cool down sufficiently, oil can be hot and cause burns.

1. Replace the oil filter cartridge after the initial 50 hours of operation and every 200 hours thereafter.
2. Remove the old oil filter cartridge with a filter wrench.
3. Apply a film of oil to the gasket for the new cartridge.
4. Screw in the cartridge by hand. When the gasket contacts the seal surface, tighten the cartridge enough by hand. Because, if you tighten the cartridge with a wrench, it will be tightened too much.



(1) Oil filter cartridge
Remove with a filter wrench
(Tighten with your hand)

5. After the new cartridge has been replaced, the engine oil level normally decreases a little. Thus, run the engine for a while and check for oil leaks through the seal before checking the engine oil level. Add oil if necessary.

NOTE :

- Wipe off any oil sticking to the machine completely.

RADIATOR

Coolant will last for one day's work if filled all the way up before operation start. Make it a rule to check the coolant level before every operation.



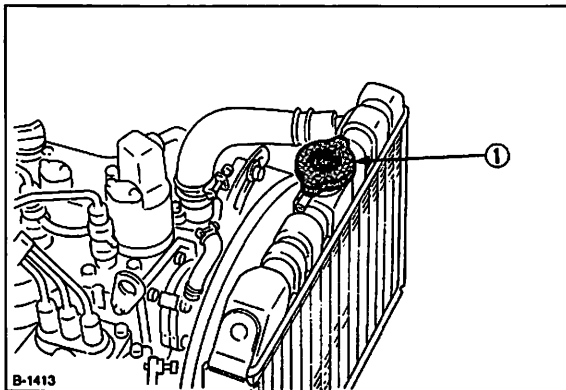
WARNING

To avoid personal injury:

- Do not stop the engine suddenly, stop it after about 5 minutes of unloaded idling.
- Work only after letting the engine and radiator cool off completely (more than 30 minutes after it has been stopped).
- Do not remove the radiator cap while coolant is hot. When cool to the touch, rotate cap to the first stop to allow excess pressure to escape. Then remove cap completely. If overheats should occur, steam may gush out from the radiator or recovery tank; Severe burns could result.

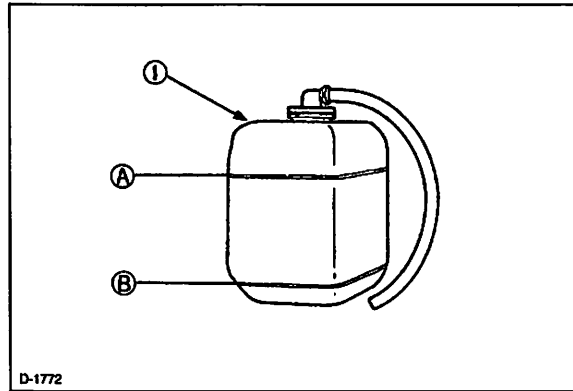
■ Checking coolant level, adding coolant

1. Remove the radiator cap, after the engine has completely cooled, and check to see that coolant reaches the supply port.



(1) Radiator pressure cap

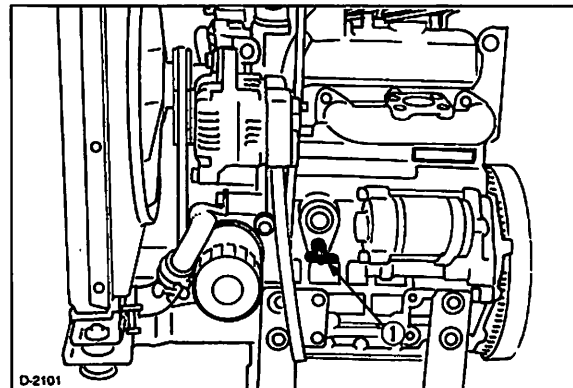
2. If the radiator is provided with a recovery tank, check the coolant level of the recovery tank. When it is between the "FULL" and "LOW" marks, the coolant will last for one day's work.



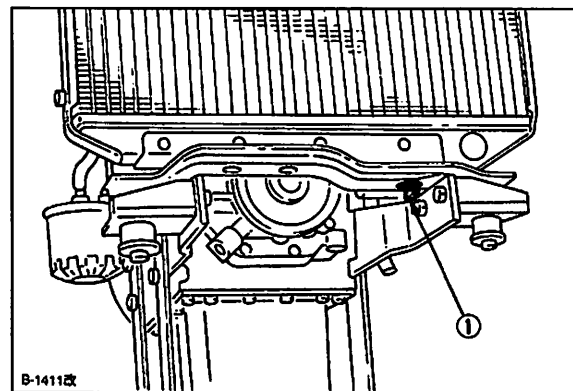
(1) Recovery tank

(A) "FULL"
(B) "LOW"

3. When the coolant level drops due to evaporation, add water only up to the full level.
4. Check to see that two drain cocks; one is at the crankcase side and the other is at the lower part of the radiator as figures below.



D-2101



B-1411改

(1) Coolant drain cock

IMPORTANT :

- If the radiator cap has to be removed, follow the caution and securely retighten the cap.
- If coolant should be leak, consult your local KUBOTA dealer.
- Make sure that muddy or sea water does not enter the radiator.
- Use clean, fresh water and 50% anti-freeze to fill the recovery tank.
- Do not refill recovery tank with coolant over the "FULL" level mark.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and decrease quickly.

■ Changing coolant

1. To drain coolant, always open both drain cocks and simultaneously open the radiator cap as well. With the radiator cap kept closed, a complete drain of water is impossible.
2. Remove the overflow pipe of the radiator pressure cap to drain the recovery tank.
3. Prescribed coolant volume (U.S.gallons)

Models	Quantity
D1005-E4, D1105-E4, D1305-E4	3.1 L (0.82 U.S.gals.)
V1505-E4	4.0 L (1.06 U.S.gals.)

NOTE :

- Coolant quantities shown are for standard radiators.
4. An improperly tightened radiator cap or a gap between the cap and the seat quickens loss of coolant.
 5. Coolant (Anti-freeze)

Season	Coolant
All seasons	Pure water and anti-freeze (See "Anti-freeze" in "RADIATOR" section.)

■ Remedies for quick decrease of coolant

1. Check any dust and dirt between the radiator fins and tube. If any, remove them from the fins and the tube.
2. Check the tightness of the fan belt. If loose, tighten it securely.
3. Check the internal blockage in the radiator hose. If scale forms in the hose, clean with the scale inhibitor or its equivalent.

■ Checking radiator hoses and clamp**CAUTION**

To avoid personal injury:

- **Be sure to check radiator hoses and hose clamps periodically. If radiator hose is damaged or coolant leaks, overheats or severe burns could occur.**

Check to see if radiator hoses are properly fixed every 200 hours of operation or 6 months, whichever comes first.

1. If hose clamps are loose or water leaks, tighten hose clamp securely.
 2. Replace hoses and tighten hose clamps securely, if radiator hoses are swollen, hardened or cracked.
- Replace hoses and hose clamps every 2 years or earlier, if checked and found that hoses are swollen, hardened or cracked.

■ Precaution at overheating

The event that the coolant temperature is nearly or more than the boiling point is called "OVERHEATING".

While running, make the following checks to see that all parts are working correctly. **If anything is unusual, inspect it, referring to the relevant description in "MAINTENANCE" and "PERIODIC SERVICE" section.**

◆ Coolant

If the coolant temperature warning lamp lights up or if steam or coolant does not stop squirting from the radiator overflow pipe, turn off the load and **keep the engine idling (COOLING-DOWN) for at least 5 minutes** to let it cool down gradually. Then stop the engine and take the following inspection and servicing.

1. Check to see if the coolant runs short or if there is any coolant leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose; and
5. Check to see if radiator water pipe is clogged.

■ Cleaning radiator core(outside)

If dust is between the fin and tube, wash it away with running water.

IMPORTANT :

- Do not clean radiator with firm tools such as spatulas or screwdrivers. They may damage specified fin or tube. It can cause coolant leaks or decrease cooling performance.

■ Anti-freeze



CAUTION

To avoid personal injury:

- When using anti-freeze, put on some protection such as rubber gloves (Anti-freeze contains poison.).
- If should drink anti-freeze, throw up at once and take medical attention.
- When anti-freeze comes in contact with the skin or clothing, wash it off immediately.
- Do not mix different types of anti-freeze. The mixture can produce chemical reaction causing harmful substances.
- Anti-freeze is extremely flammable and explosive under certain conditions. Keep fire and children away from anti-freeze.
- When draining fluids from the engine, place some container underneath the engine body.
- Do not pour waste onto the grounds, down a drain, or into any water source.
- Also, observe the relevant environmental protection regulations when disposing of anti-freeze.

Always use a 50/50 mix of long-life coolant and clean soft water in KUBOTA engines. Contact KUBOTA concerning coolant for extreme conditions.

1. Long-life coolant (hereafter LLC) comes in several types. Use ethylene glycol (EG) type for this engine.
2. Before employing LLC-mixed cooling water, flush the radiator with fresh water. Repeat this procedure 2 or 3 times to clean up the radiator and engine block from inside.
3. Mixing the LLC
Premix 50% LLC with 50% clean soft water. When mixing, stir it up well, and then fill into the radiator.
4. The procedure for the mixing of water and anti-freeze differs according to the make of the anti-freeze. Refer to SAE J1034 standard, more specifically also to SAE J814c.

Vol % Anti-freeze	Freezing Point		Boiling Point *	
	°C	°F	°C	°F
50	-37	-34	108	226

*At 1.013 x 10⁵ Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

5. Adding the LLC
 - (1) Add only water if the coolant level reduces in the cooling system by evaporation.
 - (2) If there is a coolant leak, add the LLC of the same manufacturer and type in the same coolant percentage.

*Never add any long-life coolant of different manufacturer. (Different brands may have different additive components, and the engine may fail to perform as specified.)
6. When the LLC is mixed, do not employ any radiator cleaning agent. The LLC contains anti-corrosive agent. If mixed with the cleaning agent, sludge may build up, adversely affecting the engine parts.
7. Kubota's genuine long-life coolant has a service life of 2 years. Be sure to change the coolant every 2 years.

NOTE :

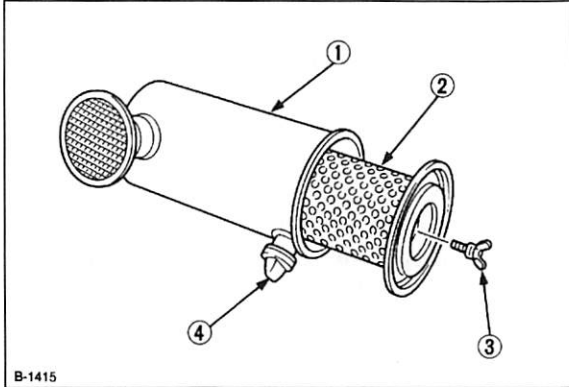
- The above data represent industry standards that necessitate a minimum glycol content in the concentrated anti-freeze.

AIR CLEANER

Since the air cleaner employed on this engine is a dry type, never apply oil to it.

1. Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place. This will get rid of large particles of dust and dirt.
2. Wipe the inside air cleaner clean with cloth if it is dirty or wet.
3. Avoid touching the element except when cleaning.
4. When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm², 30 psi).

5. Replace the element every year or every 6 cleanings.



- (1) Air cleaner body
 (2) Element
 (3) Wing bolt
 (4) Evacuator valve

IMPORTANT :

- Make sure the wing bolt for the element is tight enough. If it is loose, dust and dirt may be sucked in, wearing down the cylinder liner and piston ring earlier and thereby resulting in poor power output.
- Do not overservice the air cleaner element. Overservicing may cause dirt to enter the engine causing premature wear. Use the dust indicator as a guide on when to service.

■Evacuator valve

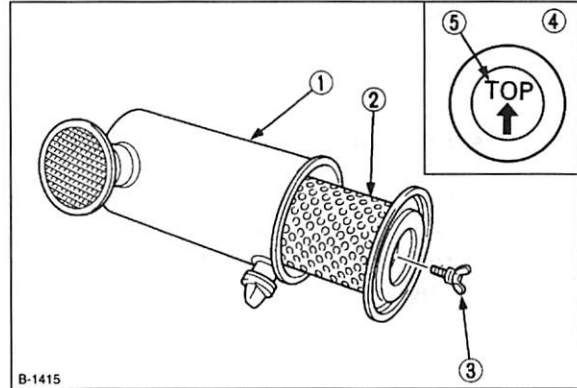
Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place - to get rid of large particles of dust and dirt.

■For the air cleaner with a dust cup (optional)

Remove and clean out the dust cup before it becomes half full with dust; usually once a week, or even every day if the working surroundings are dusty. Install the air cleaner dust cup with "TOP" indicated on the rear of the cup in the up position. (However, it may be installed in either direction when the cover is placed at the lower part.)

IMPORTANT :

- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.

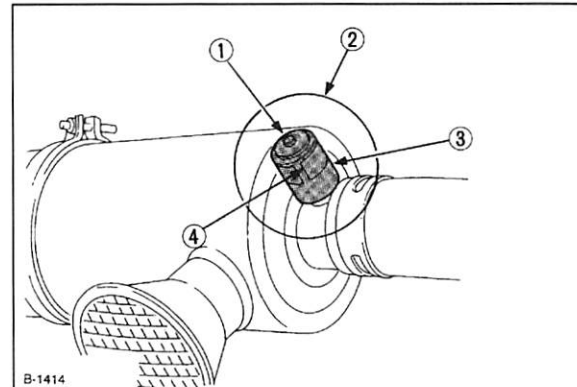


- (1) Air cleaner body
 (2) Element
 (3) Wing bolt
 (4) Dust cup
 (5) "TOP" mark

■Dust indicator (optional)

If the red signal on the dust indicator attached to the air cleaner is visible, the air cleaner has reached the service level.

Clean the element immediately, and reset the signal with the "RESET" button.



- (1) "RESET" button
 (2) Dust indicator
 (3) Service level
 (4) Signal

ELECTRIC WIRING



CAUTION

To avoid personal injury:

- ◆ Shorting of electric cable or wiring may cause a fire.
 - Check to see if electric cables and wiring are swollen, hardened or cracked.
 - Keep dust and water away from all power connections.
- Loose wiring terminal parts, make bad connections. Be sure to repair them before starting the engine.

Damaged wiring reduces the capacity of electrical parts. Change or repair damaged wiring immediately.

FAN BELT

■ Adjusting Fan Belt Tension



CAUTION

To avoid personal injury:

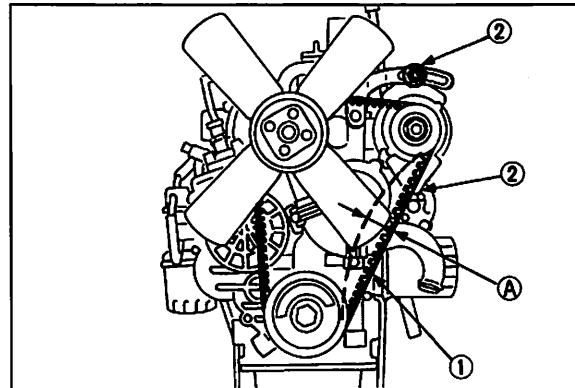
- Be sure to stop the engine and remove the key before checking the belt tension.
- Be sure to reinstall the detached safety shield after maintenance or checking.

Proper fan belt tension	A deflection of between 7 to 9 mm (0.28 to 0.35 in.) when the belt is pressed in the middle of the span.
-------------------------	--

1. Stop the engine and remove the key.
2. Apply moderate thumb pressure to belt between the pulleys.
3. If tension is incorrect, loosen the alternator mounting bolts and, using a lever placed between the alternator and the engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace fan belt if it is damaged.

IMPORTANT :

- If belt is loosen or damaged and the fan is damaged, it could result in overheats or insufficient charging. Correct or replace belt.



(1) Fan belt
(2) Bolt and nut

(A) 7 to 9 mm (0.28 to 0.35 in.)
(under load of 10 kgf (22.1 lbs))

CARRIAGE AND STORAGE

CARRIAGE



CAUTION

To avoid personal injury:

- Fix the engine securely not to fall during operation.
- Do not stand near or under the engine while carrying it.
- The engine is heavy. In handling it, be very alert not to get your hands and body caught in.

1. Use carrier such as crane when carrying the engine, or hurt your waist and yourself. Support the engine securely with rope not to fall while carrying it.
2. When lifting the engine, put the hook securely to metal fittings attached to the engine. Use strong hook and fittings enough to hang the engine.

STORAGE



CAUTION

To avoid personal injury:

- Do not clean the machine with engine running.
- To avoid the danger of exhaust fume poisoning, do not operate the engine in a closed building without proper ventilation.
- When storing the engine just after running, let the engine cool off.

Before storing the engine for more than a few months, remove any dirt on the machine, and:

1. Drain the coolant in the radiator. Open the cock at the bottom of the radiator, and remove the pressure cap to drain water completely. Leave the cock open. Hang a note written "No water" on the pressure cap. Since water may freeze when the temperature drops below 0°C (32°F), it is very important that no water is left in the machine.
2. Remove dirty engine oil, fill with new oil and run the engine for about 5 minutes to let the oil penetrate to all the parts.
3. Check all the bolts and nuts, and tighten if necessary.
4. Remove the battery from the engine, adjust the electrolyte level, and recharge it. Store the battery in a dry and dark place.
5. When the engine is not used for a long period of time, run it for about 5 minutes under no load every 2 to 3 months to keep it free from rust. If the engine is stored without any running, moisture in the air may condense into dew over the sliding parts of the engine, resulting in rust there.
6. If you forget to run the engine for longer than 5 to 6 months, apply enough engine oil to the valve guide and valve stem seal and make sure the valve works smoothly before starting the engine.
7. Store the engine in a flat place and remove the key from engine.
8. Do not store the engine in a place where has flammable materials such as dry grass or straw.
9. When covering the engine for storage, let engine and muffler cool off completely.
10. Operate the engine after checking and repairing damaged wirings or pipes, and clearing flammable materials carried by mouse.

TROUBLESHOOTING

If the engine does not function properly, use the following chart to identify and correct the cause.

■When it is difficult to start the engine

Cause	Countermeasures
Fuel is thick and doesn't flow.	<ul style="list-style-type: none"> * Check the fuel tank and fuel filter. * Remove water, dirt and other impurities. * As all fuel will be filtered by the filter, if there should be water or other foreign matters on the filter, clean the filter with kerosene.
Air or water mixed in fuel system	<ul style="list-style-type: none"> * If air is in the fuel filter or injection lines, the fuel pump will not work properly. * To attain proper fuel injection pressure, check carefully for loosened fuel line coupling, loose cap nut, etc. * Loosen joint bolt stop fuel filter and air vent screws of fuel injection pump to eliminate all the air in the fuel system.
Engine oil becomes thick in cold weather and engine cranks slow.	<ul style="list-style-type: none"> * Change grade of oil according to the weather (temperature).
Battery is discharged and the engine will not crank.	<ul style="list-style-type: none"> * Charge battery. * In winter, always remove battery from machine, charge fully and keep indoors. Install in machine at time of use.

■When output is insufficient

Cause	Countermeasures
Fuel is insufficient.	<ul style="list-style-type: none"> * Check fuel system.
Overheating of moving parts	<ul style="list-style-type: none"> * Check lubricating oil system. * Check to see if lubricating oil filter is working properly. * Filter element deposited with impurities would cause poor lubrication. Change element.
Air cleaner is dirty	<ul style="list-style-type: none"> * Clean the element every 100 hours of operation.
Injection pump wear	<ul style="list-style-type: none"> * Do not use poor quality fuel as it will cause wear of the pump. Only use No. 2-D diesel fuel. (See "FUEL" in "PERIODIC SERVICE" Section.)

NOTE :

- If the cause of trouble can not be found, contact your KUBOTA dealer.

■ When engine suddenly stops

Cause	Countermeasures
Lack of fuel	<ul style="list-style-type: none"> * Check the fuel tank and refill the fuel, if necessary. * Also check the fuel system for air or leaks.
Bad nozzle	<ul style="list-style-type: none"> * If necessary, replace with a new nozzle.
Moving parts are overheated due to shortage of lubrication oil or improper lubrication.	<ul style="list-style-type: none"> * Check amount of engine oil with oil level gauge. * Check lubricating oil system. * At every 2 times of oil change, oil filter cartridge should be replaced.

■ When color of exhaust is especially bad

Cause	Countermeasures
Fuel is of extremely poor quality.	<ul style="list-style-type: none"> * Select good quality fuel. Use No. 2-D diesel fuel only.
Nozzle is bad.	<ul style="list-style-type: none"> * If necessary, replace with new nozzle.

■ When engine must be stopped immediately

Cause	Countermeasures
Color of exhaust suddenly turns dark.	<ul style="list-style-type: none"> * Check the fuel injection system, especially the fuel injection nozzle.
Bearing parts are overheated.	<ul style="list-style-type: none"> * Check the lubricating system.
Oil lamp lights up during operation.	<ul style="list-style-type: none"> * Check the lubricating system. * Check the function of the relieve valve in the lubricating system. * Check pressure switch. * Check filter base gasket.

■ When engine overheats

Cause	Countermeasures
Engine oil insufficient	<ul style="list-style-type: none"> * Check oil level. Replenish oil as required.
Fan belt broken or elongated	<ul style="list-style-type: none"> * Change belt or adjust belt tension.
Coolant insufficient	<ul style="list-style-type: none"> * Replenish coolant.
Excessive concentration of antifreeze	<ul style="list-style-type: none"> * Add water only or change to coolant with the specified mixing ratio.
Radiator net or radiator fin clogged with dust	<ul style="list-style-type: none"> * Clean net or fin carefully.
Inside of radiator or coolant flow route corroded	<ul style="list-style-type: none"> * Clean or replace radiator and parts.
Fan or radiator or radiator cap defective	<ul style="list-style-type: none"> * Replace defective parts.
Thermostat defective	<ul style="list-style-type: none"> * Check thermostat and replace if necessary.
Temperature gauge or sensor defective	<ul style="list-style-type: none"> * Check temperature with thermometer and replace if necessary.
Overload running	<ul style="list-style-type: none"> * Reduce load.
Head gasket defective or water leakage	<ul style="list-style-type: none"> * Replace parts.
Unsuitable fuel used	<ul style="list-style-type: none"> * Use the specified fuel.

SPECIFICATIONS

Model	D1005-E4	D1105-E4
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	3	
Bore and stroke mm (in.)	76 × 73.6 (2.99 × 2.90)	78 × 78.4 (3.07 × 3.09)
Total displacement cm ³ (cu.in.)	1001 (61.08)	1123 (68.53)
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	17.7/3200 (23.7/3200)	17.8/3000 (23.9/3000)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	15.4/3200 (20.6/3200)	15.4/3000 (20.7/3000)
Maximum bare speed rpm	3420	3220
Minimum bare idling speed rpm	1300	900
Order of firing	1-2-3	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch MD Type Mini Pump	
Injection pressure	13.73 Mpa (140 kgf/cm ² , 1991 psi)	
Injection timing (Before T.D.C.)	20°	18°
Compression ratio	24 : 1	
Fuel	Diesel Fuel No.2-D (ASTM D975)	
Lubricant (API classification)	above CF grade	
Dimension mm (in.) (length × width × height)	497.8 × 396.0 × 602.0 (19.60 × 15.59 × 23.7)	
Dry weight (BB Spec.) kg (lbs.)	93 (205.0)	
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 1.2 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 65 AH, equivalent	

NOTE :

- Specifications are subject to change without notice.

Model	D1305-E4	V1505-E4
Type	Vertical, water-cooled, 4-cycle diesel engine	
Number of cylinders	3	4
Bore and stroke mm (in.)	78 × 88 (3.07 × 3.46)	78 × 78.4 (3.07 × 3.09)
Total displacement cm ³ (cu.in.)	1261 (76.95)	1498 (91.41)
Combustion chamber	Spherical Type (E-TVCS)	
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	17.9/2600 (24/2600)	17.7/2300 (23.7/2300)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	15.5/2600 (20.8/2600)	15.4/2300 (20.6/2300)
Maximum bare speed rpm	2820	2520
Minimum bare idling speed rpm	1100	1150
Order of firing	1-2-3	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch MD Type Mini Pump	
Injection pressure	13.73 Mpa (140 kgf/cm ² , 1991 psi)	
Injection timing (Before T.D.C.)	16°	14°
Compression ratio	24 : 1	
Fuel	Diesel Fuel No.2-D (ASTM D975)	
Lubricant (API classification)	above CF grade	
Dimension mm (in.) (length × width × height)	497.6 × 396.0 × 590.1 (19.59 × 15.59 × 23.2)	591.3 × 396.0 × 607.0 (23.28 × 15.59 × 23.90)
Dry weight (BB Spec.) kg (lbs.)	95 (209)	110 (242.5)
Starting system	Cell starter (with glow plug)	
Starting motor	12 V, 1.2 kW	
Charging generator	12 V, 480 W	
Recommended battery capacity	12 V, 65 AH, equivalent	12 V, 75 AH, equivalent

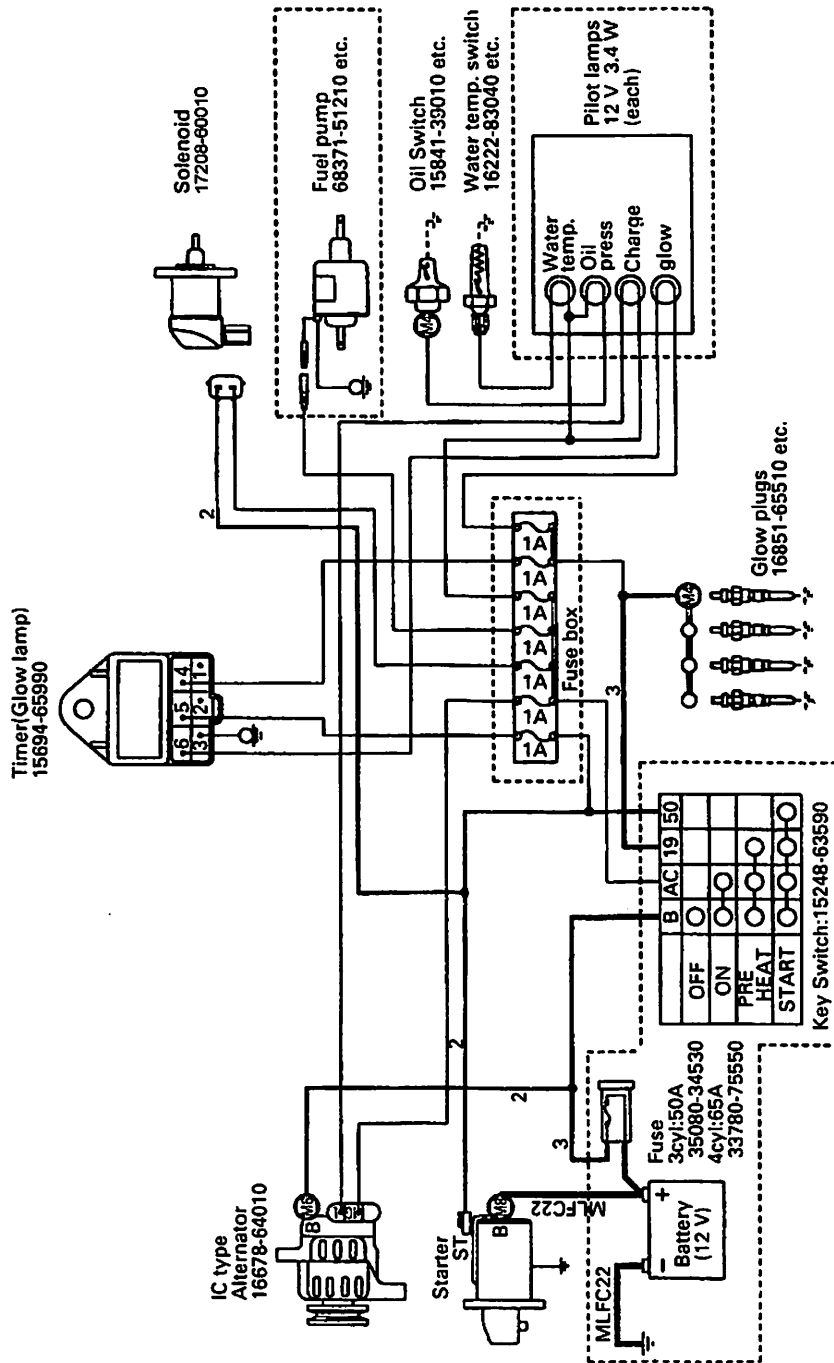
NOTE :

- Specifications are subject to change without notice.

WIRING DIAGRAMS

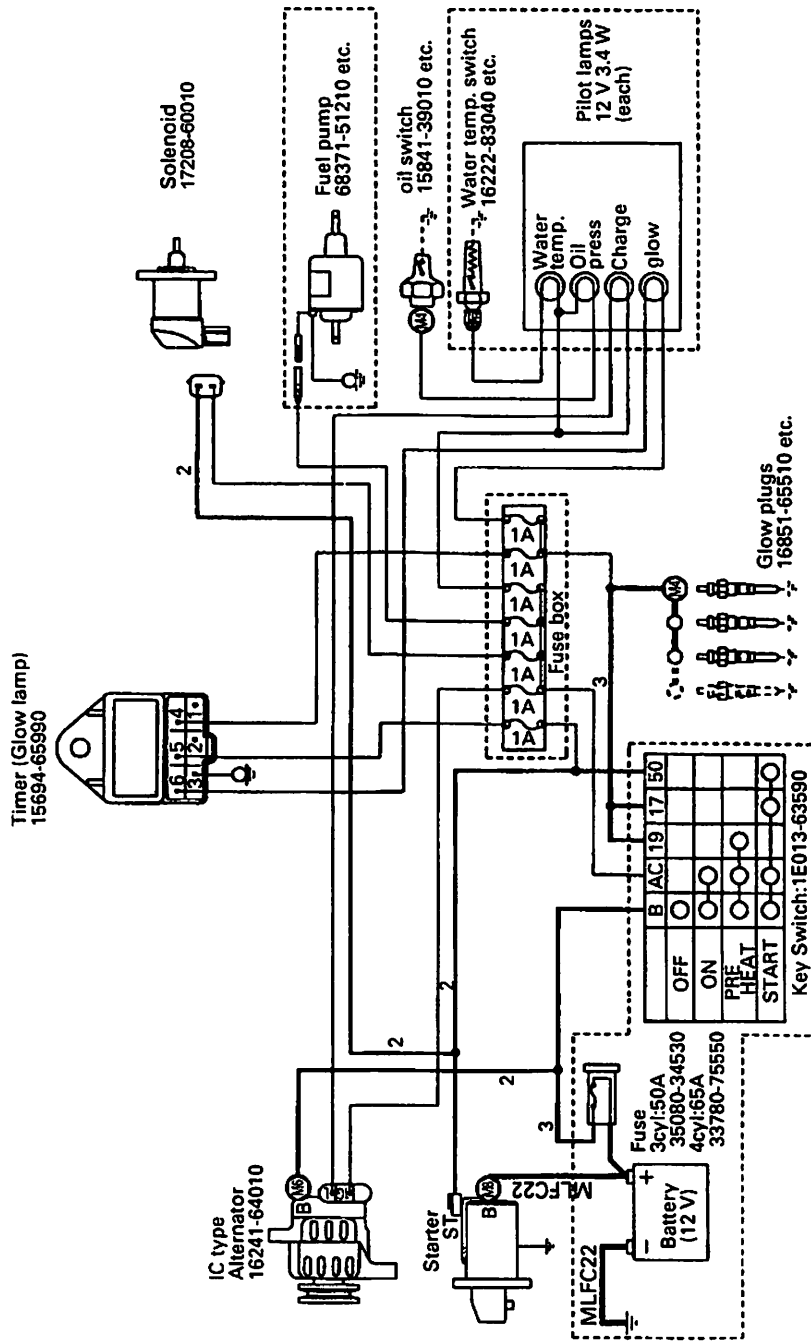
ENGLISH

EU standard
(Energize to run)



★ The parts boxed in [] are reference, NOT equipped for standard engine spec.
★ Non marked wire dia. is 0.8~1.25 mm².

KEA/SAE standard
(Energize to run)



★ The parts boxed in [] are reference, NOT equipped for standard engine spec.
★ Non marked wire dia. is 0.8~1.25 mm².

WSM

WORKSHOP MANUAL
DIESEL ENGINE

**05-E4B SERIES,
05-E4BG SERIES**

Kubota

TO THE READER

This Workshop Manual tells the servicing personnel about the mechanism, servicing and maintenance of the 05-E4B and 05-E4BG. It contains 4 parts: "**Information**", "**General**", "**Mechanism**" and "**Servicing**".

■ Information

This section primarily contains information below.

- Safety First
- Specification
- Performance Curve
- Dimension

■ General

This section primarily contains information below.

- Engine Identification
- Muffler Full Assembly Identification
- General Precautions
- Maintenance Check List
- Check and Maintenance
- Special Tools

■ Mechanism

This section contains information on the structure and the function of the unit. Before you continue with the subsequent sections, make sure that you read this section.

Refer to Workshop Manual (Code No. 9Y021-01870) for the diesel engine mechanism that this workshop manual does not include.

■ Servicing

This section primarily contains information below.

- Troubleshooting
- Servicing Specifications
- Tightening Torques
- Checking, Disassembling and Servicing

All illustrations, photographs and specifications contained in this manual are of the newest information available at the time of publication.

KUBOTA reserves the right to change all information at any time without notice.

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February, 2013

Record of Revisions

For pdf, use search function {Search word} to find all the revised locations.

Last digit of the Code No.	Issue month	Main Revised Point and Corrective Measures {Search word}	Reference Page
1	2014.04	<ul style="list-style-type: none"> • Add D1005-E4B 3000 rpm specifications type {2. SPECIFICATIONS} {12} CHECK POINTS OF EVERY 3000 HOURS {(4) Fuel System} • Add BG type {2. SPECIFICATIONS} {4. DIMENSIONS} {3. MAINTENANCE CHECK LIST} {4. CHECK AND MAINTENANCE} {1. ENGINE BODY} {2. SERVICING SPECIFICATIONS} {2} TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS {1} CHECKING AND ADJUSTING 	<p>1-5, 1-8 G-23 1-S19 1-7 1-16, 1-17 G-5 G-9, G-14, G-23 1-M1 1-S5 1-S13 1-S14</p>

I INFORMATION

INFORMATION

CONTENTS

1. SAFETY FIRST	I-1
2. SPECIFICATIONS.....	I-5
3. PERFORMANCE CURVES.....	I-8
4. DIMENSIONS	I-13

1. SAFETY FIRST

SAFETY FIRST

- This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.
- It is essential that you read the instructions and safety regulations before you try to repair or use this unit.

DANGER

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

WARNING

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

CAUTION

- Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

■ IMPORTANT

- Indicates that equipment or property damage could result if instructions are not followed.

■ NOTE

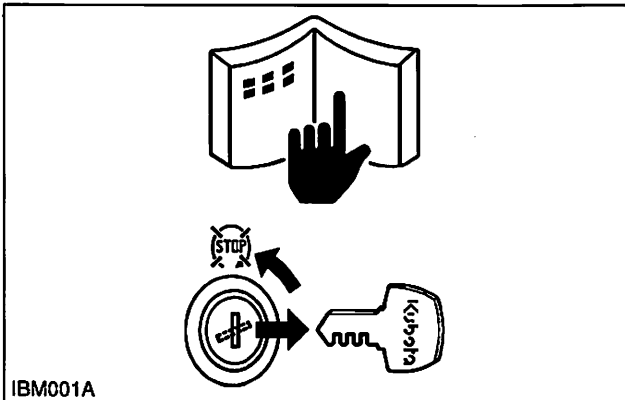
- Gives helpful information.

WSM000001INI0001US1

BEFORE YOU START SERVICE

- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a stable and level ground.
- Let the temperature of the engine decrease before you start a job.
- Stop the engine, then remove the key.
- Disconnect the battery negative cable.
- Hang a "DO NOT OPERATE" tag in the operator station.

WSM000001INI0002US0

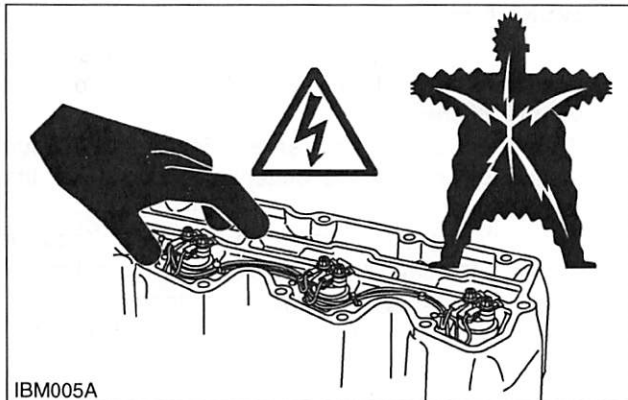
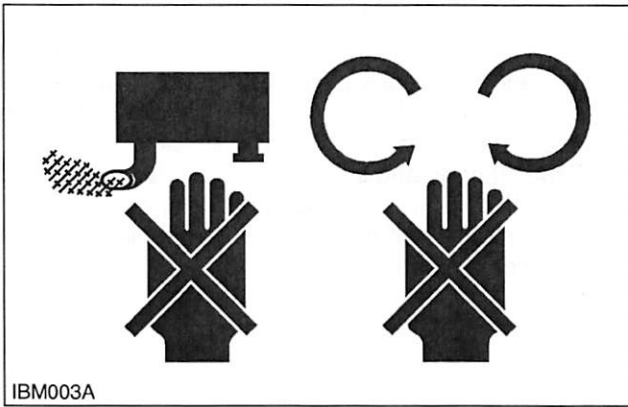


START SAFELY

- Do not do the procedures below when you start the engine.
 - short across starter terminals
 - bypass the safety start switch
- Do not make unauthorized modifications to the engine. This can cause damage and decrease the engine life.

WSM000001INI0003US0





OPERATE SAFELY

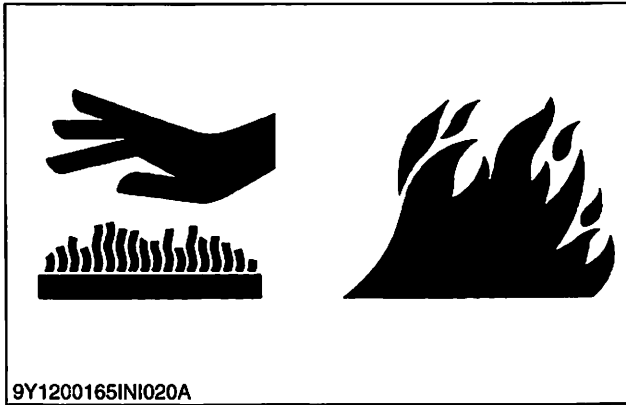
- Do not use the machine after you consume alcohol or medication or when you are tired.
- Put on applicable clothing and safety equipment.
- Use applicable tools only. Do not use alternative tools or parts.
- When 2 or more persons do servicing, make sure that you do it safely.
- Do not touch the hot parts or parts that turn when the engine operates.
- Do not remove the radiator cap when the engine operates, or immediately after it stops. If not, hot water can spout out from the radiator. Only remove the radiator cap when it is at a sufficiently low temperature to touch with bare hands. Slowly loosen the cap to release the pressure before you remove it fully.
- Released fluid (fuel or hydraulic oil) under pressure can cause damage to the skin and cause serious injury. Release the pressure before you disconnect hydraulic or fuel lines. Tighten all connections before you apply the pressure.
- Do not open a fuel system under high pressure. The fluid under high pressure that stays in fuel lines can cause serious injury. Do not disconnect or repair the fuel lines, sensors, or any other components between the fuel pump and injectors on engines with a common rail fuel system under high pressure.
- Put on an applicable ear protective device (earmuffs or earplugs) to prevent injury against loud noises.
- Be careful about electric shock. The engine generates a high voltage of more than DC100 V in the ECU and is applied to the injector.

WSM000001INI0004US0

PROTECT AGAINST HIGH PRESSURE SPRAY

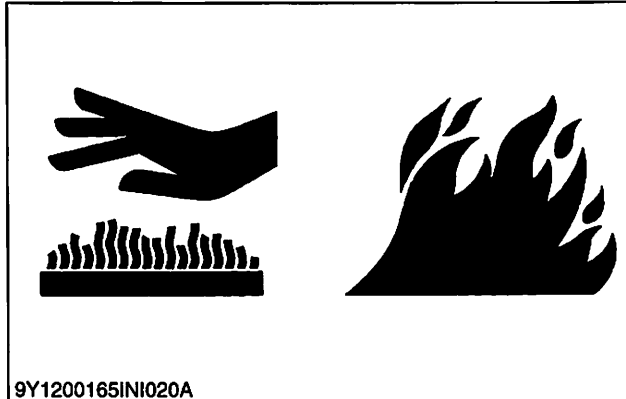
- Spray from high pressure nozzles can penetrate the skin and cause serious injury. Keep spray from contacting hands or body.
 - If an accident occurs, see a doctor immediately. Any high pressure spray injected into the skin must be surgically removed within a few hours or gangrene may result.
- Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

9Y1210651INI0014US0

**AVOID HOT EXHAUST**

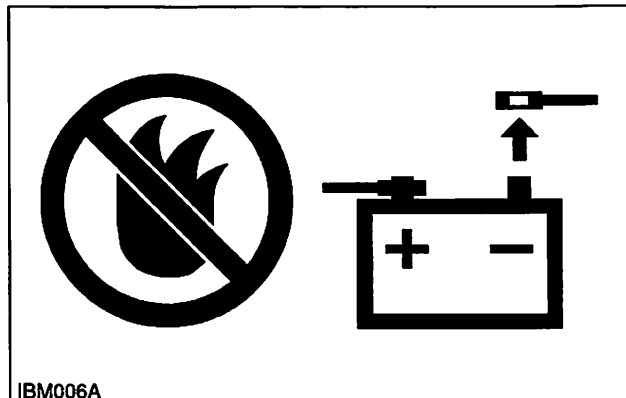
- Servicing machine or attachments with engine operating can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.
- Exhaust parts and streams become very hot during operation. Exhaust gases and components reach temperatures hot enough to burn people, ignite, or melt common materials.

9Y1210651INI0015US0

**EXHAUST FILTER CLEANING**

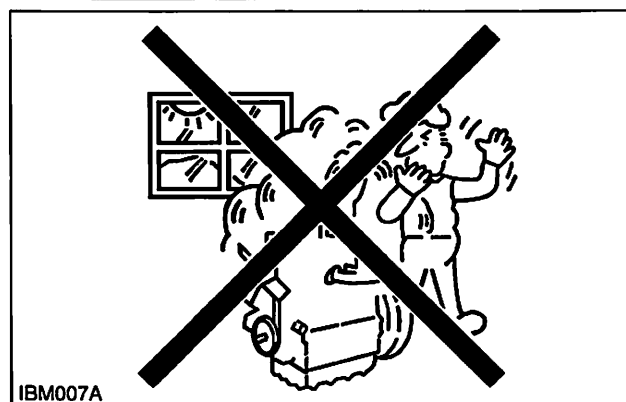
- Servicing machine or attachments during exhaust filter cleaning can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.
- During auto or manual/stationary exhaust filter cleaning operations, the engine will operate at elevated idle and hot temperatures for an extended period of time. Exhaust gases and exhaust filter components reach temperatures hot enough to burn people, or ignite, or melt common materials.

9Y1210651INI0016US0

**PREVENT A FIRE**

- Fuel is very flammable and explosive under some conditions. Do not smoke or let flames or sparks in your work area.
- To prevent sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- The battery gas can cause an explosion. Keep the sparks and open flame away from the top of battery, especially when you charge the battery.
- Make sure that you do not spill fuel on the engine.

WSM000001INI0005US0

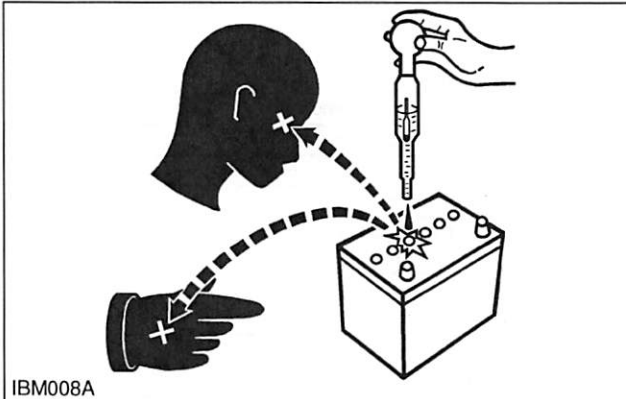
**KEEP A GOOD AIRFLOW IN THE WORK AREA**

- If the engine is in operation, make sure that the area has good airflow. Do not operate the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

WSM000001INI0006US0



IBM009A



IBM008A



IBM010A

DISCARD FLUIDS CORRECTLY

- Do not discard fluids on the ground, down the drain, into a stream, pond, or lake. Obey related environmental protection regulations when you discard oil, fuel, coolant, electrolyte and other dangerous waste.

WSM000001INI0007US0

PREVENT ACID BURNS

- Keep electrolyte away from your eyes, hands and clothing. Sulfuric acid in battery electrolyte is poisonous and it can burn your skin and clothing and cause blindness. If you spill electrolyte on yourself, clean yourself with water, and get medical aid immediately.

WSM000001INI0008US0

PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher ready at all times.
- Keep the emergency contact telephone numbers near your telephone at all times.

WSM000001INI0009US0

2. SPECIFICATIONS

Model	D1005-E4B		D1105-E4B
Number of Cylinder	3		
Engine Type	Vertical, water-cooled, 4-cycle diesel engine		
Bore × Stroke	76.0 × 73.6 mm (2.99 × 2.90 in.)		78.0 × 78.4 mm (3.07 × 3.09 in.)
Total Displacement	1001 cm ³ (61.08 cu.in.)		1123 cm ³ (68.53 cu.in.)
ISO Net Continuous	14.6 kW / 3000 min ⁻¹ (rpm) (19.6 HP / 3000 min ⁻¹ (rpm))	15.4 kW / 3200 min ⁻¹ (rpm) (20.6 HP / 3200 min ⁻¹ (rpm))	15.4 kW / 3000 min ⁻¹ (rpm) (20.7 HP / 3000 min ⁻¹ (rpm))
ISO/SAE Net Intermittent	16.8 kW / 3000 min ⁻¹ (rpm) (22.5 HP / 3000 min ⁻¹ (rpm))	17.7 kW / 3200 min ⁻¹ (rpm) (23.7 HP / 3200 min ⁻¹ (rpm))	17.8 kW / 3000 min ⁻¹ (rpm) (23.9 HP / 3000 min ⁻¹ (rpm))
SAE Gross Intermittent	17.5 kW / 3000 min ⁻¹ (rpm) (23.5 HP / 3000 min ⁻¹ (rpm))	18.5 kW / 3200 min ⁻¹ (rpm) (24.8 HP / 3200 min ⁻¹ (rpm))	18.5 kW / 3000 min ⁻¹ (rpm) (24.8 HP / 3000 min ⁻¹ (rpm))
Maximum Bare Speed	3220 min ⁻¹ (rpm)	3420 min ⁻¹ (rpm)	3220 min ⁻¹ (rpm)
Minimum Bare Idling Speed	900 min ⁻¹ (rpm)	1300 min ⁻¹ (rpm)	900 min ⁻¹ (rpm)
Combustion Chamber	Spherical type (E-TVCS)		
Fuel Injection Pump	Bosch MD type mini pump		
Governor	All speed mechanical governor		
Direction of Rotation	Counter-clockwise (viewed from flywheel side)		
Injection Nozzle	Mini Nozzle (DNOFD)		
Injection Timing	0.3142 rad (18.00 °) before T.D.C.	0.3491 rad (20.00 °) before T.D.C.	0.3142 rad (18.00 °) before T.D.C.
Firing Order	1-2-3		
Injection Pressure	13.73 MPa (140.0 kgf/cm ² , 1991 psi)		
Compression Ratio	24 : 1		
Lubricating System	Forced lubrication by trochoid pump		
Oil Pressure Indicating	Electrical type switch		
Lubricating Filter	Full flow paper filter (Cartridge type)		
Cooling System	Pressurized radiator, forced circulation with water pump		
Starting System	Electric Starting with Starter		
Starter Motor	12 V, 1.2 kW		
Starting Support Device	By glow plug in combustion chamber		
EGR	None		
Battery	12 V, 65 AH, equivalent		
Charging Alternator	12 V, 480 W		
Fuel	Diesel Fuel No.2-D (ASTM D975)		
Lubricating Oil	Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-6, G-9.		
Lubricating Oil Capacity	5.1 L (1.3 U.S.gals)		
Weight (Dry)	93.0 kg (205 lbs)		

- The specification described above is of the standard engine of each model.
- Conversion Formula: HP = 0.746 kW, PS = 0.7355 kW

9Y1210784INI0001US0

Model	D1305-E4B	V1505-E4B
Number of Cylinder	3	4
Engine Type	Vertical, water-cooled, 4-cycle diesel engine	
Bore × Stroke	78.0 × 88.0 mm (3.07 × 3.46 in.)	78.0 × 78.4 mm (3.07 × 3.09 in.)
Total Displacement	1261 cm ³ (76.95 cu.in.)	1498 cm ³ (91.41 cu.in.)
ISO Net Continuous	15.5 kW / 2600 min ⁻¹ (rpm) (20.8 HP / 2600 min ⁻¹ (rpm))	15.4 kW / 2300 min ⁻¹ (rpm) (20.6 HP / 2300 min ⁻¹ (rpm))
ISO/SAE Net Intermittent	17.9 kW / 2600 min ⁻¹ (rpm) (24.0 HP / 2600 min ⁻¹ (rpm))	17.7 kW / 2300 min ⁻¹ (rpm) (23.7 HP / 2300 min ⁻¹ (rpm))
SAE Gross Intermittent	18.5 kW / 2600 min ⁻¹ (rpm) (24.8 HP / 2600 min ⁻¹ (rpm))	18.5 kW / 2300 min ⁻¹ (rpm) (24.8 HP / 2300 min ⁻¹ (rpm))
Maximum Bare Speed	2820 min ⁻¹ (rpm)	2520 min ⁻¹ (rpm)
Minimum Bare Idling Speed	1100 min ⁻¹ (rpm)	1150 min ⁻¹ (rpm)
Combustion Chamber	Spherical type (E-TVCS)	
Fuel Injection Pump	Bosch MD type mini pump	
Governor	All speed mechanical governor	
Direction of Rotation	Counter-clockwise (viewed from flywheel side)	
Injection Nozzle	Mini Nozzle (DNOPD)	
Injection Timing	0.2793 rad (16.00 °) before T.D.C.	0.2443 rad (14.00 °) before T.D.C.
Firing Order	1-2-3	1-3-4-2
Injection Pressure	13.73 MPa (140.0 kgf/cm ² , 1991 psi)	
Compression Ratio	24 : 1	
Lubricating System	Forced lubrication by trochoid pump	
Oil Pressure Indicating	Electrical type switch	
Lubricating Filter	Full flow paper filter (Cartridge type)	
Cooling System	Pressurized radiator, forced circulation with water pump	
Starting System	Electric Starting with Starter	
Starter Motor	12 V, 1.2 kW	
Starting Support Device	By glow plug in combustion chamber	
EGR	None	
Battery	12 V, 65 AH, equivalent	12 V, 75 AH, equivalent
Charging Alternator	12 V, 480 W	
Fuel	Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil	Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-6, G-9.	
Lubricating Oil Capacity	5.7 L (1.5 U.S.gals)	6.7 L (1.8 U.S.gals)
Weight (Dry)	95.0 kg (209 lbs)	110.0 kg (242.5 lbs)

- The specification described above is of the standard engine of each model.
- Conversion Formula: HP = 0.746 kW, PS = 0.7355 kW

9Y1210784INI0002US0

Model	D1005-E4BG	D1105-E4BG	D1305-E4BG	V1505-E4BG
	BG1	BG1	BG1	BG1
Number of Cylinder	3			4
Engine Type	Vertical, Water-cooled, 4 cycle diesel engine			
Bore × Stroke	76.0 × 73.6 mm (2.99 × 2.90 in.)	78.0 × 78.4 mm (3.07 × 3.09 in.)	78.0 × 88.0 mm (3.07 × 3.46 in.)	78.0 × 78.4 mm (3.07 × 3.09 in.)
Total Displacement	1001 cm ³ (61.08 cu.in.)	1123 cm ³ (68.53 cu.in.)	1261 cm ³ (76.95 cu.in.)	1498 cm ³ (91.41 cu.in.)
STANDBY ISO 3046	9.8 kW / 1800 min ⁻¹ (rpm)	11.5 kW / 1800 min ⁻¹ (rpm)	13.1 kW / 1800 min ⁻¹ (rpm)	15.1 kW / 1800 min ⁻¹ (rpm)
SAE J-1349	13.1 HP / 1800 min ⁻¹ (rpm)	15.4 HP / 1800 min ⁻¹ (rpm)	17.6 HP / 1800 min ⁻¹ (rpm)	20.2 HP / 1800 min ⁻¹ (rpm)
NET Continuous ISO 3046	8.7 kW / 1800 min ⁻¹ (rpm)	10.1 kW / 1800 min ⁻¹ (rpm)	11.6 kW / 1800 min ⁻¹ (rpm)	13.4 kW / 1800 min ⁻¹ (rpm)
SAE J-1349	11.7 HP / 1800 min ⁻¹ (rpm)	13.5 HP / 1800 min ⁻¹ (rpm)	15.6 HP / 1800 min ⁻¹ (rpm)	18.0 HP / 1800 min ⁻¹ (rpm)
Governor Regulation	Less than 5 %			
Combustion Chamber	Spherical type (E-TVCS)			
Fuel Injection Pump	Bosch MD type mini pump			
Governor	All speed mechanical governor			
Direction of Rotation	Counter-clockwise (viewed from flywheel side)			
Injection Nozzle	Mini Nozzle (DNOPD)			
Injection Timing	0.2705 rad (15.50 °) before T.D.C.		0.2618 rad (15.00 °) before T.D.C.	
Firing Order	1-2-3		1-3-4-2	
Injection Pressure	13.73 MPa (140.0 kgf/cm ² , 1991 psi)			
Compression Ratio	24 : 1			
Lubricating System	Forced lubrication by trochoid pump			
Oil Pressure Indication	Electrical type switch			
Lubricating Filter	Full flow paper filter (Cartridge type)			
Cooling System	Pressurized radiator, forced circulation with water pump			
Starting System	Electric Starting with Starter			
Starting Motor	12 V, 1.0 kW		12 V, 1.2 kW	
Starting Support Device	By glow plug in combustion chamber			
EGR	None			
Battery	12 V, 65 AH, equivalent		12 V, 75 AH, equivalent	
Charging Alternator	12 V, 360 W			
Fuel	Diesel Fuel No. 2-D (ASTM D975)			
Lubricating Oil	Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-6, G-9.			
Lubricating Oil Capacity	5.1 L (1.3 U.S.gals)		5.7 L (1.5 U.S.gals)	6.7 L (1.8 U.S.gals)
Weight (Dry)	110 kg (242 lbs)		112 kg (247 lbs)	127 kg (280 lbs)

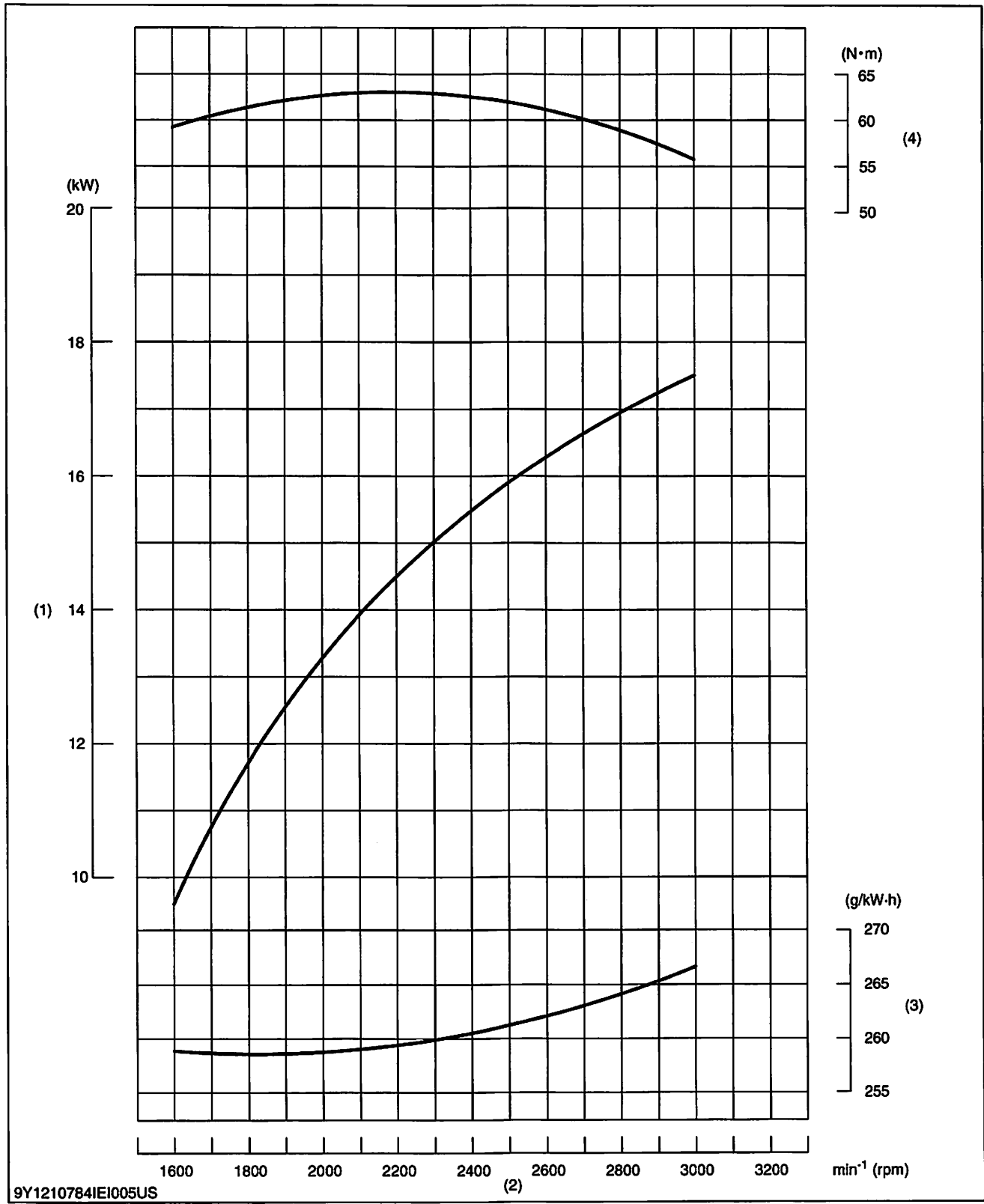
* The specification described above is of the standard engine of each model.

* Conversion Formula: HP = 0.746 kW, PS = 0.7355 kW

9Y1210784INI0010US0

3. PERFORMANCE CURVES

D1005-E4B (3000 rpm)



9Y1210784IEI005US

(1) Brake Horsepower

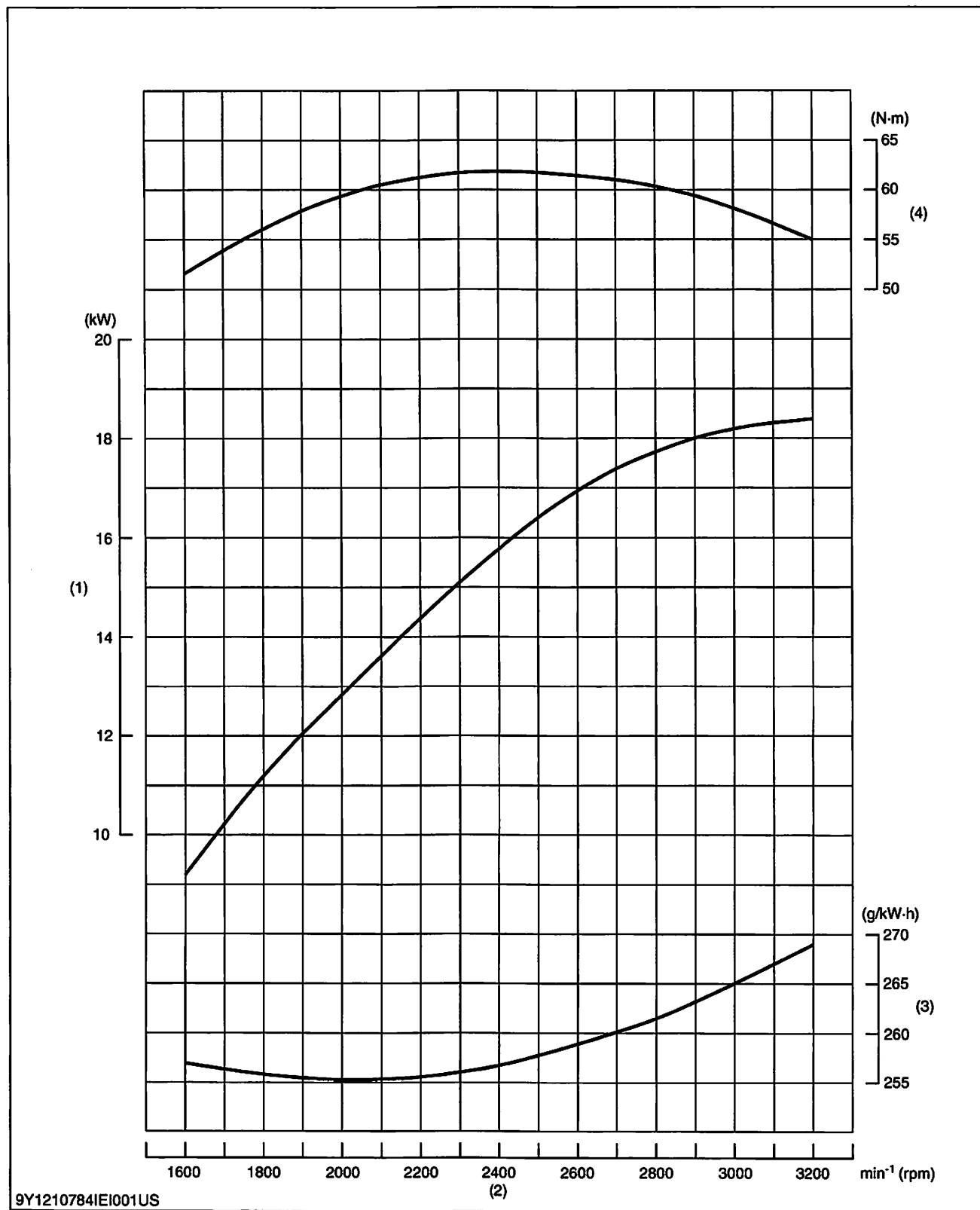
(2) Engine Speed

(3) B.S.F.C. (Brake Specific Fuel Consumption)

(4) Torque

9Y1210784INI0011US0

D1005-E4B (3200 rpm)



9Y1210784IEI001US

(1) Brake Horsepower

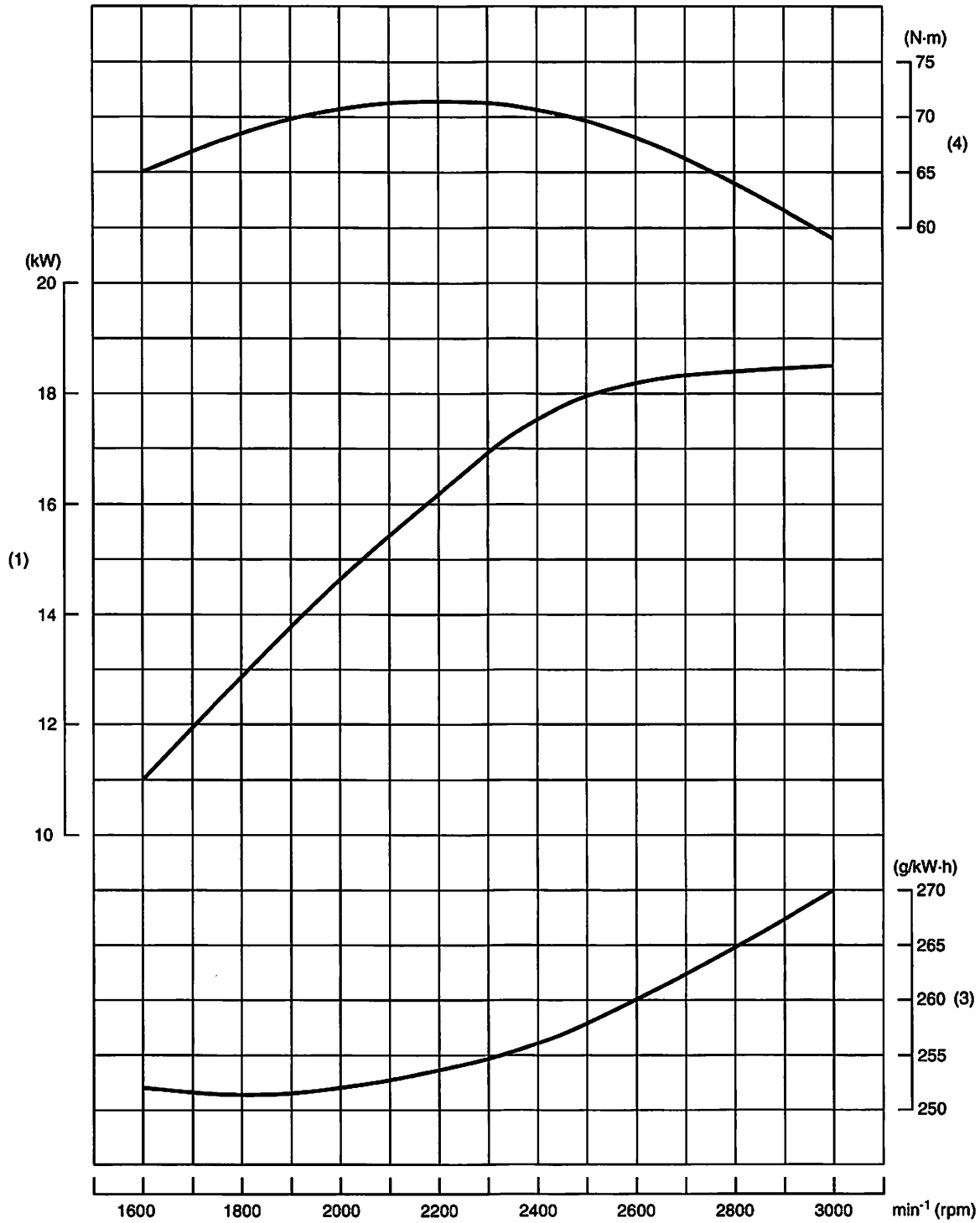
(2) Engine Speed

(3) B.S.F.C. (Brake Specific Fuel Consumption)

(4) Torque

9Y1210784INI0003US0

D1105-E4B



9Y1210784IEI002US

(1) Brake Horsepower

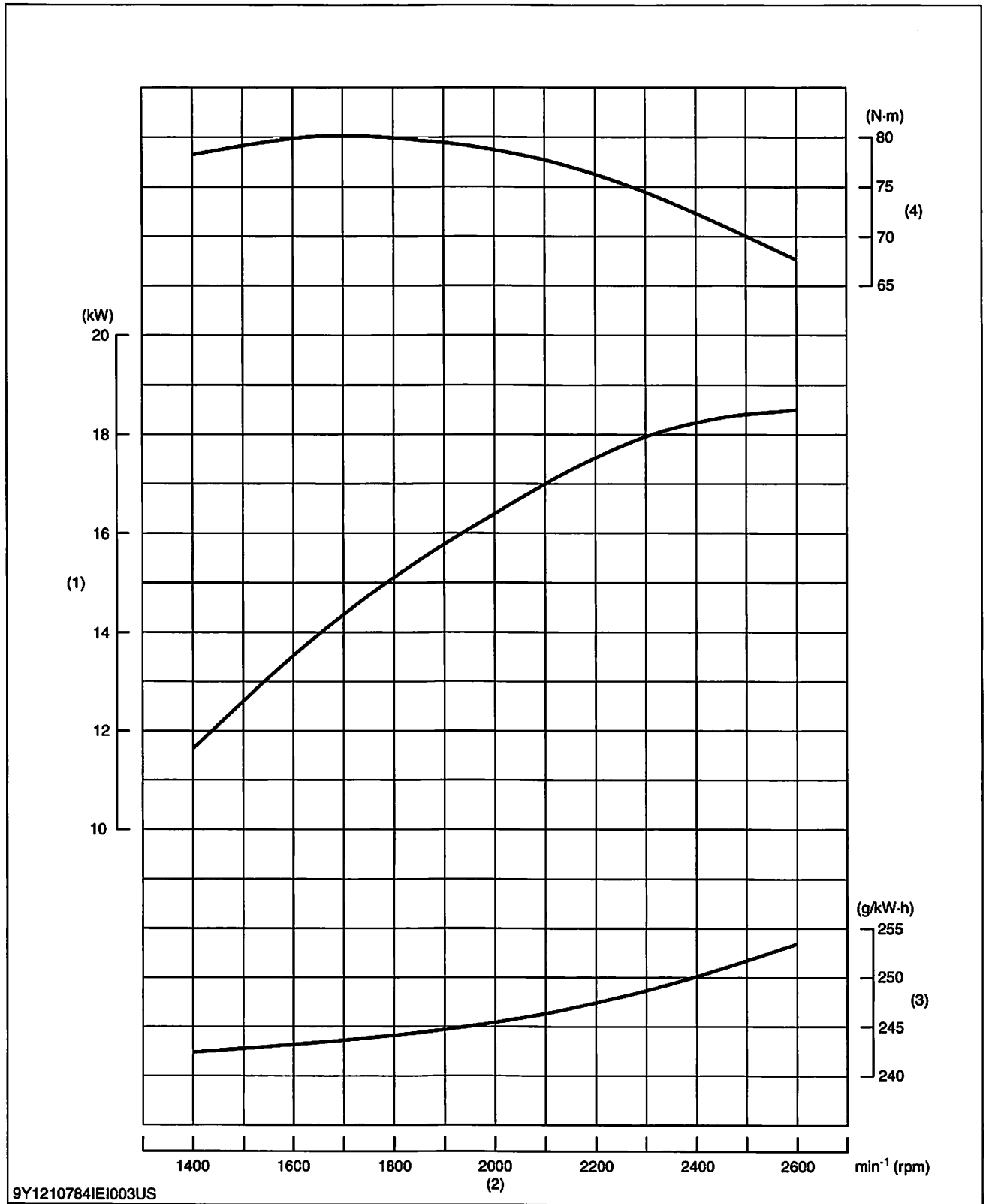
(2) Engine Speed

(3) B.S.F.C. (Brake Specific Fuel Consumption)

(4) Torque

9Y1210784INI0004US0

D1305-E4B



9Y1210784IEI003US

(1) Brake Horsepower

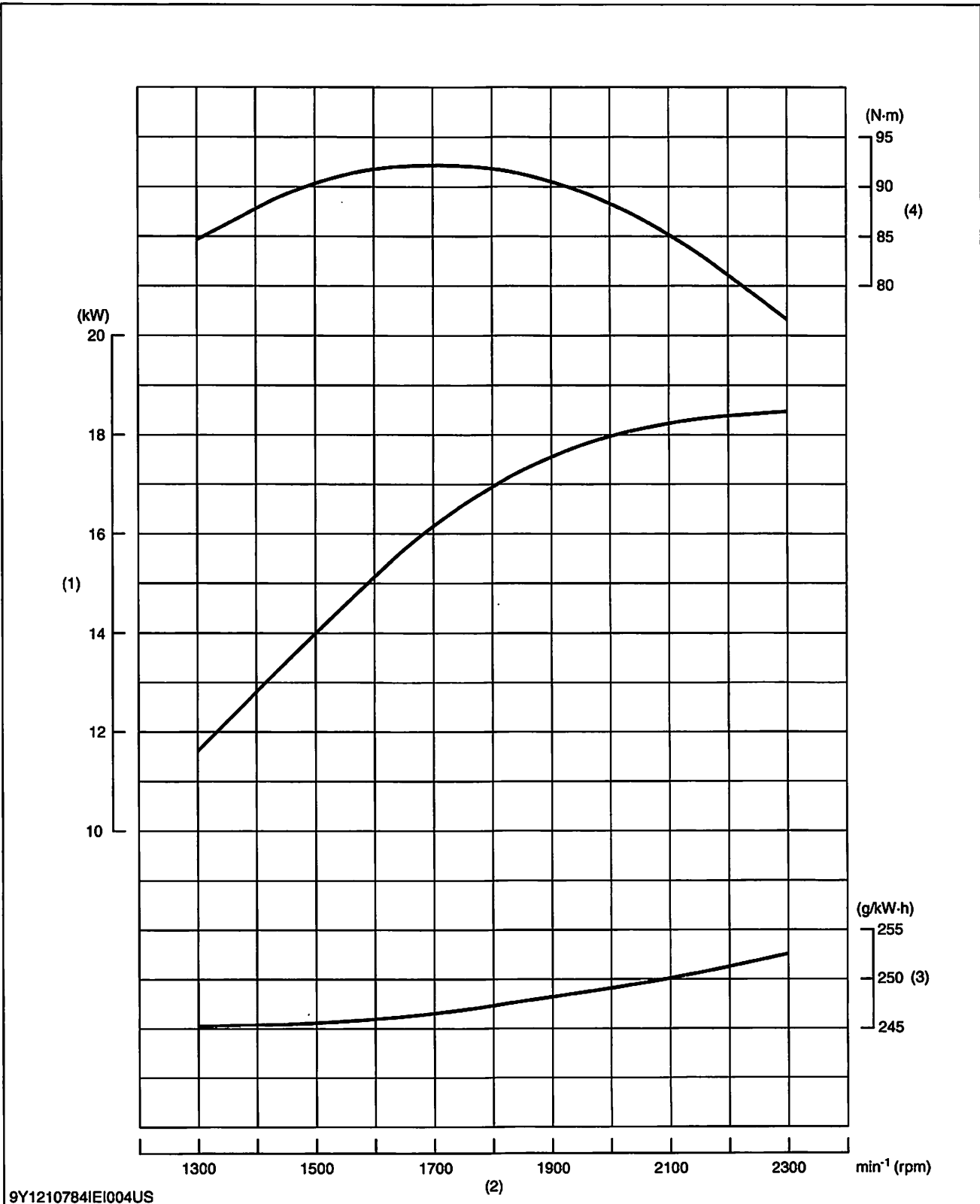
(2) Engine Speed

(3) B.S.F.C. (Brake Specific Fuel Consumption)

(4) Torque

9Y1210784INI0005US0

V1505-E4B



9Y1210784IEI004US

(1) Brake Horsepower

(2) Engine Speed

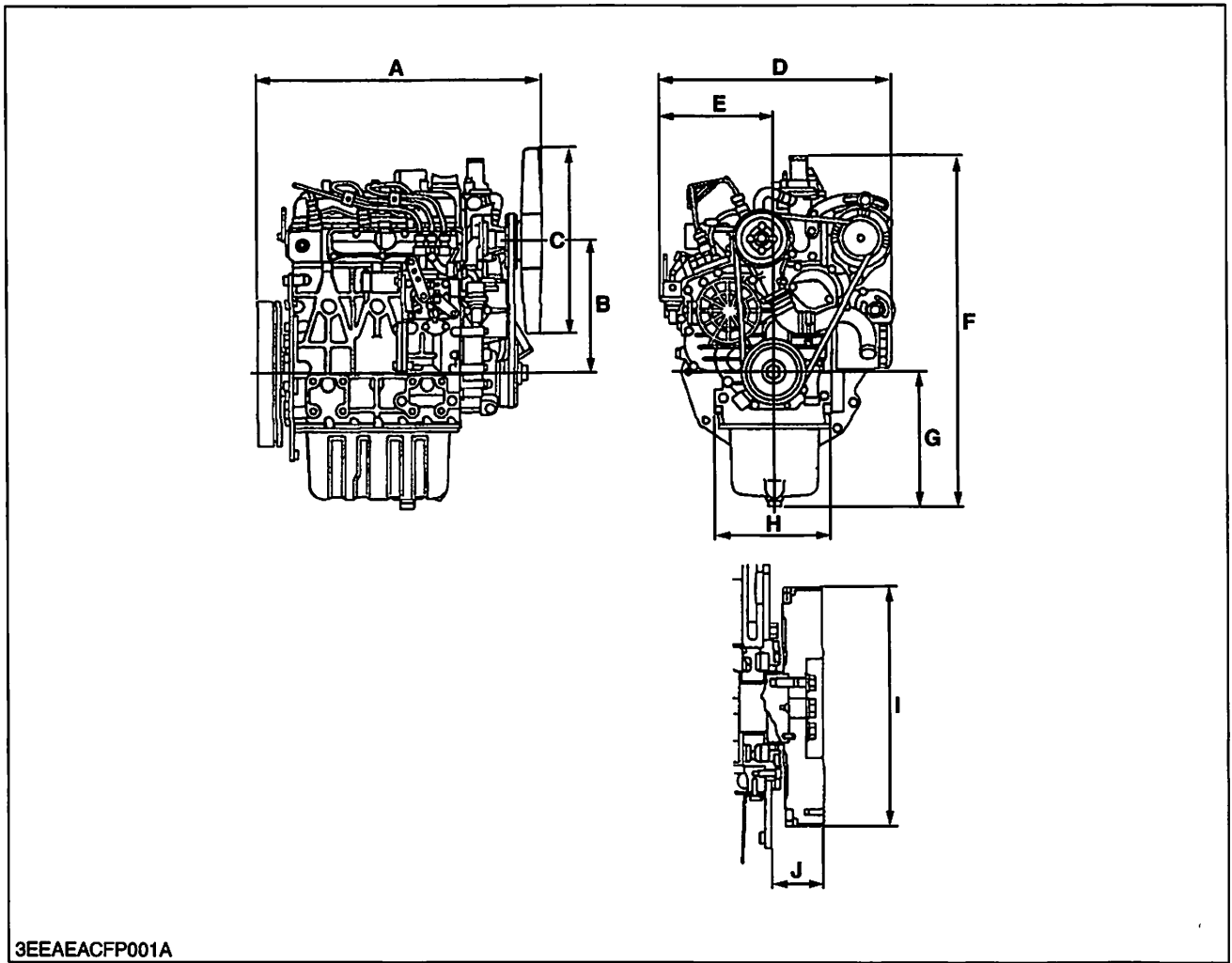
(3) B.S.F.C. (Brake Specific Fuel Consumption)

(4) Torque

9Y1210784INI0006US0

4. DIMENSIONS

D1005-E4B, D1105-E4B

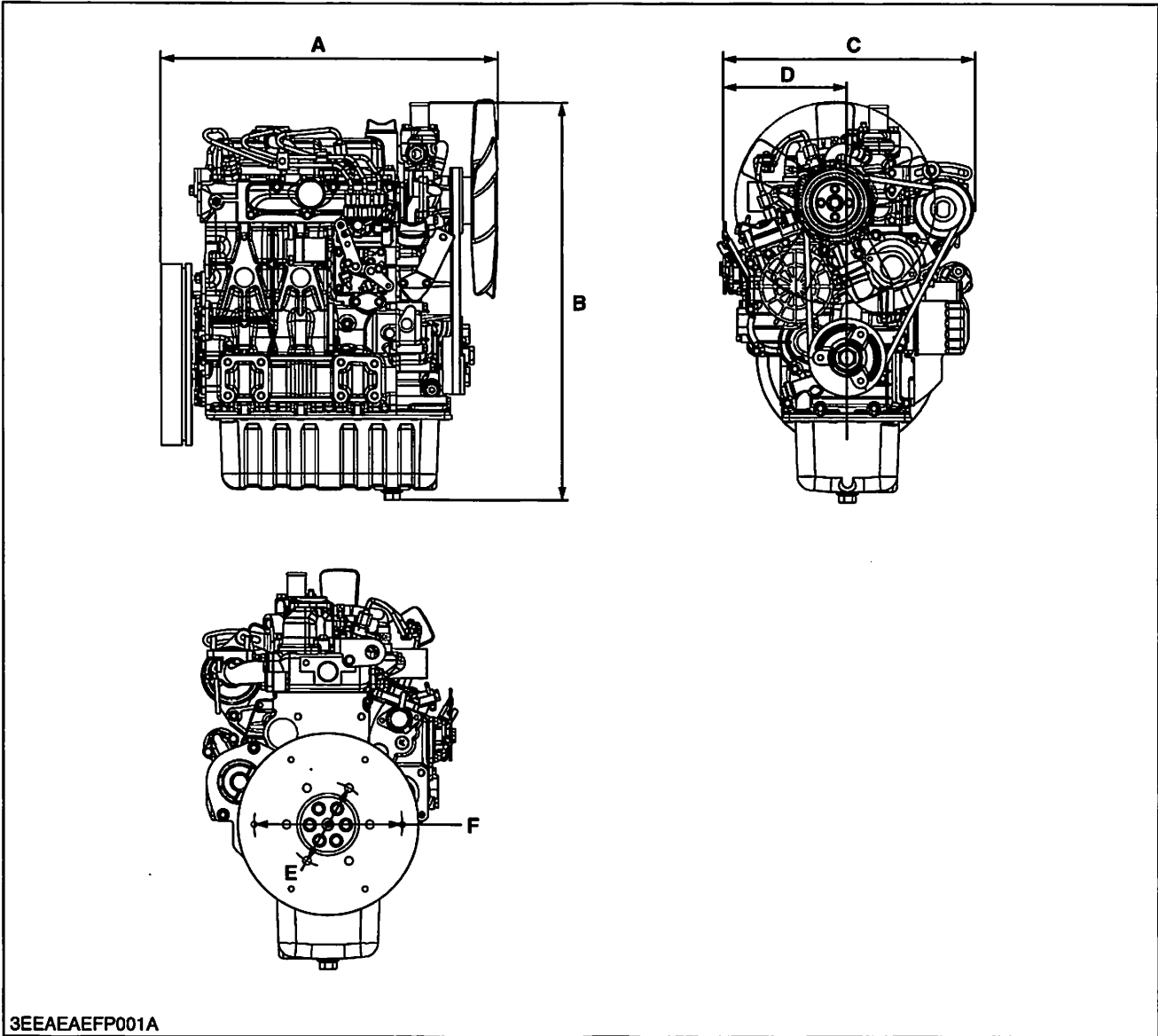


3EEEAEACFP001A

	D1005-E4B	D1105-E4B
A	497.8 mm (19.60 in.)	497.8 mm (19.60 in.)
B	230 mm (9.06 in.)	230 mm (9.06 in.)
C	330 mm dia. (13.0 in. dia.)	330 mm dia. (13.0 in. dia.)
D	396 mm (15.6 in.)	396 mm (15.6 in.)
E	194 mm (7.64 in.)	194 mm (7.64 in.)
F	602.0 mm (23.70 in.)	602.0 mm (23.70 in.)
G	233.5 mm (9.193 in.)	233.5 mm (9.193 in.)
H	200 mm (7.87 in.)	200 mm (7.87 in.)
I	250.81 to 251.12 mm dia. (9.8744 to 9.8866 in. dia.)	250.81 to 251.12 mm dia. (9.8744 to 9.8866 in. dia.)
J	56 mm (2.2 in.)	56 mm (2.2 in.)

9Y1210784INI0007US0

D1305-E4B

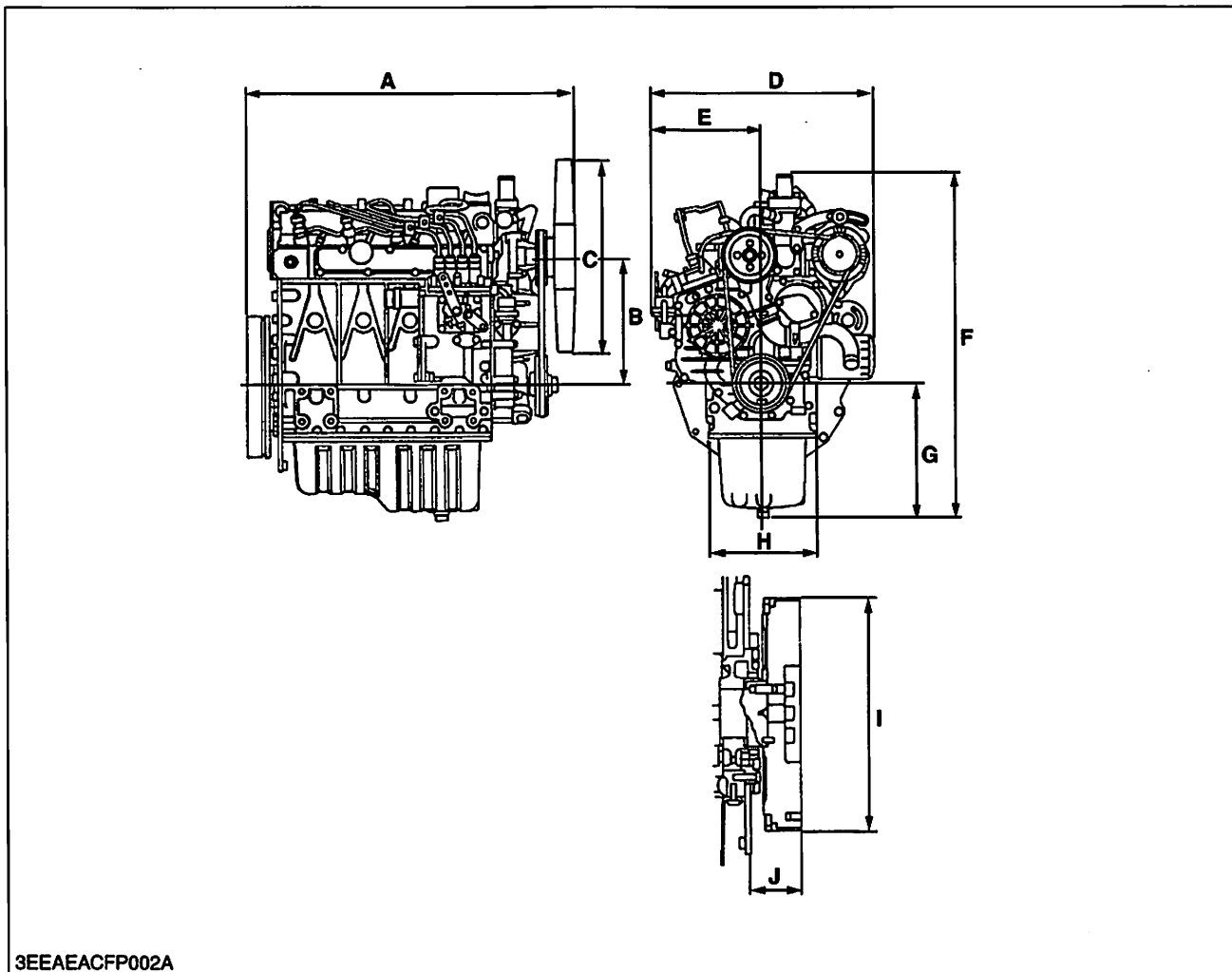


3EEAEAEFP001A

D1305-E4B	
A	497.6 mm (19.59 in.)
B	590.1 mm (23.23 in.)
C	396.0 mm (15.59 in.)
D	185.3 mm (7.295 in.)
E	125 mm dia. (4.92 in. dia.)
F	222.2 mm dia. (8.748 in. dia.)

9Y1210784INI0008US0

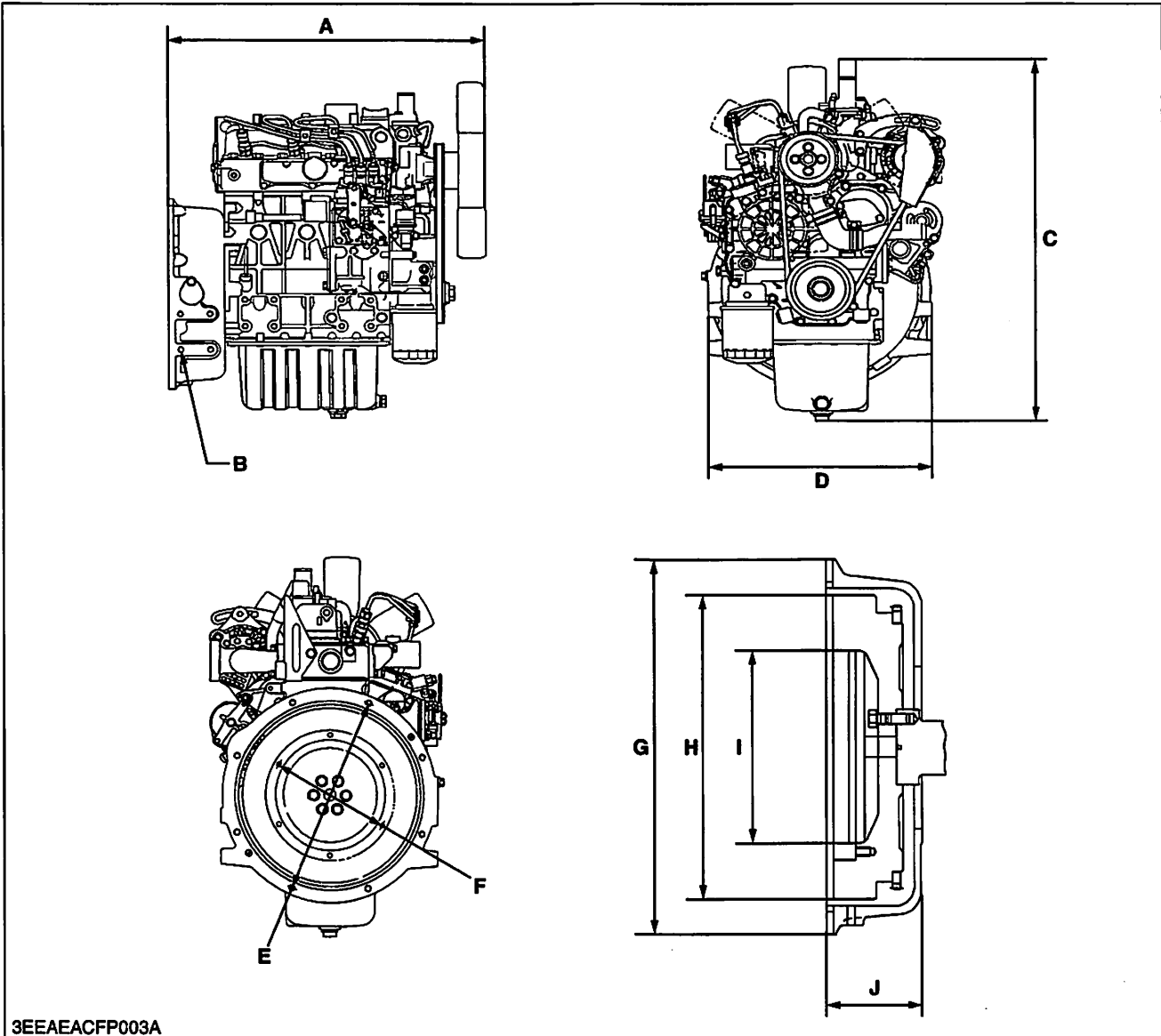
V1505-E4B



V1505-E4B	
A	591.3 mm (23.28 in.)
B	230 mm (9.06 in.)
C	370 mm dia. (14.6 in. dia.)
D	396 mm (15.6 in.)
E	194 mm (7.64 in.)
F	607.0 mm (23.90 in.)
G	238.5 mm (9.390 in.)
H	200 mm (7.87 in.)
I	250.81 to 251.12 mm dia. (9.8744 to 9.8866 in. dia.)
J	56 mm (2.2 in.)

9Y1210784INI0009US0

D1005-E4BG, D1105-E4BG, V1505-E4BG

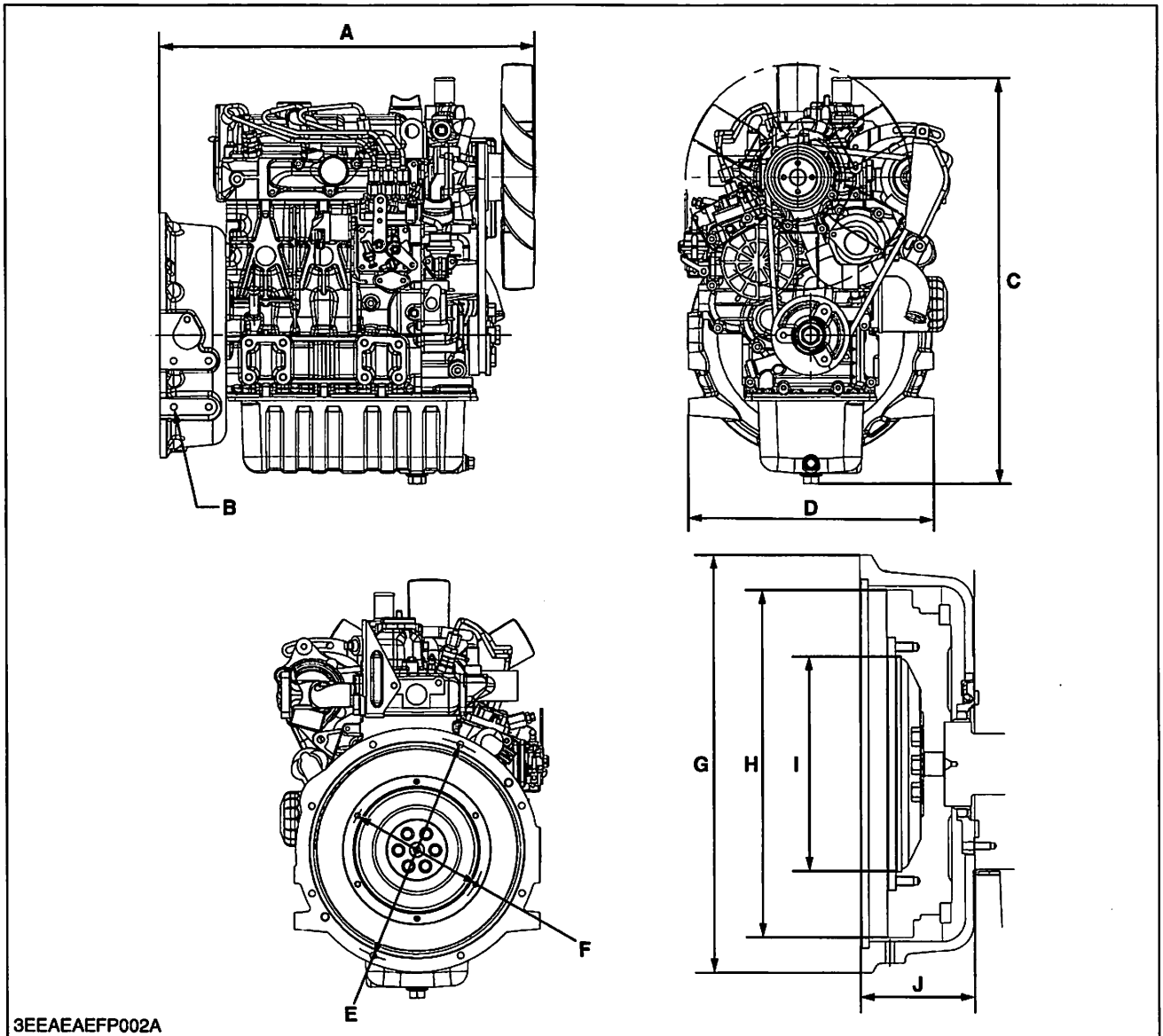


3EEAEACFP003A

	D1005-E4BG	D1105-E4BG	V1505-E4BG
A	546.6 mm (21.52 in.)	546.6 mm (21.52 in.)	634.3 mm (24.97 in.)
B	4-3/8-16 UNC-2B Depth 16 mm (0.63 in.)	4-3/8-16 UNC-2B Depth 16 mm (0.63 in.)	4-3/8-16 UNC-2B Depth 16 mm (0.63 in.)
C	608.7 mm (23.96 in.)	608.7 mm (23.96 in.)	613.7 mm (24.16 in.)
D	360 mm (14.2 in.)	360 mm (14.2 in.)	360 mm (14.2 in.)
E	333.38 mm dia. (13.125 in. dia.)	333.38 mm dia. (13.125 in. dia.)	333.38 mm dia. (13.125 in. dia.)
F	200.02 mm dia. (7.8748 in. dia.)	200.02 mm dia. (7.8748 in. dia.)	200.02 mm dia. (7.8748 in. dia.)
G	356 mm dia. (14.0 in. dia.)	356 mm dia. (14.0 in. dia.)	356 mm dia. (14.0 in. dia.)
H	290 mm dia. (11.4 in. dia.)	290 mm dia. (11.4 in. dia.)	290 mm dia. (11.4 in. dia.)
I	184.2 mm dia. (7.252 in. dia.)	184.2 mm dia. (7.252 in. dia.)	184.2 mm dia. (7.252 in. dia.)
J	98 mm (3.9 in.)	98 mm (3.9 in.)	98 mm (3.9 in.)

9Y1210784INI0012US0

D1305-E4BG



3EEAEAFP002A

D1305-E4BG	
A	551.3 mm (21.70 in.)
B	4-3/8-16 UNC-2B Depth 16 mm (0.63 in.)
C	590.1 mm (23.23 in.)
D	360 mm (14.2 in.)
E	333.38 mm dia. (13.125 in. dia.)
F	200.02 mm dia. (7.8748 in. dia.)
G	356 mm dia. (14.0 in. dia.)
H	296 mm dia. (11.7 in. dia.)
I	184.2 mm dia. (7.252 in. dia.)
J	98 mm (3.9 in.)

9Y1210784INI0013US0

G GENERAL

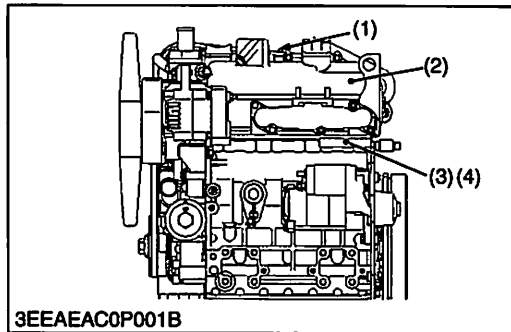
GENERAL

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1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER



You must identify the engine model name and serial number before you start a job. When you get in touch with the manufacturer, always tell your engine model name and serial number.

Engine Serial Number

The engine serial number is an identified number for the engine. It appears after the engine model number.

It shows the month and year of manufacture as below.

Engine Series

Number	Series	Number	Series
1	05 Series (Include: WG)	5	Air Cooled Gasoline
2	V3 Series	6	GZ, OC, AC, EA and E Series
3	08 Series	7	03 Series
4	SM Series (Include: WG)	8	07 Series

Year of manufacture

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

- (1) Engine Label
- (2) Emission Label

- (3) Engine Model
- (4) Serial Number

(To be continued)

(Continued)

Month of manufacture

Month	Engine Lot Number	
January	A0001 ~ A9999	B0001 ~ BZ999
February	C0001 ~ C9999	D0001 ~ DZ999
March	E0001 ~ E9999	F0001 ~ FZ999
April	G0001 ~ G9999	H0001 ~ HZ999
May	J0001 ~ J9999	K0001 ~ KZ999
June	L0001 ~ L9999	M0001 ~ MZ999
July	N0001 ~ N9999	P0001 ~ PZ999
August	Q0001 ~ Q9999	R0001 ~ RZ999
September	S0001 ~ S9999	T0001 ~ TZ999
October	U0001 ~ U9999	V0001 ~ VZ999
November	W0001 ~ W9999	X0001 ~ XZ999
December	Y0001 ~ Y9999	Z0001 ~ ZZ999

* Alphabetical letters "I" and "O" are not used.

(a) (b)(c)(d) (e)
e.g. D1105 - 1 D L A001

- (a) Engine Model Name: **D1105**
- (b) Engine Series: 1 indicates 05 Series
- (c) Year: D indicates 2013
- (d) Month: L or M indicates June
- (e) Lot Number: (0001 ~ 9999 or A001 ~ Z999)

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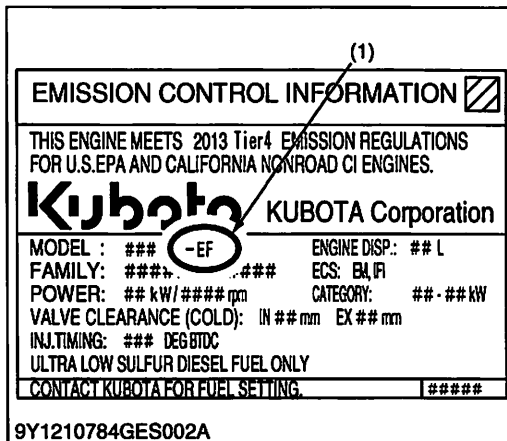
[2] E4B ENGINE

[Example: Engine Model Name D1105-E4B-XXXX]

The emission controls previously implemented in various countries to prevent air pollution will be stepped up as Nonroad Emission Standards continue to change. The timing or applicable date of the specific Nonroad Emission regulations depends on the engine output classification.

Over the past several years, KUBOTA has been supplying diesel engines that comply with regulations in the respective countries affected by Nonroad Emission regulations. For KUBOTA Engines, E4B will be the designation that identifies engine models affected by the next emission phase (See the table below).

When servicing or repairing ###-E4B series engines, use only replacement parts for that specific E4B engine, designated by the appropriate E4B KUBOTA Parts List and perform all maintenance services listed in the appropriate KUBOTA Operator's Manual or in the appropriate E4B KUBOTA Workshop Manual. Use of incorrect replacement parts or replacement parts from other emission level engines (for example: E3B engines), may result in emission levels out of compliance with the original E4B design and EPA or other applicable regulations. Please refer to the emission label located on the engine head cover to identify Output classification and Emission Control Information. E4B engines are identified with "EF" at the end of the Model designation, on the US EPA label. Please note: E4B is not marked on the engine.

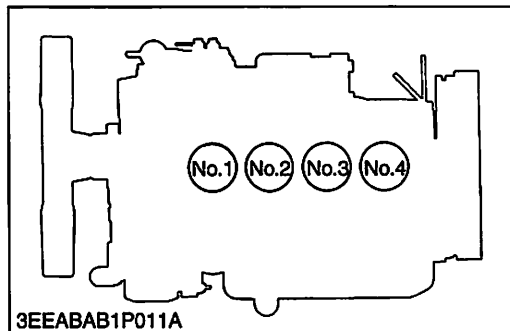


Category	Engine output classification	EPA regulation
EF	Less than 19 kW	Tier 4
	From 19 to less than 56 kW	Interim Tier 4
	From 56 to less than 75 kW	Interim Tier 4
	From 75 to less than 130 kW	Interim Tier 4

(1) "E4B" engines are identified with "EF" at the end of the Model designation, on the US EPA label. "E4B" designates some Interim Tier 4 / Tier 4 models, depending on engine output classification.

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[3] CYLINDER NUMBER

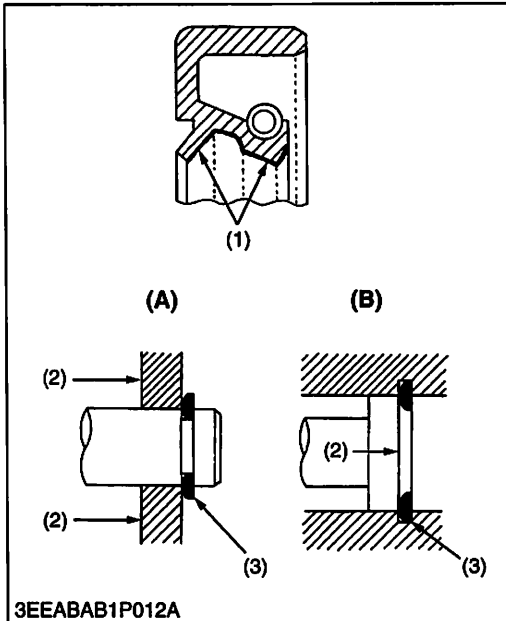


You can see the cylinder numbers of KUBOTA diesel engine in the figure.

The sequence of cylinder numbers is No.1, No.2, No.3 and No.4 and it starts from the gear case side.

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2. GENERAL PRECAUTIONS



- When you disassemble, carefully put the parts in a clean area to make it easy to find the parts.
You must install the screws, bolts and nuts in their initial position to prevent the reassembly errors.
- When it is necessary to use special tools, use KUBOTA special tools. Refer to the drawings when you make special tools that you do not use frequently.
- Before you disassemble or repair machine, make sure that you always disconnect the ground cable from the battery first.
- Remove oil and dirt from parts before you measure.
- Use only KUBOTA genuine parts for replacement to keep the machine performance and to make sure of safety.
- You must replace the gaskets and O-rings when you assemble again. Apply grease (1) to new O-rings or oil seals before you assemble.
- When you assemble the external or internal snap rings, make sure that the sharp edge (3) faces against the direction from which force (2) is applied.
- Make sure that you try to operate the engine after you repair or assemble it.

- (1) Grease
(2) Force
(3) Sharp Edge

- (A) External Snap Ring
(B) Internal Snap Ring

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3. MAINTENANCE CHECK LIST

To make sure that the engine operates safely for a long time, refer to the table below to do regular inspections.

Item	Service Interval										
	Every										
	50 hrs	100 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
* Checking fuel hoses and clamp bands	☆										
Changing engine oil (Oil pan depth: 110 mm (4.33 in.), 125 mm (4.92 in.), 130 mm (5.12 in.))	★		☆								
* Cleaning air cleaner element (Replace the element after 6 times cleaning)		☆									
Cleaning fuel filter element		☆									
Check fan belt tension and damage		☆									
Checking battery electrolyte level		☆									
* Replacing oil filter cartridge (Oil pan depth: 110 mm (4.33 in.), 125 mm (4.92 in.), 130 mm (5.12 in.))	★		☆	☆ (BG type)							
Checking radiator hoses and clamp bands			☆								
* Checking intake air line			☆								
Replacing fuel filter cartridge				☆							
Cleaning water jacket and radiator interior					☆						
Replacing fan belt					☆						
Recharging battery						☆					
* Replacing air cleaner element							☆				
Checking valve clearance								☆			
* Checking injection nozzle pressure									☆		
Checking injection pump										☆	
Checking injection timing										☆	
Changing radiator coolant (L.L.C.)											☆
Replacing radiator hoses and clamp bands											☆
* Replacing fuel hoses and clamps											☆
* Replacing intake air line											☆
Replacing battery											☆

★ Change engine oil and replace oil filter cartridge after the first 50 hours of operation.

* The items listed above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.

Please see the emission Warranty Statement in detail.

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 **CAUTION**

- When changing or inspecting, be sure to level and stop the engine.

 **NOTE**
Engine oil

- Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used: (Low Sulfur, Ultra Low Sulfur or High Sulfur Fuels).

Fuel Type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	CF (If the "CF-4, CG-4, CH-4, or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	–
Low Sulfur Fuel [Sulfur Content < 0.05 % (500 ppm)] or Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	CF, CF-4, CG-4, CH-4 or CI-4	CF or CI-4 (Class CF-4, CG-4 and CH-4 engine oils cannot be used on EGR type engines.)

EGR: Exhaust Gas Re-circulation

- **CJ-4 classification oil is intended for use in engines equipped with DPF (Diesel Particulate Filter) and is Not Recommended for use in Kubota E3 specification engines.**
- Oil used in the engine should have API classification and Proper SAE Engine Oil Viscosity according to the ambient temperatures where the engine is operated.
- With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Nonroad engine runs on high sulfur fuel, it is advisable to use a "CF or better" classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).

Fuel

- **Cetane Rating:** The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below –20 °C (–4 °F) or elevations above 1500 m (5000 ft).
- **Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.**
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half)
- **DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).**
- Diesel fuels specified to EN 590 or ASTM D975 are recommended.
- No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of low sulfur fuel or ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S500 or S15 diesel fuel as an alternative to No.2-D, and use No.1-D S500 or S15 diesel fuel as an alternative to No.1-D for ambient temperatures below –10 °C (14 °F).

1) SAE: Society of Automotive Engineers

2) EN: European Norm

3) ASTM: American Society of Testing and Materials

4) US EPA: United States Environmental Protection Agency

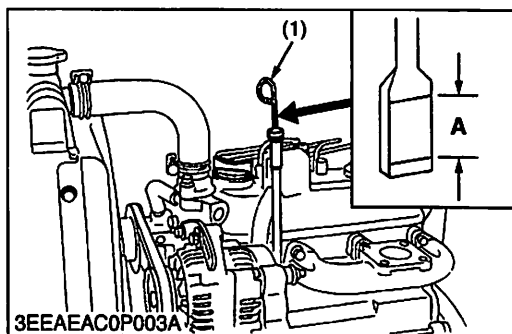
5) No.1-D or No.2-D, S500: Low Sulfur Diesel (LSD) less than 500 ppm or 0.05 wt. %

No.1-D or No.2-D, S15: Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt. %

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4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



Checking Engine Oil Level

1. Level the engine.
2. To check the oil level, draw out the dipstick (1), wipe it clean, reinsert it, and draw it out again.
Check to see that the oil level lies "A" between the two notches.
3. If the level is too low, add new oil to the specified level.

■ IMPORTANT

- When using an oil of different maker or viscosity from the previous, drain old oil. Never mix two different types of oil.

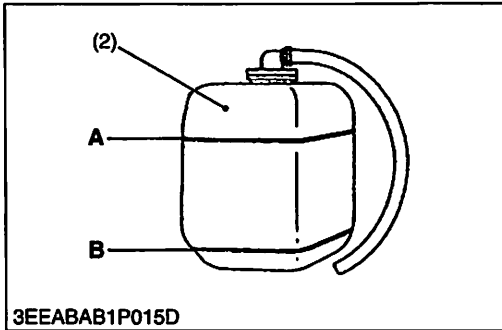
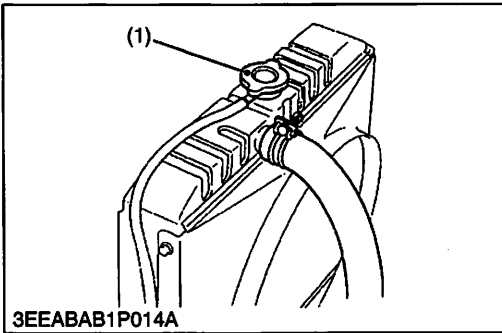
■ NOTE

- Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.
- Be sure to keep the oil level between upper and lower limits of the dipstick. Too much oil may cause a drop in output or excessive blow-by gas. On the closed breather type engine in which mist is sucked through port, too much oil may caused oil hammer. While too little oil, may seize the engine's rotating and sliding parts.

(1) Dipstick

A: Oil Level

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Checking and Replenish Coolant

1. Without recovery tank:
Remove the radiator cap (1) and check to see that the coolant level is just below the port.
With recovery tank (2):
Check to see that the coolant level lies between **FULL "A"** and **LOW "B"**.
2. If coolant level is too low, check the reason for decreasing coolant.
 - (Case 1)
If coolant is decreasing by evaporation, replenish only fresh, soft water.
 - (Case 2)
If coolant is decreasing by leak, replenish coolant of the same manufacture and type in the specified mixture ratio (fresh, soft water and L.L.C.). If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new brand of coolant mix.

⚠ CAUTION

- Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.

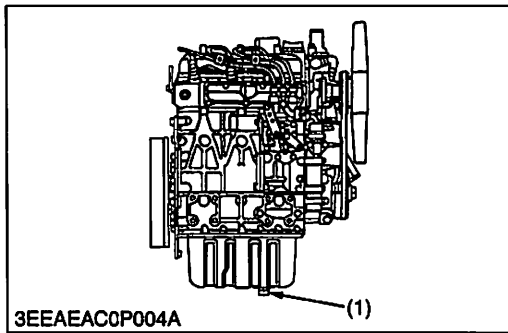
■ IMPORTANT

- During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the radiator upper and lower hoses.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.
- Do not use an antifreeze and scale inhibitor at the same time.
- Never mix the different type or brand of L.L.C..

- | | |
|-------------------|---------|
| (1) Radiator Cap | A: FULL |
| (2) Recovery Tank | B: LOW |

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[2] CHECK POINTS OF INITIAL 50 HOURS



Changing Engine Oil

CAUTION

- Be sure to stop engine before changing engine oil.
- 1. Start and warm up the engine for approx. 5 minutes.
- 2. Place an oil pan underneath the engine.
- 3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
- 4. Screw the drain plug (1).
- 5. Fill new oil up to upper line on the dipstick.

■ IMPORTANT

- When using an oil of different maker or viscosity from the previous one, remove all of the old oil.
- Never mix two different types of oil.
- Engine oil should have properties of API classification. (See page G-6.)
- Use the proper SAE Engine Oil according to ambient temperature.
- Upon an oil change, be sure to replace the gasket with new one.

Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	Oil Pan Depth		
	110 mm (4.33 in.)	125 mm (4.92 in.)	130 mm (5.12 in.)
D1005-E4B/E4BG, D1105-E4B/E4BG	-	5.1 L 1.3 U.S.gals	-
D1305-E4B/E4BG	5.7 L 1.5 U.S.gals	-	-
V1505-E4B/E4BG	-	-	6.7 L 1.8 U.S.gals

Tightening torque	Drain plug with copper gasket	M12 × 1.25	33 to 37 N·m 3.3 to 3.8 kgf·m 24 to 27 lbf·ft
	Drain plug with rubber coated gasket	M22 × 1.5	45 to 53 N·m 4.5 to 5.5 kgf·m 33 to 39 lbf·ft

(1) Drain Plug

9Y1210784GEG0009US0

Replacing Oil Filter Cartridge

CAUTION

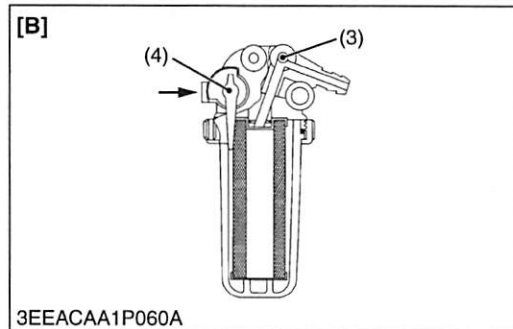
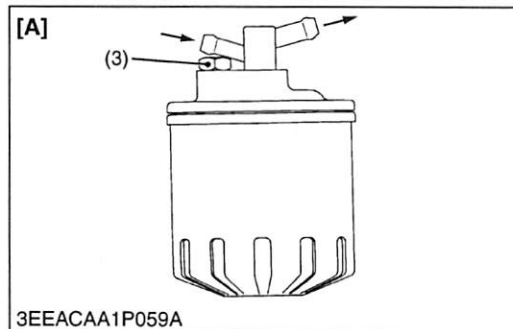
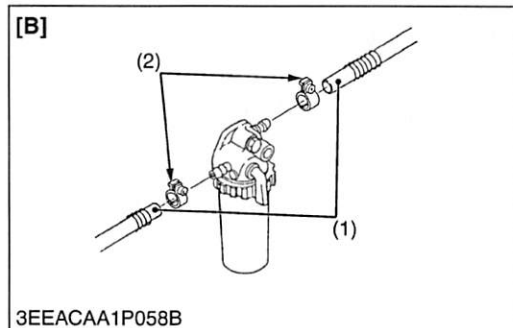
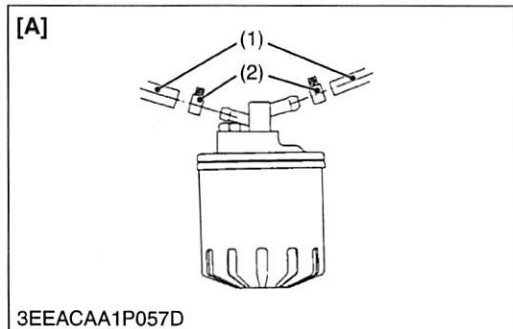
- **Be sure to stop the engine before changing filter cartridge.**
- 1. Remove the oil filter cartridge with the filter wrench.
- 2. Apply a slight coat of oil onto the new cartridge gasket.
- 3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
- 4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

■ IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

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[3] CHECK POINT OF EVERY 50 HOURS



Checking Fuel Hose

1. If the clamp (2) is loose, apply oil to the threads and securely retighten it.
2. The fuel hose (1) is made of rubber and ages regardless of the period service.
Change the fuel hose together with the clamp every two years.
3. However, if the fuel hose and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel hose and the clamp have been changed, bleed the fuel system.

⚠ CAUTION

- Stop the engine when attempting the check and change prescribed above.

(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel valve (4).
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent valve on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to AC position and pump the fuel up for 10 to 15 seconds.
If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent valve after air bleeding.

■ NOTE

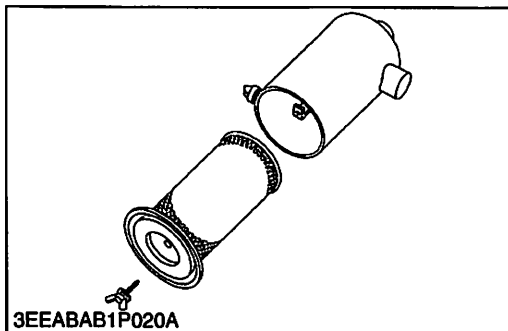
- Always keep the air vent valve on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

- (1) Fuel Hose
- (2) Clamp
- (3) Air Vent Plug
- (4) Fuel Valve

- [A] Cartridge Type
- [B] Element Type

9Y1210784GEG0011US0

[4] CHECK POINTS OF EVERY 100 HOURS



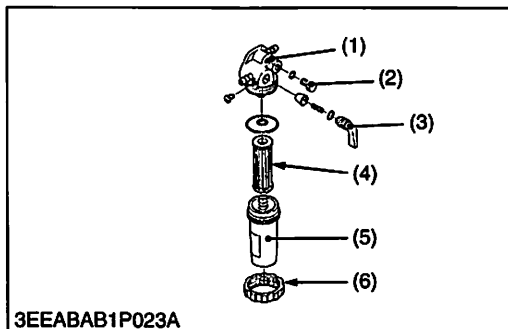
Cleaning Air Cleaner Element

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm², 30 psi). Maintain reasonable distance between the nozzle and the filter.

■ **NOTE**

- The air cleaner uses a dry element. Never apply oil to it.
- Do not run the engine with filter element removed.
- Change the element once a year or every 6th cleaning.

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Cleaning Fuel Filter (Element Type Only)

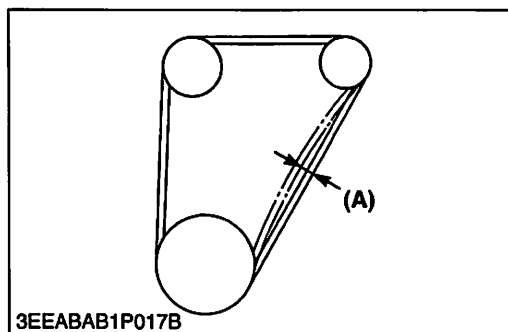
1. Close the fuel valve (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ **IMPORTANT**

- If dust and dirt enter the fuel, the fuel injection pump and injection nozzle will wear quickly. To prevent this, be sure to clean the fuel filter cup (5) periodically.

- | | |
|---------------------|--------------------|
| (1) Fuel Valve Body | (4) Filter Element |
| (2) Air Vent Plug | (5) Filter Cup |
| (3) Fuel Valve | (6) Retaining Ring |

9Y1210784GEG0013US0



Fan Belt Tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbf).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory specification	7.0 to 9.0 mm 0.28 to 0.35 in.
----------------	-----------------------	-----------------------------------

(A) Deflection

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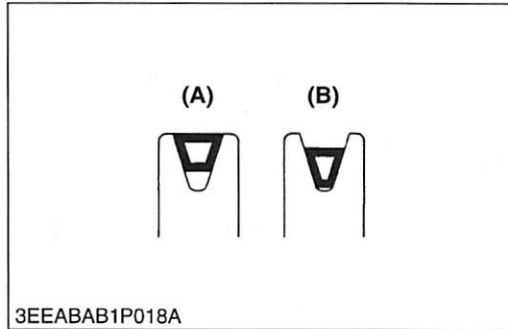
Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good

(B) Bad

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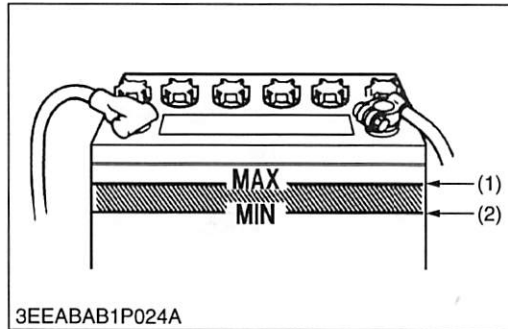
Checking Battery Electrolyte Level

1. Check the battery electrolyte level.
2. If the level is below than lower level line (2), and the distilled water to pour level of each cell.

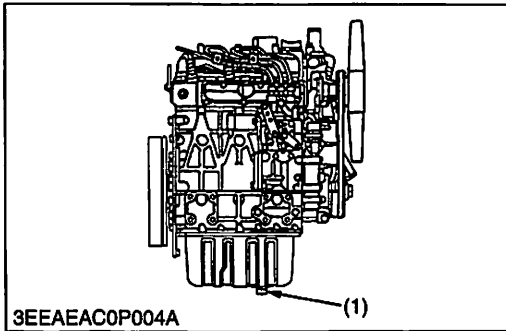
(1) Upper Level Line

(2) Lower Level Line

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[5] CHECK POINTS OF EVERY 200 HOURS



Changing Engine Oil

⚠ CAUTION

- **Be sure to stop engine before changing engine oil.**
- 1. Start and warm up the engine for approx. 5 minutes.
- 2. Place an oil pan underneath the engine.
- 3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
- 4. Screw the drain plug (1).
- 5. Fill new oil up to upper line on the dipstick.

■ IMPORTANT

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification. (See page G-6.)**
- **Use the proper SAE Engine Oil according to ambient temperature.**
- **Upon an oil change, be sure to replace the gasket with new one.**

Above 25 °C (77 °F)	SAE 30 or SAE 10W-30, SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30, SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30, SAE 10W-40

Models	Oil Pan Depth		
	110 mm (4.33 in.)	125 mm (4.92 in.)	130 mm (5.12 in.)
D1005-E4B/E4BG, D1105-E4B/E4BG	-	5.1 L 1.3 U.S.gals	-
D1305-E4B/E4BG	5.7 L 1.5 U.S.gals	-	-
V1505-E4B/E4BG	-	-	6.7 L 1.8 U.S.gals

Tightening torque	Drain plug with copper gasket	M12 × 1.25	33 to 37 N·m 3.3 to 3.8 kgf·m 24 to 27 lbf·ft
	Drain plug with rubber coated gasket	M22 × 1.5	45 to 53 N·m 4.5 to 5.5 kgf·m 33 to 39 lbf·ft

(1) Drain Plug

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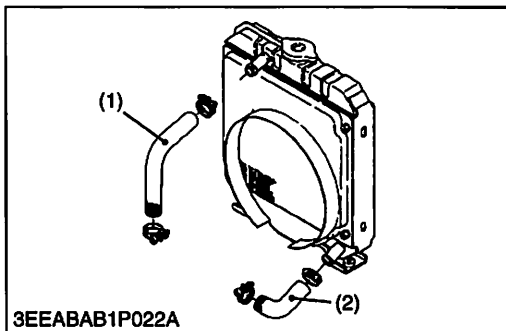
Replacing Oil Filter Cartridge**⚠ CAUTION**

- **Be sure to stop the engine before changing filter cartridge.**
1. Remove the oil filter cartridge with the filter wrench.
 2. Apply a slight coat of oil onto the new cartridge gasket.
 3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
 4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

■ IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

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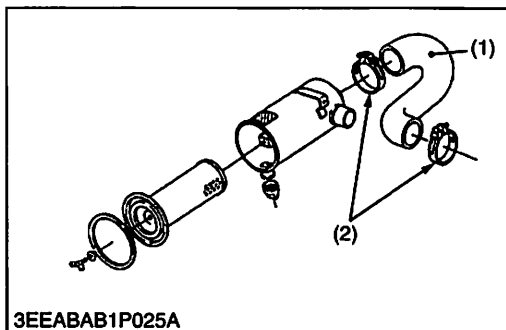
**Checking Radiator Hoses and Clamp Bands**

1. Check to see if the radiator hoses are properly fixed every 200 hours of operation or every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water hose is made of rubber and tens to age. It must be replaced every two years. Also replace the clamp and tighten it securely.

(1) Upper Hose

(2) Lower Hose

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**Checking Intake Air Line**

1. Check to see if the intake air hose(s) are properly fixed every 200 hours of operation.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) is made of rubber and tends to age. It must be changed every two years. Also change the clamp and tighten it securely.

■ IMPORTANT

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose

(2) Clamp

9Y1210784GEG0018US0

[6] CHECK POINTS OF EVERY 400 HOURS

Replacing Oil Filter Cartridge (for BG Type)

⚠ CAUTION

- Be sure to stop the engine before changing filter cartridge.
1. Remove the oil filter cartridge with the filter wrench.
 2. Apply a slight coat of oil onto the new cartridge gasket.
 3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
 4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

■ IMPORTANT

- To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.

9Y1210784GEG0050US0

Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 400 hours service.

1. Remove the used filter cartridge with filter wrench.
2. Apply a thin film of fuel to the surface of new filter cartridge gasket before screwing on.
3. Then tighten enough by hand.
4. Loosen the air vent plug to let the air out.
5. Start engine and check for fuel leakage.

(1) Fuel Filter Cartridge

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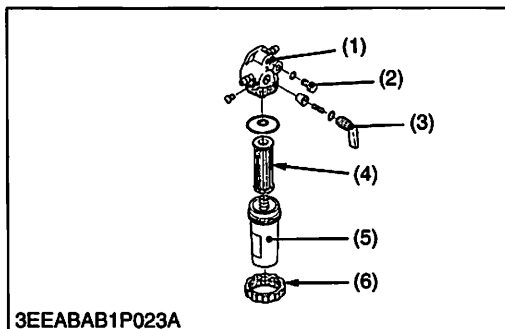
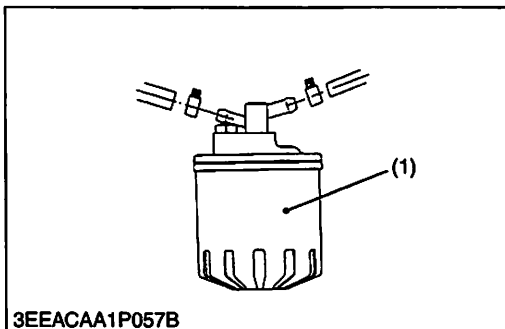
Replacing Fuel Filter Element (Element Type)

1. Close the fuel valve (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Replace the filter element (4).
4. Reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

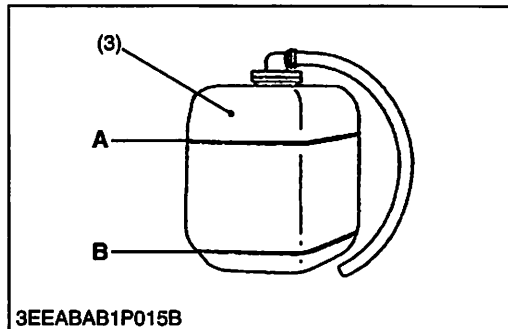
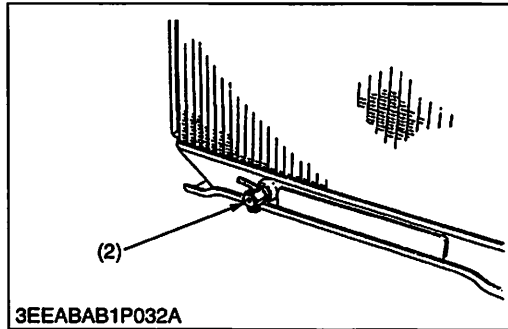
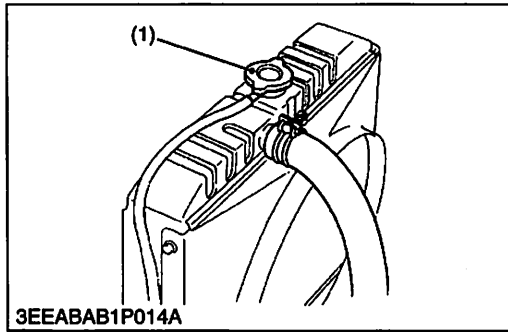
(1) Fuel Valve Body
 (2) Air Vent Plug
 (3) Fuel Valve

(4) Filter Element
 (5) Filter Cup
 (6) Retaining Ring

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[7] CHECK POINTS OF EVERY 500 HOURS



Cleaning Water Jacket and Radiator Interior

CAUTION

- Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.
1. Stop the engine and let cool down.
 2. To drain the coolant, open the radiator drain valve (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain valve of engine body.
 3. After all coolant is drained, close the drain valve (2).
 4. Fill with clean water and cooling system cleaner.
 5. Follow directions of the cleaner instruction.
 6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
 7. Fill with coolant up to FULL "A" mark on the recovery tank (3).
 8. Start and operate the engine for few minutes.
 9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (3) and add coolant if necessary.

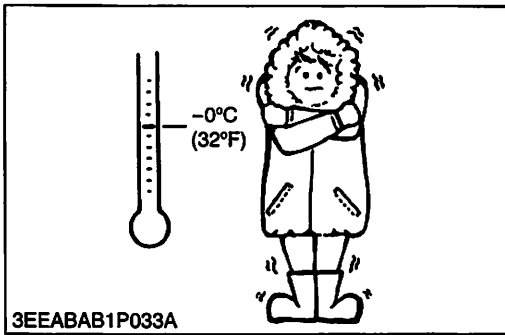
IMPORTANT

- Do not start engine without coolant.
- Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.
- When the anti-freeze is mixed with fresh, soft water, the antifreeze mixing ratio must be less than 50 %.
- Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.

- (1) Radiator Cap
 (2) Drain Valve
 (3) Recovery Tank

- A: Full
 B: Low

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Anti-freeze

- There are 2 types of anti-freeze available: use the permanent type (PT) for this engine.
- When you add anti-freeze for the first time, flush the water jacket and radiator interior with clean, soft water several times.
- The brand of the anti-freeze and the ambient temperature have an effect on the procedure to mix water and anti-freeze. Refer to the SAE J1034 standard, especially to the SAE J814c.
- Mix the anti-freeze with clean, soft water, and then fill into the radiator.

IMPORTANT

- Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.

Vol % Anti-freeze	Freezing Point		Boiling Point*	
	°C	°F	°C	°F
40	-24	-11	106	223
50	-37	-35	108	226

* At 1.01 × 100000 Pa (760 mmHg) pressure (atmospheric). Use a radiator pressure cap that lets the pressure collect in the cooling system to get a higher boiling point.

NOTE

- The above data is the industrial standards that shows the minimum glycol content necessary in the concentrated anti-freeze.
- When the coolant level decreases because of evaporation, add clean, soft water only to keep the anti-freeze mixing ratio less than 50 %. If there is a leakage, add anti-freeze and clean, soft water in the specified mixing ratio.
- The anti-freeze absorbs moisture. Keep new anti-freeze in a tightly sealed container.
- Do not use the radiator cleaning agents after you add anti-freeze to the coolant. Anti-freeze contains an anti-corrosive agent, which reacts with the radiator cleaning agent to make sludge and cause damages to the engine parts.

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Replacing Fan Belt

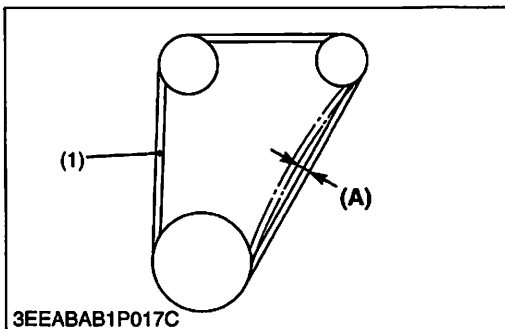
1. Remove the alternator.
2. Remove the fan belt (1).
3. Replace new fan belt.
4. Install the alternator.
5. Check the fan belt tension.

Deflection (A)	Factory specification	7.0 to 9.0 mm / 98 N 0.28 to 0.35 in. / 98 N (10 kgf, 22 lbf)
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(1) Fan Belt

(A) Deflection

9Y1210784GEG0023US0



[8] CHECK POINTS OF EVERY 1 OR 2 MONTHS

Recharging

CAUTION

- When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.
- When charging battery, remove battery vent plugs.
- When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.
- Never check battery charge by placing a metal object across the posts.
Use a voltmeter or hydrometer.

(1) Slow Charging

1. Add distilled water if the electrolyte level is low. When charging, the amount of electrolyte should be slightly lower than the specified level to prevent overflow.
2. Connect the battery to the charging unit, following the manufacture's instructions.
3. As the electrolyte generates gas while charging, remove all port caps.
4. The electrolyte temperature must not exceed 40 °C (104 °F) during charging.
If it exceed 40 °C (104 °F), decrease the charging amperage or stop charging for a while.
5. When charging several batteries in series, charge at the rate of the smallest battery in the line.

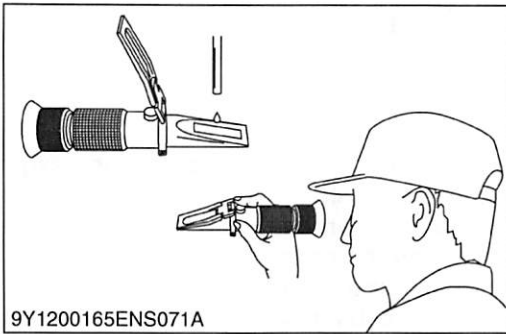
(2) Quick Charging

1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

■ Precaution for Operating a Quick Charger

- Operate with a quick charger differs according to the type.
Consult the instruction manual and use accordingly.

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Battery Specific Gravity

1. Measure the specific gravity of the electrolyte in each cell with a battery and coolant tester.
2. If the electrolyte temperature is different from the one that the battery and coolant tester calibrated, correct the specific gravity measurement. Use the formula below in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity is different between 2 cells by more than 0.05, replace the battery.

(Reference)

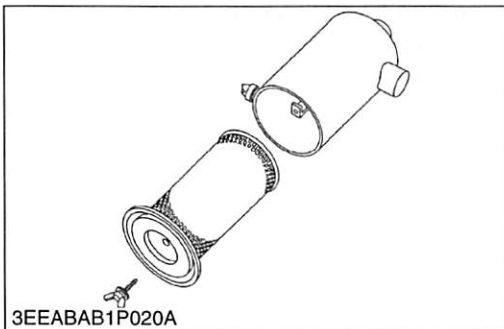
- The specific gravity changes with temperature. To be accurate, the specific gravity decreases by 0.0007 when temperature increases by 1 °C (decreases by 0.0004 when temperature increases by 1 °F), increases by 0.0007 when temperature decreases by 1 °C (increases by 0.0004 when temperature decreases by 1 °F). Thus, if you refer to 20 °C (68 °F), correct the specific gravity reading by the formula below:
 - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature –20 °C)
 - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature –68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

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[9] CHECK POINT OF EVERY YEAR



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Replacing Air Cleaner Element

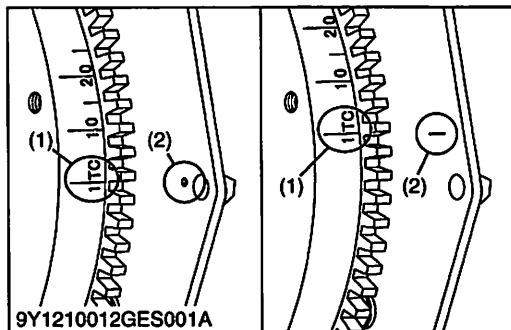
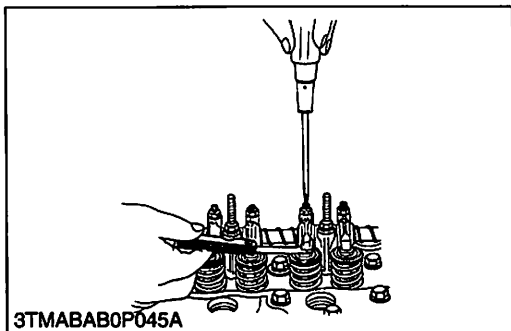
1. Remove used air cleaner element.
2. Replace new air cleaner element.

■ **NOTE**

- The air cleaner uses a dry element. Never apply oil to it.
- Do not run the engine with filter element removed.

9Y1210784GEG0026US0

[10] CHECK POINT OF EVERY 800 HOURS



Checking Valve Clearance

■ IMPORTANT

- Valve clearance must be checked and adjusted when engine is cold.
1. Remove the cylinder head cover and the glow plugs.
 2. Align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the compression top dead center.
 3. Check the following valve clearance marked with "☆" using a feeler gauge.
 4. If the clearance is not within the factory specifications, adjust with the adjusting screw.
 5. Then turn the flywheel 6.28 rad (360 °), and align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the overlap position.
 6. Check the following valve clearance marked with "☆" using a feeler gauge.
 7. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Adjustable Cylinder Location of Piston		3 cylinder		4 cylinder	
		IN.	EX.	IN.	EX.
When No. 1 piston is at compression top dead center	1	☆	☆	☆	☆
	2		☆	☆	
	3	☆			☆
	4				
When No. 1 piston is at overlap position	1				
	2	☆			☆
	3		☆	☆	
	4			☆	☆

Valve clearance	Factory specification	0.145 to 0.185 mm 0.00571 to 0.00728 in.
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■ NOTE

- The sequence of cylinder numbers is given as No. 1, No. 2, No. 3 and No. 4 starting from the gear case side.
- After adjusting the valve clearance, secure the adjusting screw with the lock nut.

(1) "1TC" Mark

(2) Alignment Mark

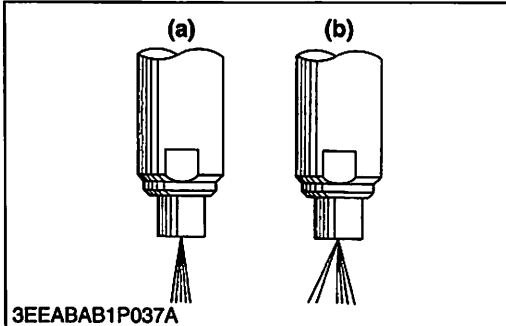
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[11] CHECK POINTS OF EVERY 1500 HOURS

CAUTION

- Check the injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.
If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.

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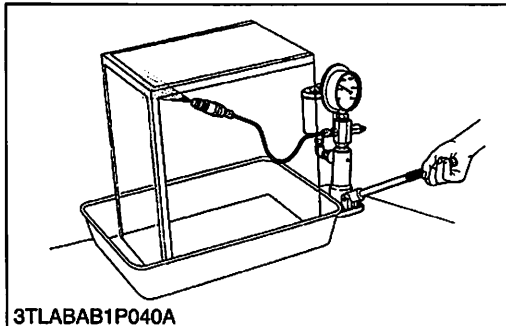
Nozzle Spraying Condition

- Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
- If the spraying condition is damaged, replace the nozzle piece.

(a) Good

(b) Bad

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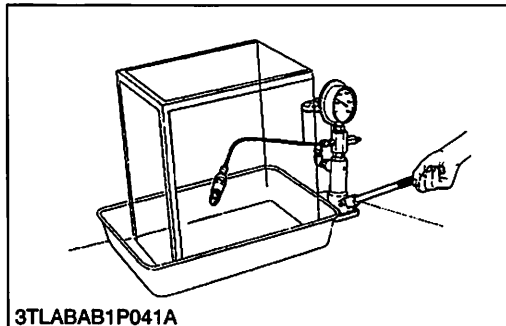


Fuel Injection Pressure

- Set the injection nozzle to a nozzle tester.
- Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
- If the measurement is not within the factory specifications, replace the adjusting washer in the nozzle holder to adjust it.

Fuel injection pressure	Factory specification	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm ² 1992 to 2133 psi
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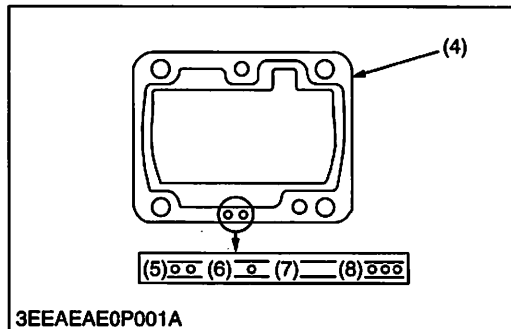
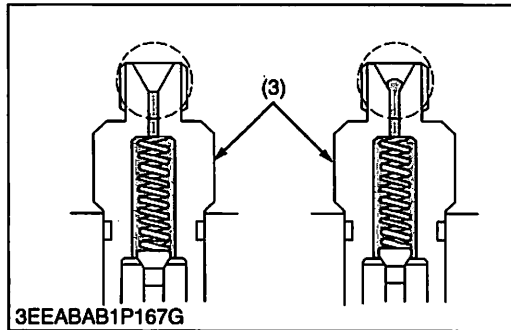
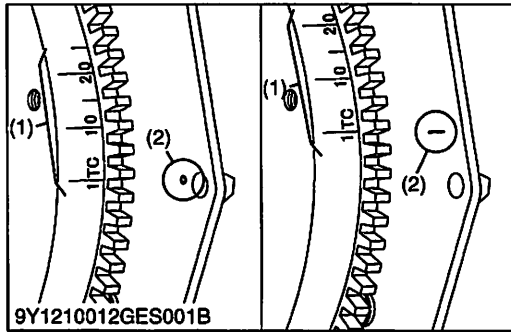
Valve Seat Tightness

- Set the injection nozzle to a nozzle tester.
- Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm², 1849 psi) for 10 seconds.
- If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory specification	No fuel leak at 12.75 MPa 130.0 kgf/cm ² 1849 psi
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[12] CHECK POINTS OF EVERY 3000 HOURS



Injection Timing

1. Remove the injection pipes.
2. Remove the engine stop solenoid.
3. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (3) for No. 1 cylinder.
4. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.6 rad (90°).
5. Turn the flywheel counterclockwise to set at around 0.44 rad (25°) before T.D.C..
6. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
7. Check to see the degree on flywheel.
The flywheel gas mark "1TC", "10" and "20" for the crank angle before the top dead center of No. 1 cylinder.
8. If injection timing is out of adjustment, readjust the timing with shims.

Injection timing (3000 min ⁻¹ (rpm))	Factory specifica- tion	D1005-E4B	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.
Injection timing (3200 min ⁻¹ (rpm))		D1005-E4B	0.3360 to 0.3621 rad (19.25 to 20.75 °) before T.D.C.
Injection timing (3000 min ⁻¹ (rpm))		D1105-E4B	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.
Injection timing (2600 min ⁻¹ (rpm))		D1305-E4B	0.2662 to 0.2923 rad (15.25 to 16.75 °) before T.D.C.
Injection timing (2300 min ⁻¹ (rpm))		V1505-E4B	0.2313 to 0.2574 rad (13.25 to 14.75 °) before T.D.C.
Injection timing (1800 min ⁻¹ (rpm))		D1505-E4BG, D1105-E4BG	0.2575 to 0.2836 rad (14.75 to 16.25 °) before T.D.C.
Injection timing (1800 min ⁻¹ (rpm))		D1305-E4BG, V1505-E4BG	0.2487 to 0.2748 rad (14.25 to 15.75 °) before T.D.C.

- | | |
|-----------------------------------|---------------------------------------|
| (1) Timing Line | (5) Two-holes: 0.20 mm (0.0079 in.) |
| (2) Alignment Mark | Two-holes: 0.175 mm (0.00689 in.) |
| (3) Delivery Valve Holder | (6) One-hole: 0.25 mm (0.0098 in.) |
| (4) Shim (Soft Metal Gasket Shim) | (7) Without hole: 0.30 mm (0.012 in.) |
| | (8) Three-holes: 0.35 mm (0.014 in.) |

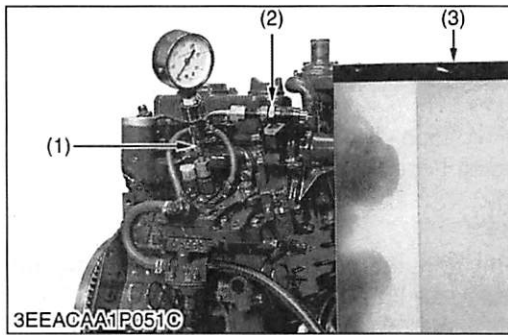
(To be continued)

(Continued)

■ **NOTE**

- The liquid gasket is not required for assembling.
- Shims are available in thickness of 0.20 mm (0.0079 in.), 0.25 mm (0.0098 in.), 0.30 mm (0.012 in.), 0.35 mm (0.014 in.) and 0.175 mm (0.00689 in.). Combine these shims for adjustments.
- Addition or reduction of shim (0.025 mm, 0.00098 in.) delays or advances the injection timing by approx. 0.0044 rad (0.25 °).
- In disassembling and replacing the injection pump, be sure to use the same number of new shims with the same thickness.
- The 0.175 mm thick shim is coated only on the lower face. Therefore, do not use the 0.175 mm thick shim as the top shim of the combination (injection pump side), because this can cause oil leakage.

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Checking Injection Pump

(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the photo.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 13.73 MPa (140.0 kgf/cm², 1991 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 13.73 to 12.75 MPa (from 140.0 to 130.0 kgf/cm², from 1991 to 1849 psi).
8. Measure the time needed to decrease the pressure from 13.73 to 12.75 MPa (140.0 to 130.0 kgf/cm², 1991 to 1849 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	13.73 MPa 140.0 kgf/cm ² 1991 psi
Fuel tightness of delivery valve	Factory specification	10 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm ² 1991 → 1849 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm ² 1991 → 1849 psi

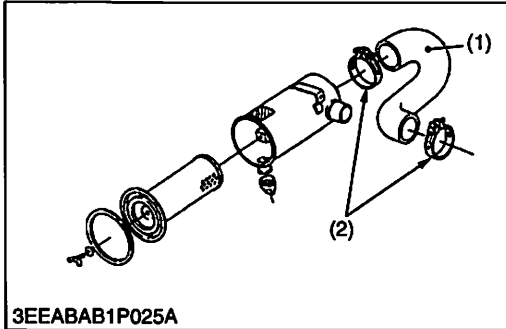
■ NOTE

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubotaauthorized pump service shop.**

- (1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

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[13] CHECK POINTS OF EVERY 2 YEARS



Replacing Intake Air Line

1. Loosen the clamp (2).
2. Remove the intake air hose (1) and clamp (2).
3. Replace new intake air hose (1) and new clamp (2).
4. Tighten the clamp (2).

NOTE

- To prevent serious damage to the engine, keep out any dust inside the intake air line.

(1) Intake Air Hose

(2) Clamp

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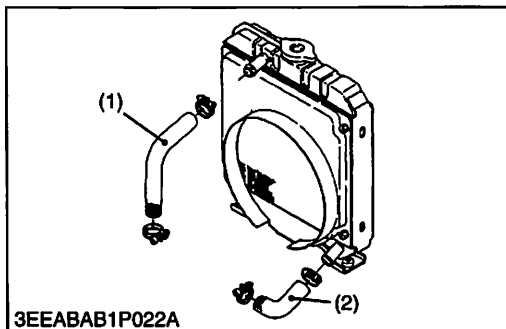
Replacing Battery

CAUTION

- When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.
- When charging battery, remove battery vent plugs.
- When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.
- Never check battery charge by placing a metal object across the posts.

1. Disconnect the negative terminal and positive terminal.
2. Remove the battery holder.
3. Remove the used battery.
4. Replace the new battery.
5. Tighten the battery holder.
6. Connect the positive terminal.
7. Connect the negative terminal.

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Replacing Radiator Hoses and Clamp Bands

CAUTION

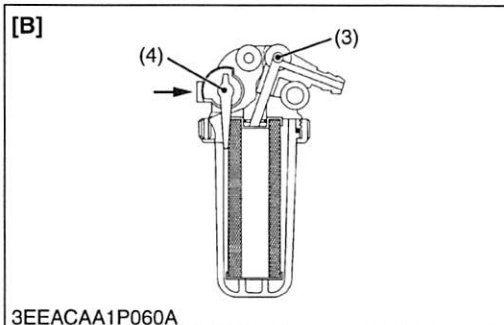
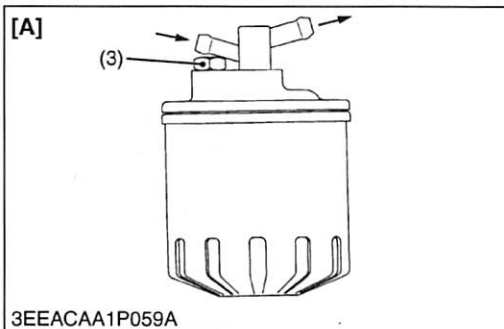
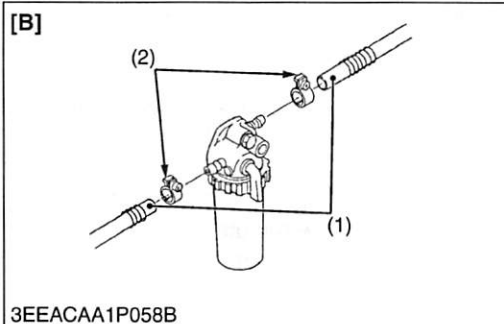
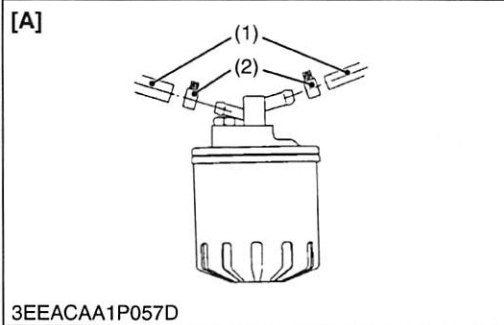
- Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

1. Drain the coolant.
2. Loosen the clamp bands.
3. Remove the upper hose (1) and lower hose (2).
4. Replace new upper / lower hose (1), (2) and clamp bands.
5. Tighten the clamp bands.
6. Fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap securely.

(1) Upper Hose

(2) Lower Hose

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Replacing Fuel Hoses and Clamp Bands

1. Loosen the clamp (2) and remove the fuel hose (1).
2. Replace new fuel hose (1) and new clamp (2).
3. Tighten the clamp (2).

⚠ CAUTION

- Stop the engine when attempting the check and change prescribed above.

(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel valve (4).
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent valve on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to AC position and pump the fuel up for 10 to 15 seconds.
If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent valve after air bleeding.

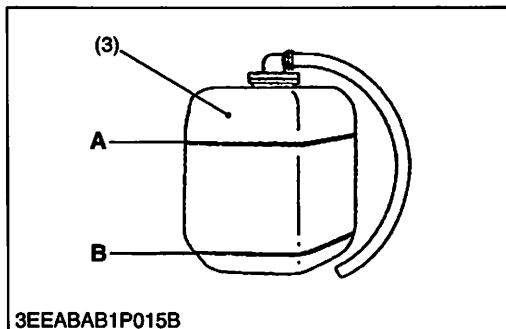
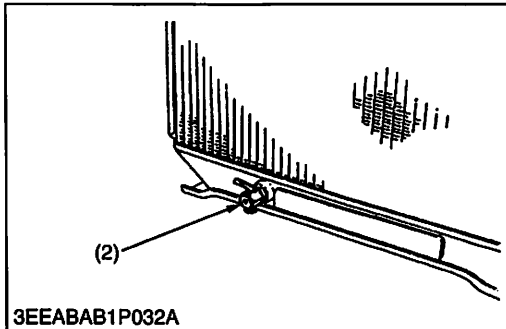
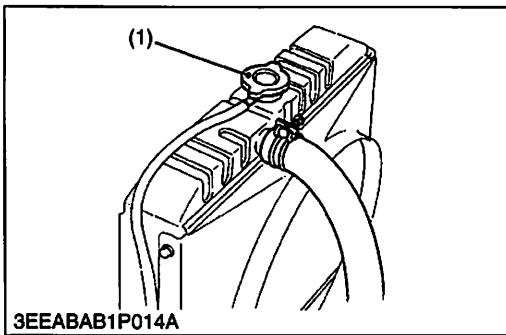
■ NOTE

- Always keep the air vent valve on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

- (1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Valve

- [A] Cartridge Type
[B] Element Type

9Y1210784GEG0037US0



Changing Radiator Coolant (L.L.C.)

⚠ CAUTION

- Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.
1. Stop the engine and let cool down.
 2. To drain the coolant, open the radiator drain valve (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain valve of engine body.
 3. After all coolant is drained, close the drain valve (2).
 4. Fill with clean water and cooling system cleaner.
 5. Follow directions of the cleaner instruction.
 6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
 7. Fill with coolant up to FULL "A" mark on the recovery tank (3).
 8. Start and operate the engine for few minutes.
 9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (3) and add coolant if necessary.

■ IMPORTANT

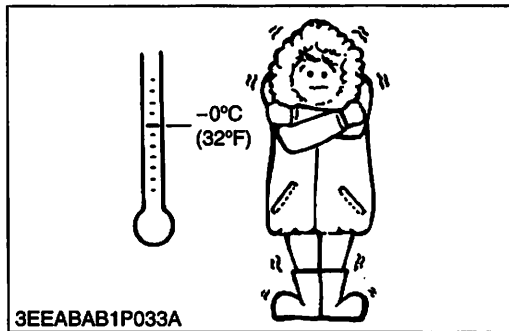
- Do not start engine without coolant.
- Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.
- When the anti-freeze is mixed with fresh, soft water, the antifreeze mixing ratio must be less than 50 %.
- Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.

- (1) Radiator Cap
 (2) Drain Valve
 (3) Recovery Tank

- A: Full
 B: Low

(To be continued)

(Continued)



■ Anti-freeze

- There are 2 types of anti-freeze available: use the permanent type (PT) for this engine.
- When you add anti-freeze for the first time, flush the water jacket and radiator interior with clean, soft water several times.
- The brand of the anti-freeze and the ambient temperature have an effect on the procedure to mix water and anti-freeze. Refer to the SAE J1034 standard, especially to the SAE J814c.
- Mix the anti-freeze with clean, soft water, and then fill into the radiator.

■ IMPORTANT

- **Make sure that when you mix the anti-freeze and water, the ratio of anti-freeze is less than 50 %.**

Vol % Anti-freeze	Freezing Point		Boiling Point*	
	°C	°F	°C	°F
40	-24	-11	106	223
50	-37	-35	108	226

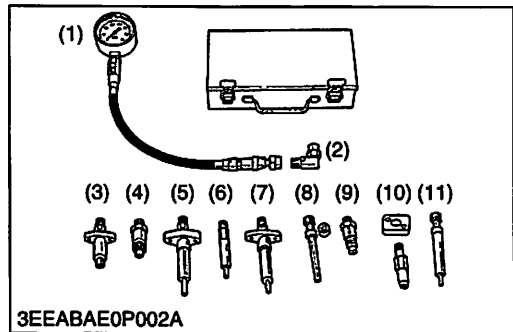
* At 1.01×100000 Pa (760 mmHg) pressure (atmospheric). Use a radiator pressure cap that lets the pressure collect in the cooling system to get a higher boiling point.

■ NOTE

- **The above data is the industrial standards that shows the minimum glycol content necessary in the concentrated anti-freeze.**
- **When the coolant level decreases because of evaporation, add clean, soft water only to keep the anti-freeze mixing ratio less than 50 %. If there is a leakage, add anti-freeze and clean, soft water in the specified mixing ratio.**
- **The anti-freeze absorbs moisture. Keep new anti-freeze in a tightly sealed container.**
- **Do not use the radiator cleaning agents after you add anti-freeze to the coolant. Anti-freeze contains an anti-corrosive agent, which reacts with the radiator cleaning agent to make sludge and cause damages to the engine parts.**

9Y1210784GEG0038US0

5. SPECIAL TOOLS



Diesel Engine Compression Tester (for Nozzle Hole)

Code No.

- 07909-30208 (Assembly)
- 07909-30934 (A to F)
- 07909-31211 (E and F)
- 07909-31231 (H)
- 07909-31251 (G)
- 07909-31271 (I)
- 07909-31281 (J)

Application

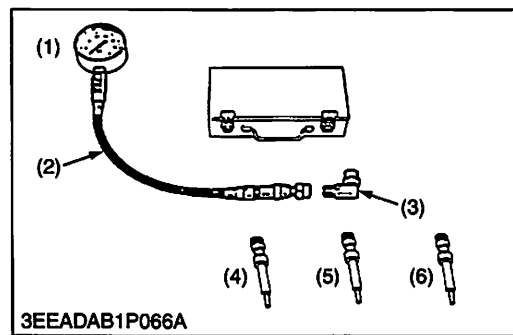
- Use to measure diesel engine compression and diagnosis of need for major overhaul.

Adaptor

- H for 05 series.

- | | |
|---------------|----------------|
| (1) Gauge | (7) Adaptor F |
| (2) L Joint | (8) Adaptor G |
| (3) Adaptor A | (9) Adaptor H |
| (4) Adaptor B | (10) Adaptor I |
| (5) Adaptor C | (11) Adaptor J |
| (6) Adaptor E | |

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Diesel Engine Compression Tester (for Glow Plug Hole)

Code No.

- 07909-39081 (Assembly)
- 07909-31291 (K)
- 07909-31301 (L)
- 07909-31311 (M)

Application

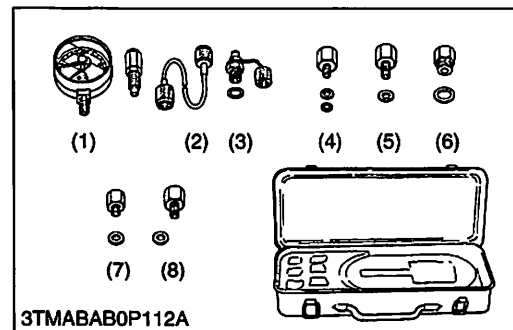
- Use to measure diesel engine compression and diagnosis of need for major overhaul.

Adaptor

- L for 05 series.

- | | |
|-------------------|---------------|
| (1) Gauge | (4) Adaptor K |
| (2) Hose Assembly | (5) Adaptor L |
| (3) L Joint | (6) Adaptor M |

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Oil Pressure Tester

Code No.

- 07916-32032

Application

- Use to measure lubricating oil pressure.

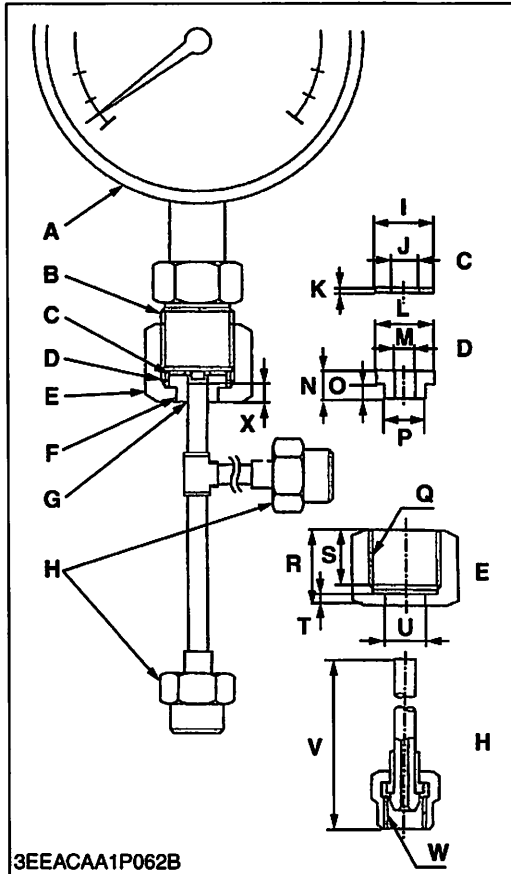
- | | |
|--------------------|---------------|
| (1) Gauge | (5) Adaptor 2 |
| (2) Cable | (6) Adaptor 3 |
| (3) Threaded Joint | (7) Adaptor 4 |
| (4) Adaptor 1 | (8) Adaptor 5 |

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■ **NOTE**

- The following special tools are not provided, so make them referring to the figure.

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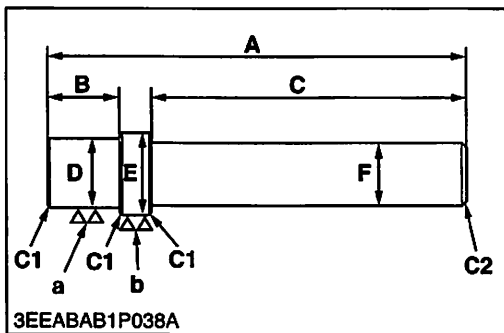
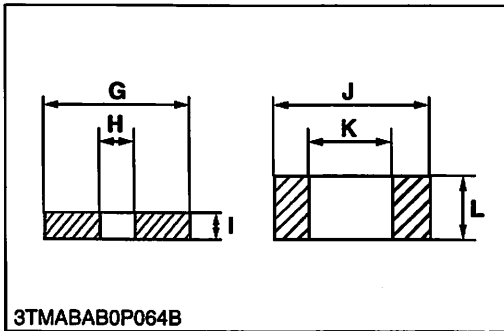
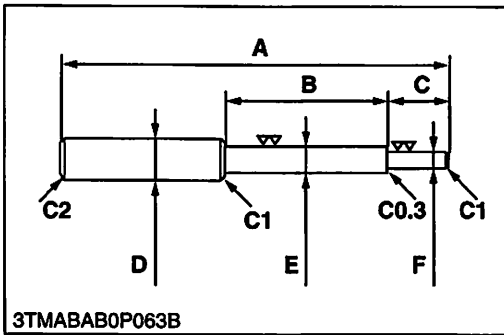
Injection Pump Pressure Tester

Application

- Use to check fuel tightness of injection pumps.

A	Pressure gauge full scale: More than 29.4 MPa (300 kgf/cm ² , 4267 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material: Steel)
E	Hex. nut 27 mm (1.1 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8.0 mm dia. (0.31 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.241 to 0.244 in. dia.)
N	8.0 mm (0.31 in.)
O	4.0 mm (0.16 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4.0 mm (0.16 in.)
U	12.00 to 12.02 mm dia. (0.472 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5.0 mm (0.20 in.)

9Y1210784GEG0042US0



Valve Guide Replacing Tool

Application

- Use to press out and press fit the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.8 in.)
C	45 mm (1.8 in.)
D	20 mm dia. (0.79 in. dia.)
E	11.7 to 11.9 mm dia. (0.461 to 0.468 in. dia.)
F	6.50 to 6.60 mm dia. (0.256 to 0.259 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	6.70 to 7.00 mm dia. (0.264 to 0.275 in. dia.)
I	5.0 mm (0.20 in.)
J	20 mm dia. (0.79 in. dia.)
K	12.5 to 12.8 mm dia. (0.493 to 0.503 in. dia.)
L	8.90 to 9.10 mm (0.351 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

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Bushing Replacing Tool

Application

- Use to press out and press fit the bushing.

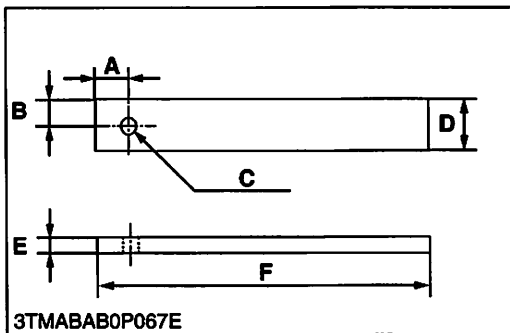
1. For small end bushing

A	157 mm (6.18 in.)
B	24 mm (0.94 in.)
C	120 mm (4.72 in.)
D	21.8 to 21.9 mm dia. (0.859 to 0.862 in. dia.)
E	24.8 to 24.9 mm dia. (0.977 to 0.980 in. dia.)
F	20 mm dia. (0.79 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

2. For idle gear bushing

A	196 mm (7.72 in.)
B	26 mm (1.0 in.)
C	150 mm (5.91 in.)
D	25.80 to 25.90 mm dia. (1.016 to 1.019 in. dia.)
E	28.80 to 28.90 mm dia. (1.134 to 1.137 in. dia.)
F	20 mm dia. (0.79 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

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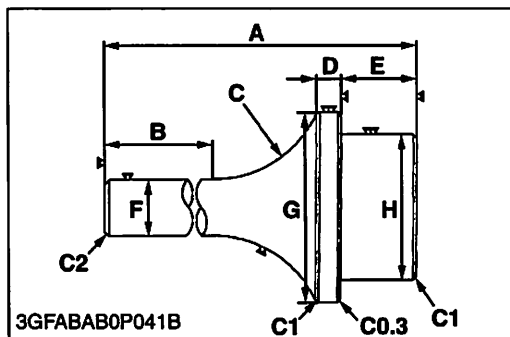
Flywheel Stopper

Application

- Use to loosen and tighten the flywheel screw.

A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.2 in.)
E	8.0 mm (0.31 in.)
F	200 mm (7.87 in.)

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Crankshaft Bearing 1 Replacing Tool

Application

- Use to press out and press fit the crankshaft bearing 1.

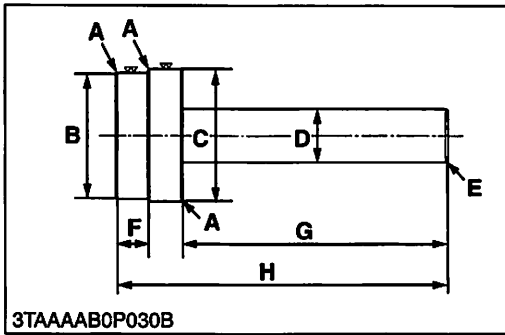
[Press Out]

A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	24 mm (0.94 in.)
F	20 mm dia. (0.79 in. dia.)
G	51.20 to 51.40 mm dia. (2.016 to 2.023 in. dia.)
H	47.30 to 47.50 mm dia. (1.863 to 1.870 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

[Press Fit]

A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	24 mm (0.94 in.)
F	20 mm dia. (0.79 in. dia.)
G	68 mm dia. (2.7 in. dia.)
H	47.30 to 47.50 mm dia. (1.863 to 1.870 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

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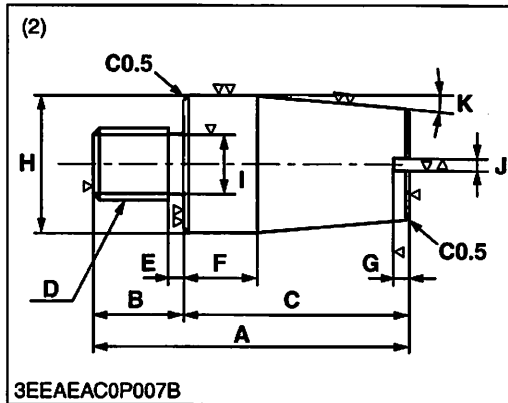
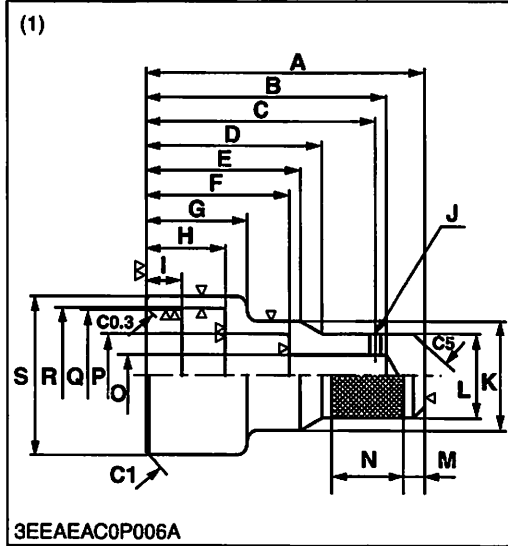
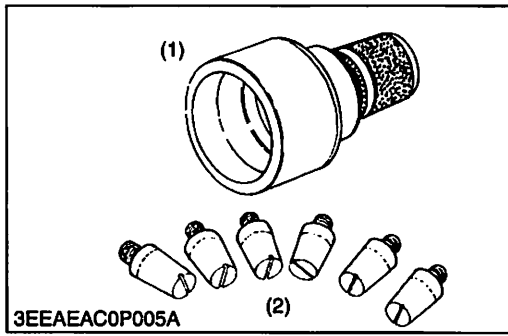
Governor Gear Holder Bushing Replacing Tool

Application

- Use to press out and to press fit the governor gear holder bushing.

A	C1: Chamfer 1.0 mm (0.039 in.)
B	73.90 to 74.00 mm dia. (2.910 to 2.913 in. dia.)
C	69.80 to 69.90 mm dia. (2.748 to 2.751 in. dia.)
D	30 mm dia. (1.2 in. dia.)
E	C2: Chamfer 2.0 mm (0.079 in.)
F	18 mm (0.71 in.)
G	150 mm (5.91 in.)
H	188 mm (7.40 in.)

9Y1210784GEG0047US0



Crank Sleeve Setter

Application

- Use to fix the crankshaft sleeve.

(1) Auxiliary Socket for Pushing

A	130 mm (5.12 in.)
B	112 mm (4.41 in.)
C	107 mm (4.21 in.)
D	82 mm (3.2 in.)
E	72 mm (2.8 in.)
F	67 mm (2.6 in.)
G	47 mm (1.8 in.)
H	36.00 to 36.20 mm (1.418 to 1.425 in.)
I	17 mm (0.67 in.)
J	5.0 mm dia. (0.20 in. dia.)
K	52 mm dia. (2.0 in. dia.)
L	40 mm dia. (1.6 in. dia.)
M	10 mm (0.39 in.)
N	33 mm (1.3 in.)
O	20 mm dia. (0.79 in. dia.)
P	40 mm dia. (1.6 in. dia.)
Q	72.10 to 72.15 mm dia. (2.839 to 2.840 in. dia.)
R	73 mm dia. (2.9 in. dia.)
S	83 mm dia. (3.3 in. dia.)
C0.3	Chamfer 0.30 mm (0.012 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C5	Chamfer 5.0 mm (0.20 in.)

(2) Sleeve Guide

A	42 mm (1.7 in.)
B	12 mm (0.47 in.)
C	30 mm (1.2 in.)
D	M10 × Pitch 1.25
E	2.0 mm (0.079 in.)
F	10 mm (0.39 in.)
G	2.0 mm (0.079 in.)
H	17.90 to 17.95 mm dia. (0.7048 to 0.7066 in. dia.)
I	8.0 mm dia. (0.31 in. dia.)
J	1.8 mm (0.071 in.)
K	0.09 rad (5 °)
C0.5	Chamfer 0.5 mm (0.02 in.)

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1 ENGINE

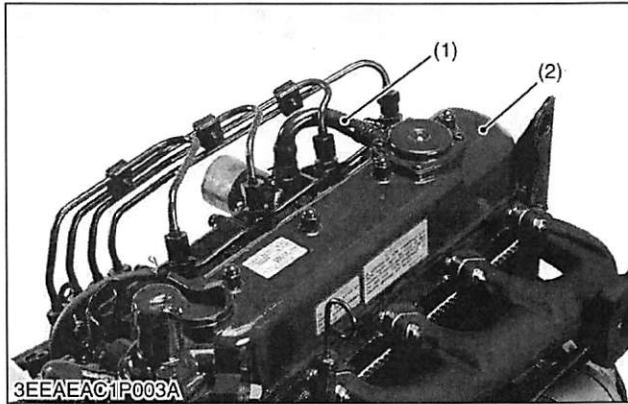
MECHANISM

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[1] CLOSED BREATHER.....	1-M1
[2] HALF-FLOATING HEAD COVER (D1305-E4B/E4BG).....	1-M1
[3] GOVERNOR.....	1-M2
[4] BOOST COMPENSATOR.....	1-M4

1. ENGINE BODY

[1] CLOSED BREATHER

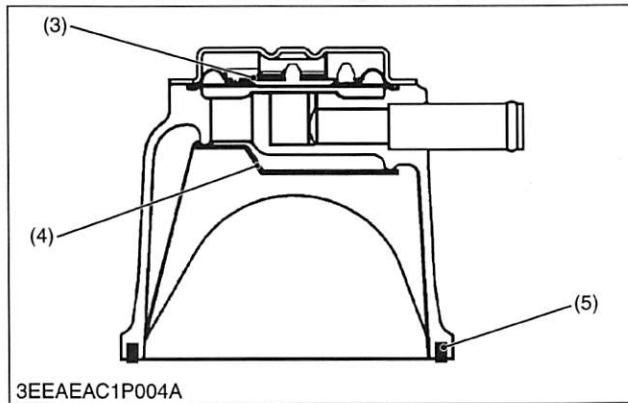


Closed breather system has been adopted to prevent the release of blow-by gas into the atmosphere.

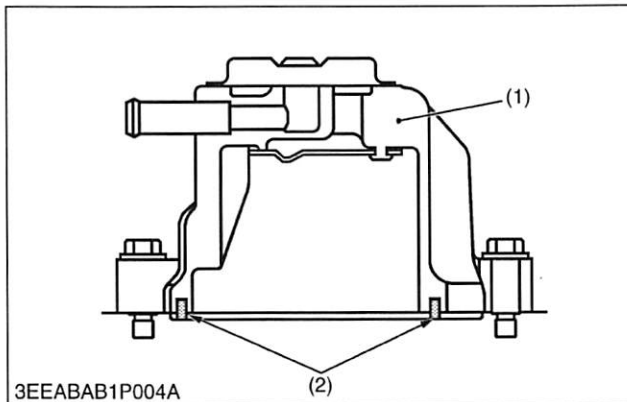
After its oil content is filtered by oil shield (4), the blow by gas in fed back to the intake manifold through breather valve (3) to be used for re-combustion.

- (1) Breather Tube
- (2) Cylinder Head Cover
- (3) Breather Valve
- (4) Oil Shield
- (5) Rubber Packing

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[2] HALF-FLOATING HEAD COVER (D1305-E4B/E4BG)

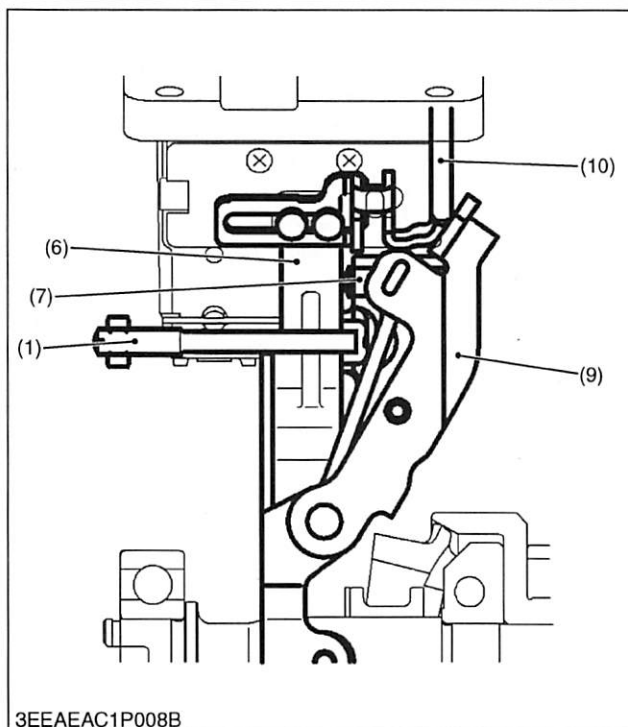
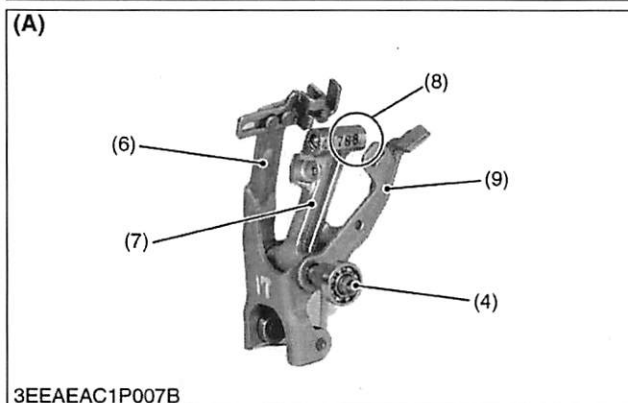
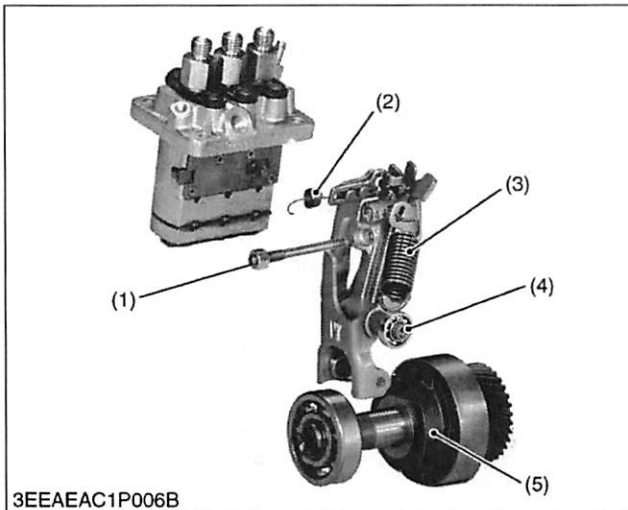


The rubber packing is fitted in to maintain the cylinder head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

- (1) Cylinder Head Cover
- (2) Rubber Packing

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[3] GOVERNOR



Three Lever Type Fork Lever (for standard type)

The governor system is a mechanical governor that used the flyweight (5).

The flyweight (5) is mounted on the governor shaft that rotates at the same speed as the crankshaft.

Because the feature of this mechanism takes out the engine speed directly as a centrifugal force of weight, the speed control that the change in the engine rotational speed is sensitively transmitted to fork lever assembly (A) and accuracy is high is enabled.

The fork lever assembly of this engine is composed of fork lever 1 (6), for lever 2 (9), and the floating lever (7). A slide plate is installed in fork lever 1. The governor spring (3) is hooked to fork lever 2 (9).

The floating lever (7) installs the torque pin (8) of the output drop prevention at the overload. The start spring (2) is hooked to a slide plate, and holds the control rack in the direction of the full fuel position.

Fork lever 2 (9) and the floating lever are installed in fork lever 1 (6) with the fork lever shaft (4). The max torque limitation (1) device limits the amount of the fuel injection at the overload with the torque pin.

- | | |
|------------------------|-------------------------|
| (1) Max Torque Limiter | (7) Floating Lever |
| (2) Start Spring | (8) Torque Pin |
| (3) Governor Spring | (9) Fork Lever 2 |
| (4) Fork Lever Shaft | |
| (5) Flyweight | |
| (6) Fork Lever 1 | (A) Fork Lever Assembly |

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(At Rated Operation)

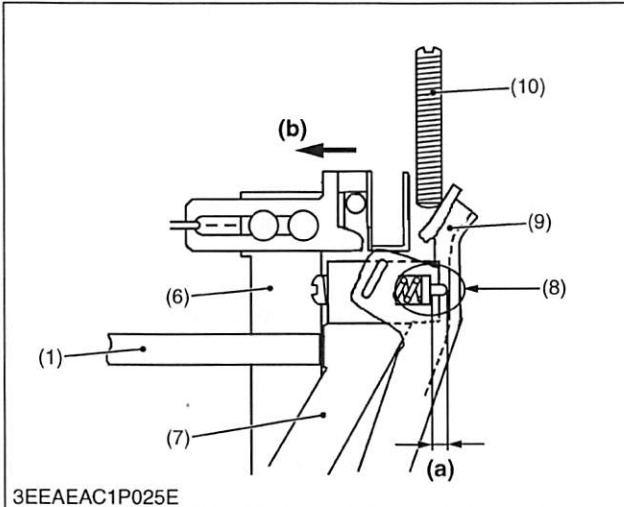
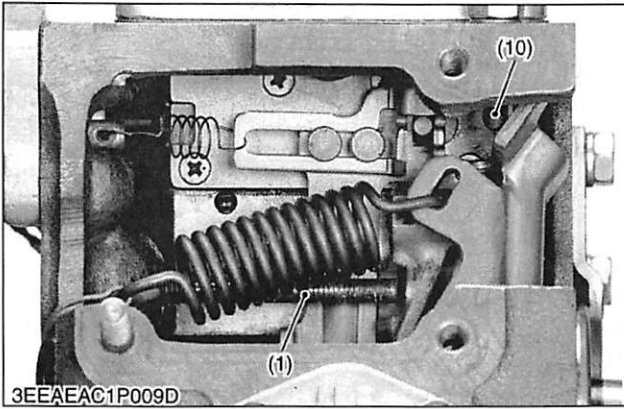
When the engine is running, the fork lever 2 (9) and the floating lever (7) are moving with the fork lever 1 (6) due to the tension of the governor spring (3).

During the time, the torque pin (8) is pressed into the floating lever by centrifugal force of the governor weight (5).

The fork lever 2 (9) comes in contact with the fuel limitation bolt (10), and the fuel injection pump supplies a fuel necessary for rated operation.

- | | |
|------------------------|---------------------------|
| (1) Max Torque Limiter | (9) Fork Lever 2 |
| (6) Fork Lever 1 | (10) Fuel Limitation Bolt |
| (7) Floating Lever | |

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(Overloaded Operation)

The amount of the movement of the fork lever assembly is limited with the fuel limitation bolt (10) and can not be moved in the direction of the fuel increase.

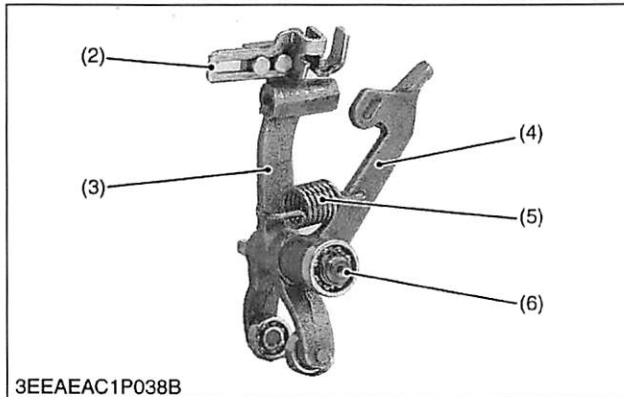
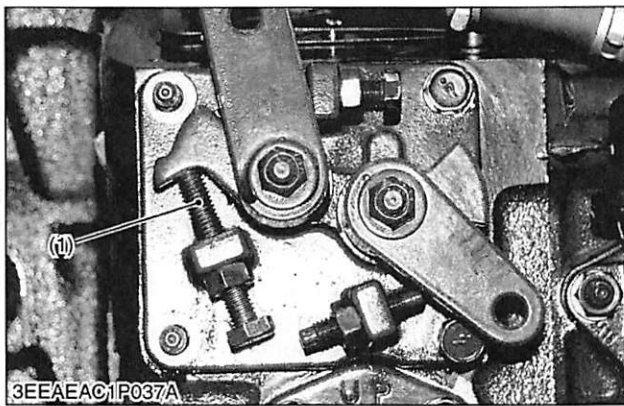
As overload reduces the centrifugal force of the governor weight, which is pressing the torque pin (8) into the floating lever (7), the floating lever pushes the fork lever 1 (6) in the way to increase the fuel supply with the help of the torque spring tension.

The fuel supply increases (b) in relation to the degree of the torque pin motion, thus preventing the engine speed from dropping.

At the time, the maximum torque limiter (1) prevents superfluous fuel supply and suppresses the generation of black smoke.

- | | |
|---------------------------|--|
| (1) Max Torque Limiter | (a) Distance to which torque pin (8) pushes fork lever 1 (6) out |
| (6) Fork Lever 1 | (b) Increase of fuel |
| (7) Floating Lever | |
| (8) Torque Pin | |
| (9) Fork Lever 2 | |
| (10) Fuel Limitation Bolt | |

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Two Lever Type Fork Lever (for BG type)

The engine speed of BG engine 1800 min⁻¹ (rpm) specification.

The fork lever assembly of BG series is composed of fork lever 1 (3), fork lever 2 (4).

A slide plate is installed in fork lever 1. The governor spring (5) is hooked to fork lever 2 (4).

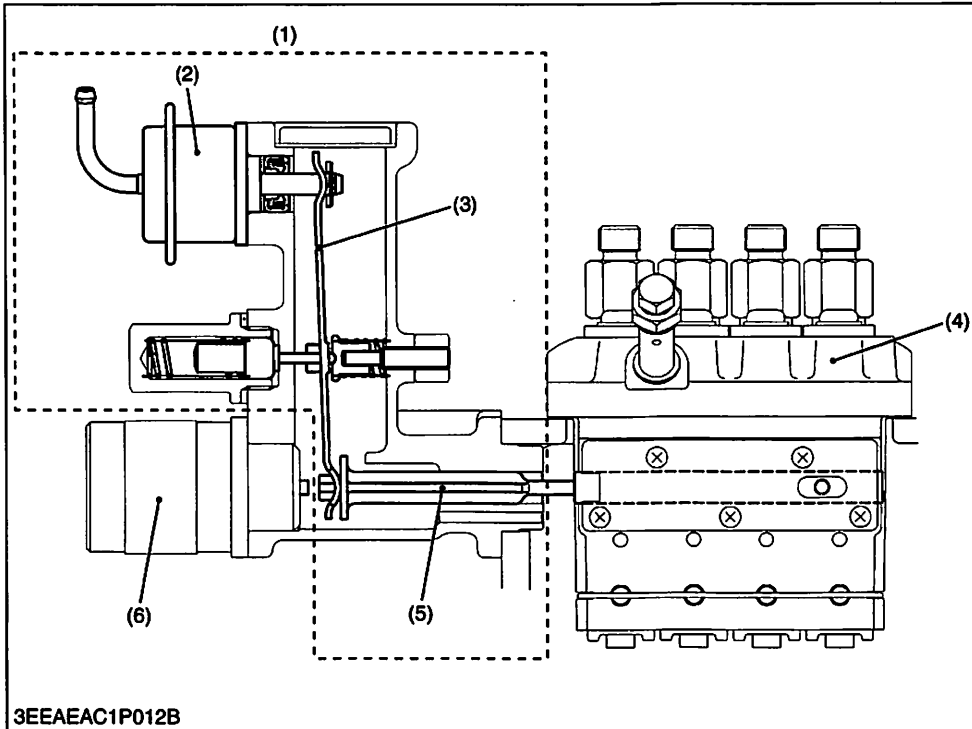
The start spring is hooked to a slide plate, and holds the control rack in the direction of full fuel position.

Fork lever 2 (4) and fork lever 1 (3) are installed with the fork lever shaft (4).

- | | |
|----------------------------|----------------------|
| (1) Idle Speed Adjust Bolt | (4) Fork Lever 2 |
| (2) Slide Plate | (5) Governor Spring |
| (3) Fork Lever 1 | (6) Fork Lever Shaft |

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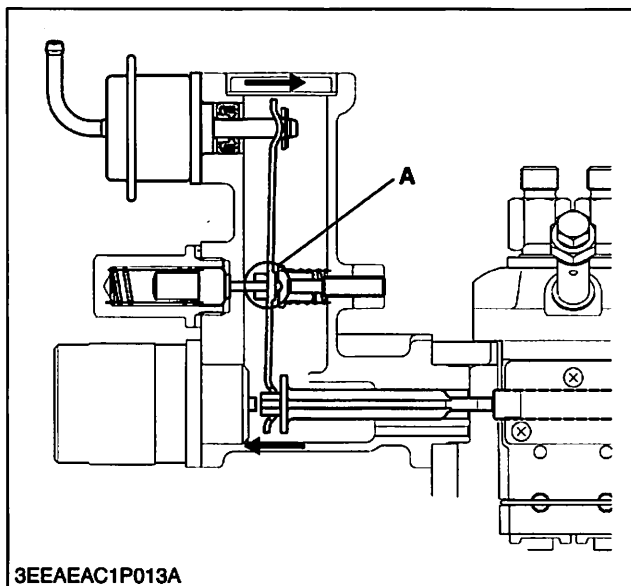
[4] BOOST COMPENSATOR



- (1) Boost Compensator Assembly
- (2) Actuator
- (3) Plate
- (4) Injection Pump Assembly
- (5) Guide
- (6) Stop Solenoid

A: Fulcrum

9Y1210784ENM0007US0



Boost compensator is the device that reduces black smoke during the engine startup and acceleration.

The rod of actuator (2) is pushed out by the rise of boost pressure, and the plate (3) moves in the direction of the fuel increase around the fulcrum "A".

9Y1210784ENM0008US0

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1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	G-11
	Air in the fuel system	Vent air	G-11
	Water in the fuel system	Change fuel and repair or replace fuel system	–
	Fuel pipe clogged	Clean or replace	G-11
	Fuel filter clogged	Replace	G-16
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	I-5, I-6, G-9
	Fuel with low cetane number	Use specified fuel	–
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	–
	Incorrect injection timing	Adjust	1-S19
	Fuel camshaft worn	Replace	1-S37
	Injection nozzle clogged	Clean or replace	1-S21, 1-S23
	Injection pump malfunctioning	Repair or replace	1-S20, 1-S36
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	1-S37, 1-S38, 1-S39, 1-S40, 1-S58, 1-S59, 1-S60, 1-S61, 1-S62, 1-S63, 1-S64
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	1-S29, 1-S30, 1-S31
	Improper valve timing	Correct or replace timing gear	1-S37
	Piston ring and cylinder worn	Replace	1-S38, 1-S39, 1-S40
Excessive valve clearance	Adjust	1-S15	
Stop solenoid malfunctioning	Replace	1-S35	
Starter Does Not Run	Battery discharged	Charge	–
	Starter malfunctioning	Repair or replace	1-S27, 1-S65, 1-S66, 1-S67
	Key switch malfunctioning	Replace	–
	Wiring disconnected	Connect	–

Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	G-16
	Air cleaner clogged	Clean or replace	G-12, G-15, G-20
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	–
	Injection pump malfunctioning	Repair or replace	1-S20, 1-S36
	Incorrect nozzle opening pressure	Adjust	1-S22
	Injection nozzle stuck or clogged	Repair or replace	1-S21, 1-S23
	Governor malfunctioning	Repair	1-S36, 1-S37
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	–
	Piston ring and cylinder worn or stuck	Repair or replace	1-S39, 1-S40, 1-S64
	Incorrect injection timing	Adjust	1-S19
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Lessen the load	–
	Low grade fuel used	Use specified fuel	I-5, I-6
	Fuel filter clogged	Replace	G-16
	Air cleaner clogged	Clean or replace	G-12, G-15, G-20
	Deficient nozzle injection	Repair or replace nozzle	1-S21, 1-S23
Deficient Output	Incorrect injection timing	Adjust	1-S19
	Engine's moving parts seem to be seizing	Repair or replace	–
	Injection pump malfunctioning	Repair or replace	1-S20, 1-S36
	Deficient nozzle injection	Repair or replace nozzle	1-S21, 1-S23
	Compression leak	Check the compression pressure and repair	1-S14
	Air cleaner dirty or clogged	Clean or replace	G-12, G-15, G-20

Symptom	Probable Cause	Solution	Reference Page
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	1-S39
	Oil ring worn or stuck	Replace	1-S39, 1-S40
	Piston ring groove worn	Replace piston	1-S38, 1-S39, 1-S40
	Valve stem and valve guide worn	Replace	1-S32, 1-S49
	Crankshaft bearing and crank pin bearing worn	Replace	1-S43
	Oil leaking due to damaged seals or packing	Replace	—
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace	1-S20, 1-S36
	Deficient nozzle injection	Repair or replace nozzle	1-S21, 1-S23
	Injection pump broken	Replace	1-S36
Water Mixed into Lubricant Oil	Head gasket damaged	Replace	1-S30, 1-S31
	Cylinder block or cylinder head flawed	Replace	1-S30, 1-S31
Low Oil Pressure	Engine oil insufficient	Replenish	G-9
	Oil strainer clogged	Clean	1-S38
	Relief valve stuck with dirt	Clean	—
	Relief valve spring weaken or broken	Replace	—
	Excessive oil clearance of crankshaft bearing	Replace	1-S41
	Excessive oil clearance of crankpin bearing	Replace	1-S41
	Excessive oil clearance of rocker arm	Replace	1-S30
	Oil passage clogged	Clean	—
	Different type of oil	Use specified type of oil	G-9
	Oil pump damaged	Replace	—
High Oil Pressure	Different type of oil	Use specified type of oil	G-9
	Relief valve damaged	Replace	—

Symptom	Probable Cause	Solution	Reference Page
Engine Overheated	Engine oil insufficient	Replenish	G-9
	Fan belt broken or elongated	Replace or adjust	G-12, G-13
	Coolant insufficient	Replenish	G-17
	Radiator net and radiator fin clogged with dust	Clean	–
	Inside of radiator corroded	Clean or replace	G-17
	Coolant flow route corroded	Clean or replace	G-17, G-26
	Radiator cap damaged	Replace	–
	Overload running	Reduce the load	–
	Head gasket damaged	Replace	1-S30, 1-S31
	Incorrect injection timing	Adjust	1-S19
	Unsuitable fuel used	Use specified fuel	I-5, I-6
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge	G-13
	Fan belt slips	Adjust belt tension or replace	G-12, G-13
	Wiring disconnected	Connect	–
	Rectifier damaged	Replace	–
	Alternator damaged	Replace	–
	Battery damaged	Replace	–

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2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit	
Valve Clearance (Cold)		0.145 to 0.185 mm 0.00571 to 0.00728 in.	—	
Compression Pressure	D1005-E4B/E4BG D1105-E4B/E4BG D1305-E4B/E4BG V1505-E4B/E4BG	3.73 to 4.11 MPa 38.0 to 42.0 kgf/cm ² 541 to 597 psi	2.26 MPa 23.0 kgf/cm ² 327 psi	
• Difference among Cylinders		—	10 % or less	
Top Clearance	D1005-E4B/E4BG D1105-E4B/E4BG V1505-E4B/E4BG	0.55 to 0.75 mm 0.022 to 0.029 in.	—	
	D1305-E4B/E4BG	0.80 to 1.0 mm 0.032 to 0.039 in.	—	
Cylinder Head Surface	Flatness	—	0.05 mm 0.002 in.	
Valve Recessing	Intake and Exhaust	-0.050 to 0.25 mm -0.0020 to 0.0098 in.	0.40 mm 0.016 in.	
Valve Stem to Valve Guide	Clearance	0.035 to 0.065 mm 0.0014 to 0.0025 in.	0.10 mm 0.0039 in.	
	• Valve Stem	O.D.	6.960 to 6.975 mm 0.2741 to 0.2746 in.	—
	• Valve Guide	I.D.	7.010 to 7.025 mm 0.2760 to 0.2765 in.	—
Valve Face	Angle (Intake)	1.0 rad 60 °	—	
	Angle (Exhaust)	0.79 rad 45 °	—	
Valve Seat	Angle (Intake)	1.0 rad 60 °	—	
	Angle (Exhaust)	0.79 rad 45 °	—	
	Width	2.12 mm 0.0835 in.	—	
Valve Spring	Free Length	37.0 to 37.5 mm 1.46 to 1.47 in.	36.5 mm 1.44 in.	
	Tilt	—	1.0 mm 0.039 in.	
	Setting Load	117.4 N / 31.0 mm 11.97 kgf / 31.0 mm 26.39 lbf / 1.22 in.	100.0 N / 31.0 mm 10.20 kgf / 31.0 mm 22.48 lbf / 1.22 in.	

Item		Factory Specification	Allowable Limit
Rocker Arm Shaft to Rocker Arm • Rocker Arm Shaft • Rocker Arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.0017 in.	0.10 mm 0.0039 in.
	O.D.	11.973 to 11.984 mm 0.47138 to 0.47181 in.	—
	I.D.	12.000 to 12.018 mm 0.47244 to 0.47314 in.	—
Push Rod	Alignment	—	0.25 mm 0.0098 in.
Tappet to Tappet Guide • Tappet • Tappet Guide	Clearance	0.020 to 0.062 mm 0.00079 to 0.0024 in.	0.07 mm 0.003 in.
	O.D.	19.959 to 19.980 mm 0.78579 to 0.78661 in.	—
	I.D.	20.000 to 20.021 mm 0.78740 to 0.78822 in.	—
Timing Gear • Crank Gear to Idle Gear 1 • Idle Gear 1 to Cam Gear • Idle Gear 1 to Injection Pump Gear • Idle Gear 1 to Idle Gear 2 • Idle Gear 2 to Governor Gear	Backlash	0.0320 to 0.115 mm 0.00126 to 0.00452 in.	0.15 mm 0.0059 in.
	Backlash	0.0360 to 0.114 mm 0.00142 to 0.00448 in.	0.15 mm 0.0059 in.
	Backlash	0.0340 to 0.116 mm 0.00134 to 0.00456 in.	0.15 mm 0.0059 in.
	Backlash	0.0330 to 0.117 mm 0.00130 to 0.00460 in.	0.15 mm 0.0059 in.
	Backlash	0.0300 to 0.117 mm 0.00119 to 0.00460 in.	0.15 mm 0.0059 in.
Governor Gear • Governor Gear to Injection Pump Gear	Backlash	0.0300 to 0.117 mm 0.00119 to 0.00460 in.	0.15 mm 0.0059 in.
Idle Gear Shaft to Gear Bushing • Idle Gear 1 • Idle Gear Bushing • Idle Gear Shaft 1 • Idle Gear 2 • Idle Gear Bushing • Idle Gear Shaft 2	Clearance	0.020 to 0.054 mm 0.00079 to 0.0021 in.	0.10 mm 0.0039 in.
	I.D.	26.000 to 26.021 mm 1.0237 to 1.0244 in.	—
	O.D.	25.967 to 25.980 mm 1.0224 to 1.0228 in.	—
	Clearance	0.020 to 0.054 mm 0.00079 to 0.0021 in.	0.10 mm 0.0039 in.
	I.D.	26.000 to 26.021 mm 1.0237 to 1.0244 in.	—
	O.D.	25.967 to 25.980 mm 1.0223 to 1.0228 in.	—

Item		Factory Specification	Allowable Limit
Idle Gear • Idle Gear 1	Side Clearance	0.20 to 0.51 mm 0.0079 to 0.020 in.	0.80 mm 0.031 in.
	• Idle Gear 2	Side Clearance	0.20 to 0.51 mm 0.0079 to 0.020 in.
Camshaft	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0086 in.	0.30 mm 0.012 in.
	Alignment	—	0.01 mm 0.0004 in.
Cam Height	Intake	28.80 mm 1.134 in.	28.75 mm 1.132 in.
	Exhaust	29.00 mm 1.142 in.	28.95 mm 1.140 in.
Camshaft Journal to Cylinder Block Bore	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
	• Camshaft Journal	O.D.	35.934 to 35.950 mm 1.4148 to 1.4153 in.
	• Cylinder Block Bore	I.D.	36.000 to 36.025 mm 1.4174 to 1.4183 in.
Piston Pin Bore	I.D.	22.000 to 22.013 mm 0.86615 to 0.86665 in.	22.03 mm 0.8673 in.
Piston Pin to Small End Bushing	Clearance	0.014 to 0.038 mm 0.00056 to 0.0014 in.	0.15 mm 0.0059 in.
	• Piston Pin	O.D.	22.002 to 22.011 mm 0.86622 to 0.86657 in.
	• Small End Bushing	I.D.	22.025 to 22.040 mm 0.86713 to 0.86771 in.
Piston Ring Gap [D1005-E4B/E4BG]	Top Ring	0.30 to 0.45 mm 0.012 to 0.017 in.	1.25 mm 0.0492 in.
	Second Ring	0.30 to 0.45 mm 0.012 to 0.017 in.	1.25 mm 0.0492 in.
	Oil Ring	0.25 to 0.45 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Piston Ring Gap [D1105-E4B/E4BG] [D1305-E4B/E4BG] [V1505-E4B/E4BG]	Top Ring	0.15 to 0.25 mm 0.0059 to 0.0098 in.	1.20 mm 0.0472 in.
	Second Ring	0.40 to 0.55 mm 0.016 to 0.021 in.	1.20 mm 0.0472 in.
	Oil Ring	0.25 to 0.45 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Piston Ring to Piston Ring Groove	• Second Ring	Clearance	0.0850 to 0.122 mm 0.00335 to 0.00480 in.
	• Oil Ring	Clearance	0.02 to 0.06 mm 0.0008 to 0.002 in.

Item		Factory Specification	Allowable Limit
Connecting Rod	Alignment	–	0.05 mm 0.002 in.
Crankshaft	Alignment	–	0.02 mm 0.0008 in.
Crankshaft to Crankshaft Bearing 1 [D1005-E4B/E4BG] [D1105-E4B/E4BG] [V1505-E4B/E4BG] • Crankshaft • Crankshaft Bearing 1	Oil Clearance	0.0340 to 0.114 mm 0.00134 to 0.00448 in.	0.20 mm 0.0079 in.
	O.D.	47.934 to 47.950 mm 1.8872 to 1.8877 in.	–
	I.D.	47.984 to 48.048 mm 1.8892 to 1.8916 in.	–
Crankshaft to Crankshaft Bearing 1 [D1305-E4B/E4BG] • Crankshaft • Crankshaft Bearing 1	Oil Clearance	0.0340 to 0.119 mm 0.00134 to 0.00468 in.	0.20 mm 0.0079 in.
	O.D.	51.921 to 51.940 mm 2.0442 to 2.0448 in.	–
	I.D.	51.974 to 52.040 mm 2.0463 to 2.0488 in.	–
Crankshaft to Crankshaft Bearing 2 [D1005-E4B/E4BG] [D1105-E4B/E4BG] [V1505-E4B/E4BG] • Crankshaft Journal • Crankshaft Bearing 2	Oil Clearance	0.034 to 0.095 mm 0.0014 to 0.0037 in.	0.20 mm 0.0079 in.
	O.D.	47.934 to 47.950 mm 1.8872 to 1.8877 in.	–
	I.D.	47.984 to 48.029 mm 1.8892 to 1.8908 in.	–
Crankshaft to Crankshaft Bearing 2 [D1305-E4B/E4BG] • Crankshaft Journal • Crankshaft Bearing 2	Oil Clearance	0.0340 to 0.103 mm 0.00134 to 0.00405 in.	0.20 mm 0.0079 in.
	O.D.	51.921 to 51.940 mm 2.0442 to 2.0448 in.	–
	I.D.	51.974 to 52.024 mm 2.0463 to 2.0481 in.	–
Crankshaft to Crankshaft Bearing 3 • Crankshaft Journal • Crankshaft Bearing 3	Oil Clearance	0.0340 to 0.103 mm 0.00134 to 0.00405 in.	0.20 mm 0.0079 in.
	O.D.	51.921 to 51.940 mm 2.0442 to 2.0448 in.	–
	I.D.	51.974 to 52.024 mm 2.0463 to 2.0481 in.	–
Crankpin to Crankpin Bearing • Crankpin • Crankpin Bearing	Oil Clearance	0.029 to 0.091 mm 0.0012 to 0.0035 in.	0.20 mm 0.0079 in.
	O.D.	39.959 to 39.975 mm 1.5732 to 1.5738 in.	–
	I.D.	40.040 to 40.050 mm 1.5764 to 1.5767 in.	–

Item		Factory Specification	Allowable Limit
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.012 in.	0.50 mm 0.020 in.
Cylinder Liner I.D.	D1005-E4B/E4BG	76.000 to 76.019 mm 2.9922 to 2.9928 in.	76.15 mm 2.998 in.
	D1105-E4B/E4BG	78.000 to 78.019 mm	78.15 mm
	D1305-E4B/E4BG	3.0709 to 3.0716 in.	3.077 in.
	V1505-E4B/E4BG		
Cylinder (Oversized)	D1005-E4B/E4BG	76.500 to 76.519 mm 3.0119 to 3.0125 in.	76.65 mm 3.018 in.
	D1105-E4B/E4BG	78.500 to 78.519 mm	78.65 mm
	D1305-E4B/E4BG	3.0906 to 3.0912 in.	3.096 in.
	V1505-E4B/E4BG		

LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure [D1005-E4B] [D1105-E4B] [D1305-E4B] [V1505-E4B]	At Idle Speed	68 kPa 0.69 kgf/cm ² 9.9 psi	—
	At Rated Speed	294 to 441 kPa 3.00 to 4.49 kgf/cm ² 42.7 to 63.9 psi	147 kPa 1.50 kgf/cm ² 21.3 psi
Engine Oil Pressure [D1005-E4BG] [D1105-E4BG] [D1305-E4BG] [V1505-E4BG]	At Idle Speed	—	—
	At Rated Speed	245 to 392 kPa 2.50 to 3.99 kgf/cm ² 35.6 to 56.8 psi	147 kPa 1.50 kgf/cm ² 21.3 psi
Inner Rotor to Outer Rotor	Clearance	0.060 to 0.18 mm 0.0024 to 0.0071 in.	—
Outer Rotor to Pump Body	Clearance	0.100 to 0.180 mm 0.00394 to 0.00708 in.	—
Inner Rotor to Cover	Clearance	0.025 to 0.075 mm 0.00099 to 0.0029 in.	—

COOLING SYSTEM

Item		Factory Specification	Allowable Limit
Fan Belt	Tension	7.0 to 9.0 mm / 98 N 0.28 to 0.35 in. / 98 N (10 kgf, 22 lbf)	—
Thermostat	Valve Opening Temperature (At Beginning)	69.5 to 72.5 °C 157.1 to 162.5 °F	—
	Valve Opening Temperature (Opened Completely)	85 °C 185 °F	—
Radiator Cap	Pressure Falling Time	10 seconds or more 88 → 59 kPa 0.89 → 0.61 kgf/cm ² 12 → 8.6 psi	—
Radiator	Water Leakage Test Pressure	No leak at specified pressure	—

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Pump [D1005-E4B] [D1105-E4B] [D1305-E4B] [V1505-E4B] [D1005-E4BG, D1105-E4BG] [D1305-E4BG, V1505-E4BG]	Injection Timing (3000 min ⁻¹ (rpm))	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.	—
	Injection Timing (3200 min ⁻¹ (rpm))	0.3360 to 0.3621 rad (19.25 to 20.75 °) before T.D.C.	—
	Injection Timing (3000 min ⁻¹ (rpm))	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.	—
	Injection Timing (2600 min ⁻¹ (rpm))	0.2662 to 0.2923 rad (15.25 to 16.75 °) before T.D.C.	—
	Injection Timing (2300 min ⁻¹ (rpm))	0.2313 to 0.2574 rad (13.25 to 14.75 °) before T.D.C.	—
	Injection Timing (1800 min ⁻¹ (rpm))	0.2575 to 0.2836 rad (14.75 to 16.25 °) before T.D.C.	—
	Injection Timing (1800 min ⁻¹ (rpm))	0.2487 to 0.2748 rad (14.25 to 15.75 °) before T.D.C.	—
Pump Element	Fuel Tightness	—	13.73 MPa 140.0 kgf/cm ² 1991 psi
Delivery Valve	Fuel Tightness	10 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi	5 seconds 13.73 → 12.75 MPa 140.0 → 130.1 kgf/cm ² 1991 → 1850 psi
Injection Nozzle	Injection Pressure	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm ² 1992 to 2133 psi	—
Injection Nozzle Valve Seat	Valve Seat Tightness	When the pressure is 12.75 MPa (130.0 kgf/cm ² , 1849 psi), the valve seat must be fuel tightness.	—

ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Glow Plug	Resistance	Approx. 0.9 Ω	—
Starter (Gear Reduction Type) • Commutator	O.D.	30.0 mm 1.18 in.	29.0 mm 1.14 in.
	• Difference	Less than 0.02 mm 0.0008 in.	0.05 mm 0.002 in.
	• Mica	Undercut 0.50 to 0.80 mm 0.020 to 0.031 in.	0.20 mm 0.0079 in.
	• Brush	Length 16.0 mm 0.630 in.	10.5 mm 0.413 in.
Starter (Electromagnetic Drive Type) • Commutator	O.D.	28.0 mm 1.10 in.	27.0 mm 1.06 in.
	• Difference	Less than 0.05 mm 0.002 in.	0.4 mm 0.02 in.
	• Mica	Undercut 0.50 to 0.80 mm 0.020 to 0.031 in.	0.20 mm 0.0079 in.
	• Brush	Length 16.0 mm 0.630 in.	10.5 mm 0.413 in.
Alternator • Stator	Resistance	Less than 1.0 Ω	—
	• Rotor	Resistance 2.9 Ω	—
	• Slip Ring	O.D. 14.4 mm 0.567 in.	14.0 mm 0.551 in.
	• Brush	Length 10.0 mm 0.394 in.	8.4 mm 0.33 in.
Stop Solenoid • Holding Coil	Resistance	Approx. 16 Ω	—
	• Pulling Coil	Resistance Approx. 0.38 Ω	—

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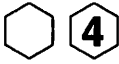

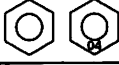
3. TIGHTENING TORQUES

Use a torque wrench to tighten the screws, bolts and nuts to the specified torque. Tighten the screws, bolts and nuts used, such as on the cylinder head in the correct sequence and torque.

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[1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS

If the tightening torque is not specified, refer to the table below for the none specified torques values.

Indication on top of bolt	 No-grade or 4T			 7T		
Indication on top of nut	 No-grade or 4T					
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
M8	18 to 20	1.8 to 2.1	13 to 15	24 to 27	2.4 to 2.8	18 to 20
M10	40 to 45	4.0 to 4.6	29 to 33	49 to 55	5.0 to 5.7	37 to 41
M12	63 to 72	6.4 to 7.4	47 to 53	78 to 90	7.9 to 9.2	58 to 66

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[2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS

■ NOTE

- For the screws, bolts and nuts with the mark "♦", apply engine oil to their threads and seats before you tighten.
- The alphabet "M" in Dimension × Pitch shows that the screw, bolt or nut dimensions are in the metric system. The dimension is the nominal external diameter in mm of the threads. The pitch is the nominal distance in mm between 2 threads.

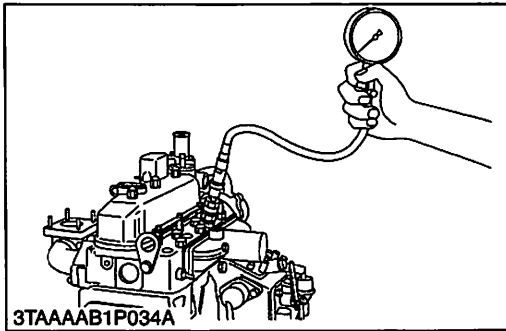
Item	Dimension × Pitch	N·m	kgf·m	lbf·ft
Cylinder head cover screw [D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]	M7 × 1.0	7 to 8	0.7 to 0.9	5 to 6
Cylinder head cover screw [D1305-E4B/E4BG]	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Cylinder head screw	M10 × 1.25	64 to 68	6.5 to 7.0	47 to 50
*Main bearing case screw 1	M8 × 1.25	30 to 34	3.0 to 3.5	22 to 25
*Main bearing case screw 2	M9 × 1.25	49 to 53	5.0 to 5.5	37 to 39
*Flywheel screw	M10 × 1.25	54 to 58	5.5 to 6.0	40 to 43
*Connecting rod screw	M8 × 1.0	42 to 46	4.2 to 4.7	31 to 33
*Rocker arm bracket nut [D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]	M7 × 1.0	22 to 26	2.2 to 2.7	16 to 19
*Rocker arm bracket screw [D1305-E4B/E4BG]	M7 × 1.0	22 to 26	2.2 to 2.7	16 to 19
*Idle gear shaft screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
*Fan drive pulley screw	M14 × 1.5	236 to 245	24.0 to 25.0	174 to 180
Bearing case cover mounting screw	M6 × 1.0	10.8 to 12.2	1.10 to 1.25	7.96 to 9.04
Glow plug	M8 × 1.0	7.9 to 14	0.80 to 1.5	5.8 to 10
Nozzle holder assembly	M20 × 1.5	49 to 68	5.0 to 7.0	37 to 50
Nozzle holder	–	35 to 39	3.5 to 4.0	26 to 28
Oil pressure switch	PT 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pipe retaining nut	M12 × 1.5	25 to 34	2.5 to 3.5	18 to 25
Overflow pipe retaining nut (Serial No.: below BTZ999)	M12 × 1.5	20 to 24	2.0 to 2.5	15 to 18
Overflow pipe retaining nut (Serial No.: above BU0001)	M12 × 1.5	35 to 39	3.5 to 4.0	26 to 28
Starter's B terminal nut	M8	5.88 to 11.8	0.600 to 1.20	4.34 to 8.70
Alternator's pulley nut	–	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
Drain plug with copper gasket	M12 × 1.25	33 to 37	3.3 to 3.8	24 to 27
Drain plug with rubber coated gasket	M22 × 1.5	45 to 53	4.5 to 5.5	33 to 39

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4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body



Compression Pressure

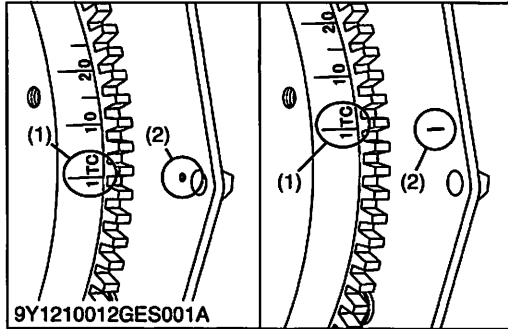
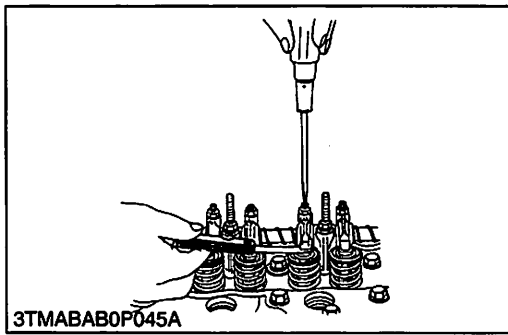
1. Run the engine until it is warmed up.
2. Stop the engine.
3. Remove the air cleaner, the muffler and all glow plugs (or nozzles).
4. Set a compression tester with the adaptor to the glow plug hole (or nozzle hole).
Nozzle hole: Adaptor H (07909-31231)
Glow plug hole: Adaptor L (07909-31301)
5. After making sure that the stop lever is set at the stop position (non-injection), run the engine with the starter and measure the compression pressure.
6. Repeat steps 4 and 5 for each cylinder.
7. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the glow plug hole (or nozzle hole) and measure the compression pressure again.
8. If the compression pressure is still less than the allowable limit, check the top clearance, valve clearance and cylinder head.
9. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ NOTE

- Check the compression pressure with the specified valve clearance.
- Always use a fully charged battery for performing this test.
- Variances in cylinder compression values should be under 10 %.

Compression pressure	D1005-E4B/ E4BG D1105-E4B/ E4BG D1305-E4B/ E4BG V1505-E4B/ E4BG	Factory specification	3.73 to 4.11 MPa 38.0 to 42.0 kgf/cm ² 541 to 597 psi
		Allowable limit	2.26 MPa 23.0 kgf/cm ² 327 psi

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Valve Clearance

■ **IMPORTANT**

- Valve clearance must be checked and adjusted when engine is cold.
1. Remove the cylinder head cover and the glow plugs.
 2. Align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the compression top dead center.
 3. Check the following valve clearance marked with "☆" using a feeler gauge.
 4. If the clearance is not within the factory specifications, adjust with the adjusting screw.
 5. Then turn the flywheel 6.28 rad (360 °), and align the "1TC" mark (1) on the flywheel and alignment mark (2) on the rear end plate so that the No. 1 piston comes to the overlap position.
 6. Check the following valve clearance marked with "☆" using a feeler gauge.

Adjustable Cylinder Location of Piston	3 cylinder		4 cylinder	
	IN.	EX.	IN.	EX.
When No. 1 piston is at compression top dead center	1	☆	☆	☆
	2		☆	☆
	3	☆		☆
	4			
When No. 1 piston is at overlap position	1			
	2	☆		☆
	3		☆	☆
	4			☆

Valve clearance	Factory specification	0.145 to 0.185 mm 0.00571 to 0.00728 in.
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■ **NOTE**

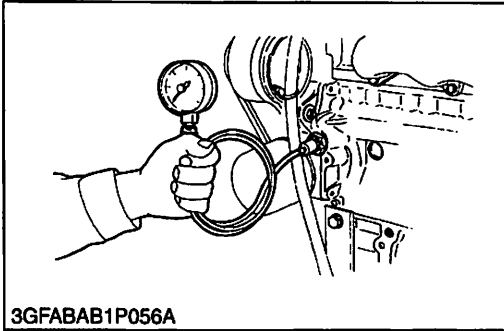
- The sequence of cylinder numbers is given as No. 1, No. 2, No. 3 and No. 4 starting from the gear case side.
- After adjusting the valve clearance, secure the adjusting screw with the lock nut.

(1) "1TC" Mark

(2) Alignment Mark

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(2) Lubricating System



3GFABAB1P056A

Engine Oil Pressure

1. Remove the engine oil pressure switch, and set an oil pressure tester.
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.
 - Engine oil insufficient
 - Oil pump damaged
 - Oil strainer clogged
 - Oil filter cartridge clogged
 - Oil gallery clogged
 - Excessive oil clearance
 - Foreign matter in the relief valve

Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.50 kgf/cm ² 7.1 psi
	At rated speed	Factory specification	197 to 441 kPa 2.00 to 4.50 kgf/cm ² 28.5 to 64.0 psi
		Allowable limit	147 kPa 1.50 kgf/cm ² 21.3 psi

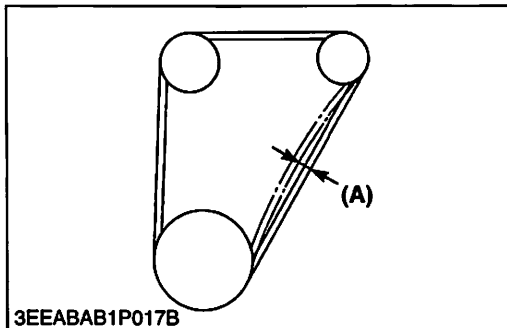
(When reassembling)

- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Tightening torque	Oil pressure switch	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft
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(3) Cooling System



3EEABAB1P017B

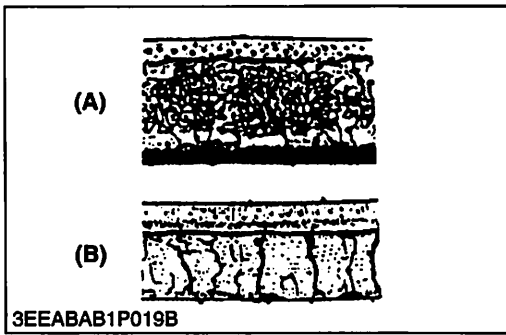
Fan Belt Tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbf).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory specification	7.0 to 9.0 mm 0.28 to 0.35 in.
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(A) Deflection

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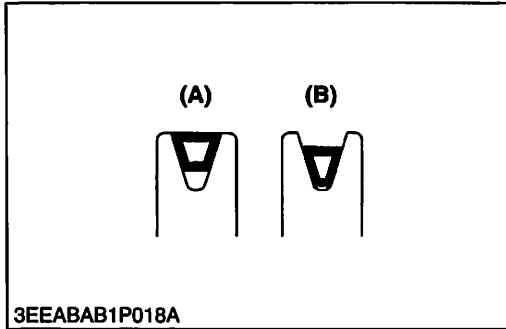
Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good

(B) Bad

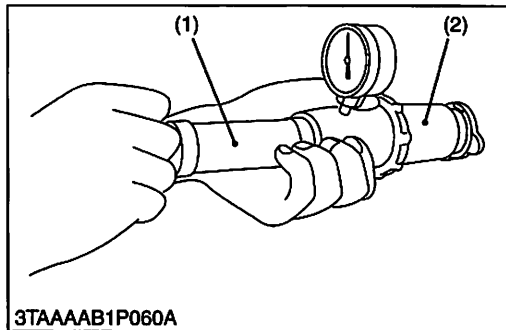
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CAUTION

- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.

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Radiator Cap Air Leakage

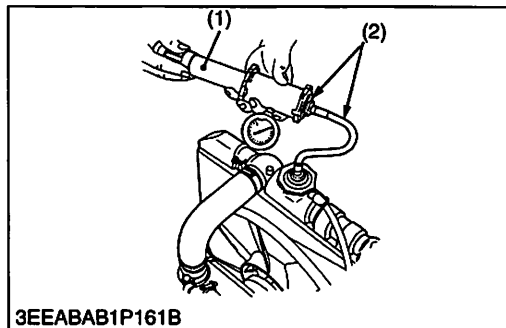
1. Set a radiator tester (1) and an adaptor (2) on the radiator cap.
2. Apply the specified pressure 88 kPa (0.89 kgf/cm², 12 psi), and measure the time for the pressure to fall to 59 kPa (0.61 kgf/cm², 8.6 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Pressure falling time	Factory specification	More than 10 seconds for pressure fall 88 → 59 kPa (0.89 → 0.61 kgf/cm ² , 12 → 8.6 psi)
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(1) Radiator Tester

(2) Adaptor

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Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester (1) and an adaptor (2) and raise the water pressure to the specified pressure.
3. Check the radiator for water leaks.
4. For water leak from the pinhole, repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator water leakage test pressure	Factory specification	No leak at specified pressure
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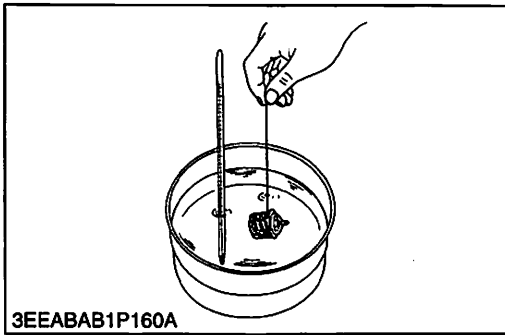
NOTE

- The pressure of the leak test is different from each radiator specification. Thus, do the leak test, refer to the test pressure of each radiator specification.

(1) Radiator Tester

(2) Adaptor

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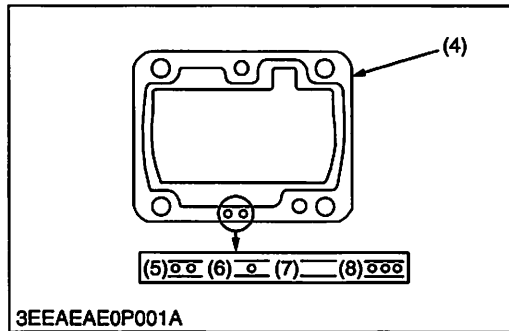
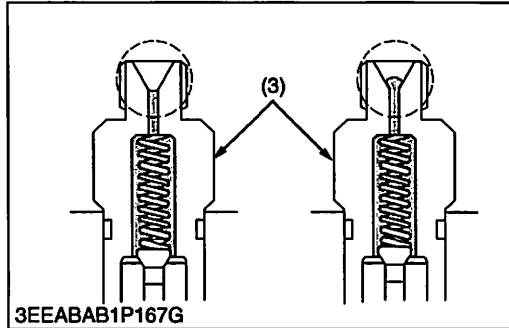
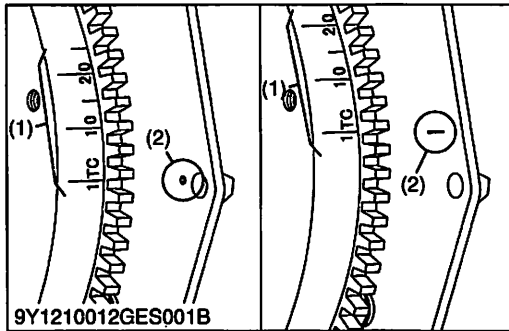
Thermostat Valve Opening Temperature

1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
3. Continue heating and read the temperature when the valve opens approx. 8 mm (0.3 in.).
4. If the measurement is not within the factory specifications, replace the thermostat.

Thermostat's valve opening temperature	Factory specification	69.5 to 72.5 °C 157.1 to 162.5 °F
Temperature at which thermostat completely opens	Factory specification	85 °C 185 °F

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(4) Fuel System



Injection Timing

1. Remove the injection pipes.
2. Remove the engine stop solenoid.
3. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (3) for No. 1 cylinder.
4. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.6 rad (90 °).
5. Turn the flywheel counterclockwise to set at around 0.44 rad (25 °) before T.D.C..
6. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
7. Check to see the degree on flywheel.
The flywheel gas mark "1TC", "10" and "20" for the crank angle before the top dead center of No. 1 cylinder.
8. If injection timing is out of adjustment, readjust the timing with shims.

Injection timing (3000 min ⁻¹ (rpm))	Factory specifica- tion	D1005-E4B	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.
Injection timing (3200 min ⁻¹ (rpm))		D1005-E4B	0.3360 to 0.3621 rad (19.25 to 20.75 °) before T.D.C.
Injection timing (3000 min ⁻¹ (rpm))		D1105-E4B	0.3011 to 0.3272 rad (17.25 to 18.75 °) before T.D.C.
Injection timing (2600 min ⁻¹ (rpm))		D1305-E4B	0.2662 to 0.2923 rad (15.25 to 16.75 °) before T.D.C.
Injection timing (2300 min ⁻¹ (rpm))		V1505-E4B	0.2313 to 0.2574 rad (13.25 to 14.75 °) before T.D.C.
Injection timing (1800 min ⁻¹ (rpm))		D1505-E4BG, D1105-E4BG	0.2575 to 0.2836 rad (14.75 to 16.25 °) before T.D.C.
Injection timing (1800 min ⁻¹ (rpm))		D1305-E4BG, V1505-E4BG	0.2487 to 0.2748 rad (14.25 to 15.75 °) before T.D.C.

- | | |
|-----------------------------------|---------------------------------------|
| (1) Timing Line | (5) Two-holes: 0.20 mm (0.0079 in.) |
| (2) Alignment Mark | Two-holes: 0.175 mm (0.00689 in.) |
| (3) Delivery Valve Holder | (6) One-hole: 0.25 mm (0.0098 in.) |
| (4) Shim (Soft Metal Gasket Shim) | (7) Without hole: 0.30 mm (0.012 in.) |
| | (8) Three-holes: 0.35 mm (0.014 in.) |

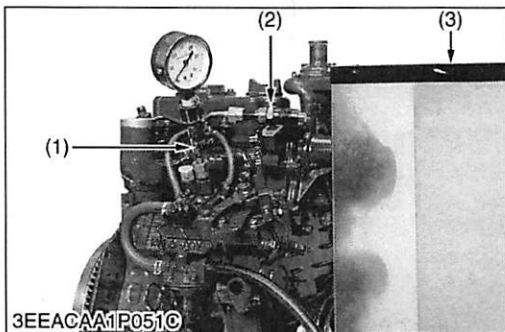
(To be continued)

(Continued)

■ NOTE

- The liquid gasket is not required for assembling.
- Shims are available in thickness of 0.20 mm (0.0079 in.), 0.25 mm (0.0098 in.), 0.30 mm (0.012 in.), 0.35 mm (0.014 in.) and 0.175 mm (0.00689 in.). Combine these shims for adjustments.
- Addition or reduction of shim (0.025 mm, 0.00098 in.) delays or advances the injection timing by approx. 0.0044 rad (0.25 °).
- In disassembling and replacing the injection pump, be sure to use the same number of new shims with the same thickness.
- The 0.175 mm thick shim is coated only on the lower face. Therefore, do not use the 0.175 mm thick shim as the top shim of the combination (injection pump side), because this can cause oil leakage.

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Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the photo.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

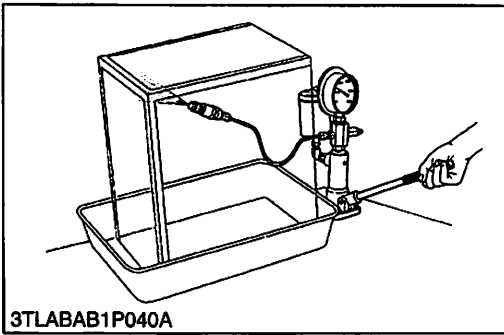
Fuel tightness of pump element	Allowable limit	13.73 MPa 140.0 kgf/cm ² 1991 psi
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■ NOTE

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

- (1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

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Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

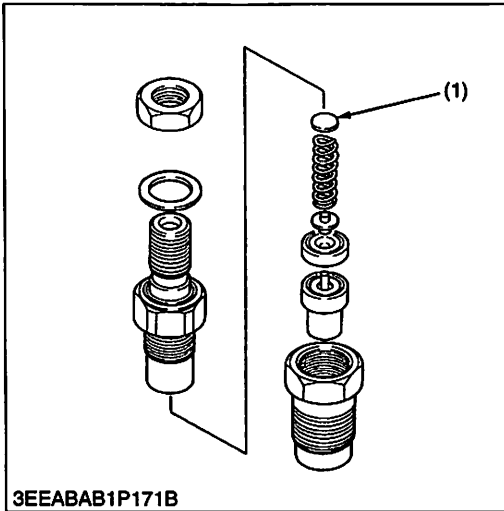
(Reference)

- Pressure variation with 0.01 mm (0.0004 in.) difference of adjusting washer thickness.
Approx. 235 kPa (2.4 kgf/cm², 34 psi)

Fuel injection pressure	Factory specification	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm ² 1992 to 2133 psi
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(1) Adjusting Washer

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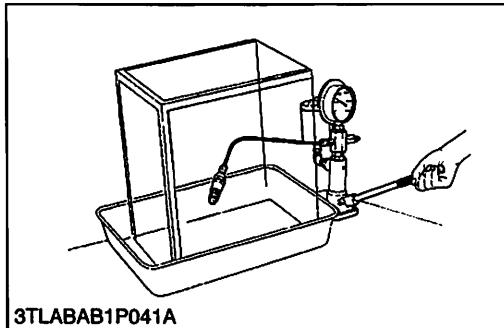


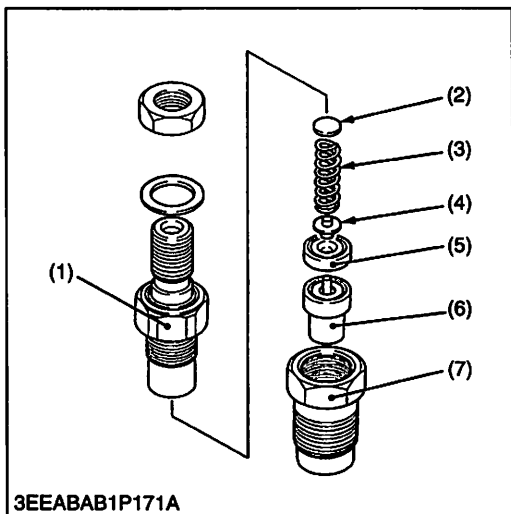
Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm², 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory specification	No fuel leak at 12.75 MPa 130.0 kgf/cm ² 1849 psi
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Nozzle Holder

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut (Serial No.: below BTZ999)	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Overflow pipe retaining nut (Serial No.: above BU0001)	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 36 to 50 lbf·ft

- | | |
|----------------------|--------------------------|
| (1) Nozzle Holder | (5) Distance Piece |
| (2) Adjusting Washer | (6) Nozzle Piece |
| (3) Nozzle Spring | (7) Nozzle Retaining Nut |
| (4) Push Rod | |

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(5) Electrical System

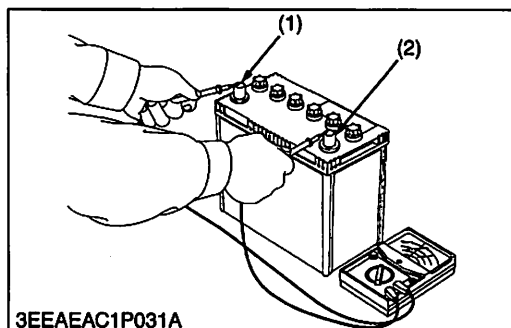
CAUTION

- To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.
- Never remove the battery cap while the engine is running.
- Keep electrolyte away from eyes, hands and clothes. If you are splattered with it, wash it away completely with water immediately.
- Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.

IMPORTANT

- If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.

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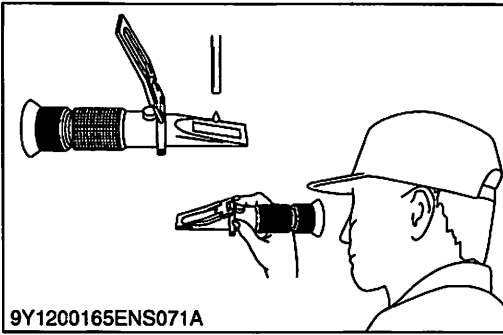
Battery Voltage

1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

Battery voltage	Factory specification	More than 12 V
-----------------	-----------------------	----------------

- | | |
|-----------------------|-----------------------|
| (1) Positive Terminal | (2) Negative Terminal |
|-----------------------|-----------------------|

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Battery Specific Gravity

1. Measure the specific gravity of the electrolyte in each cell with a battery and coolant tester.
2. If the electrolyte temperature is different from the one that the battery and coolant tester calibrated, correct the specific gravity measurement. Use the formula below in (Reference).
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity is different between 2 cells by more than 0.05, replace the battery.

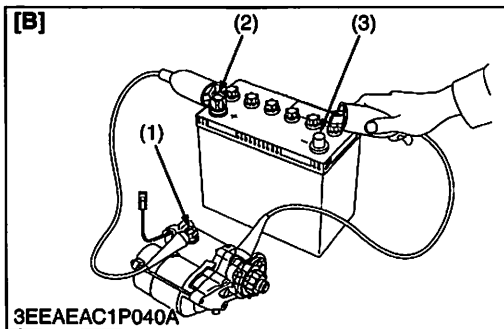
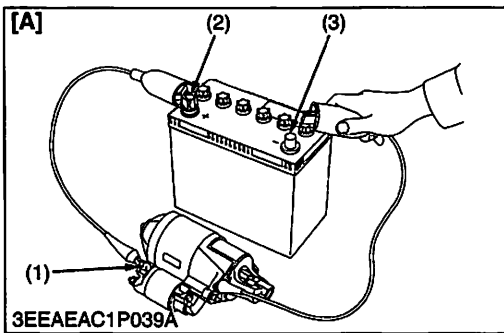
(Reference)

- The specific gravity changes with temperature. To be accurate, the specific gravity decreases by 0.0007 when temperature increases by 1 °C (decreases by 0.0004 when temperature increases by 1 °F), increases by 0.0007 when temperature decreases by 1 °C (increases by 0.0004 when temperature decreases by 1 °F). Thus, if you refer to 20 °C (68 °F), correct the specific gravity reading by the formula below:
 - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature - 20 °C)
 - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature - 68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

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Motor Test

⚠ CAUTION

- **Secure the starter to prevent it from jumping up and down while testing the motor.**
1. Disconnect the battery negative cable from the battery.
 2. Disconnect the battery positive cable from the battery.
 3. Disconnect the leads from the starter B terminal.
 4. Remove the starter from the engine.
 5. Connect a jumper lead from the starter C terminal (1) to the battery positive terminal (2).
 6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
 7. If the motor does not run, starter is failure. Repair or replace the starter.

■ NOTE

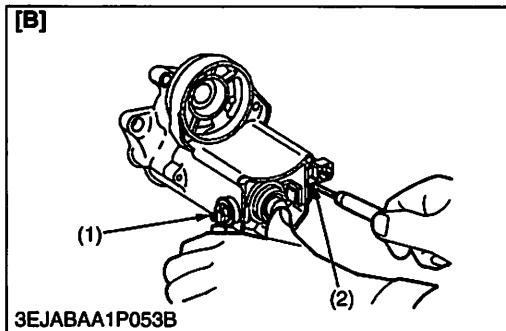
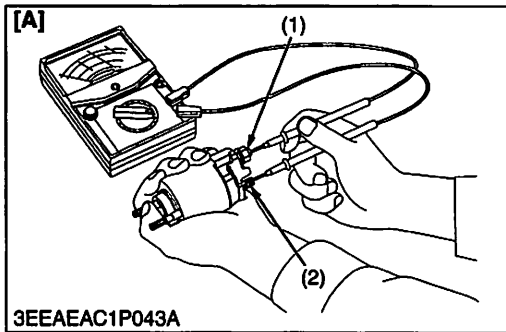
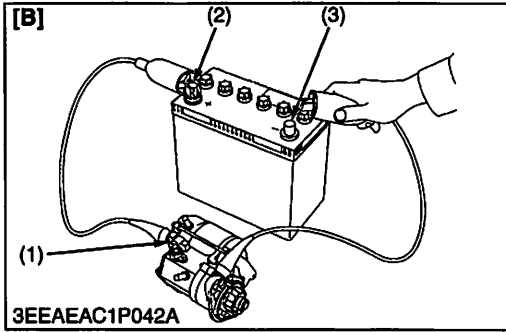
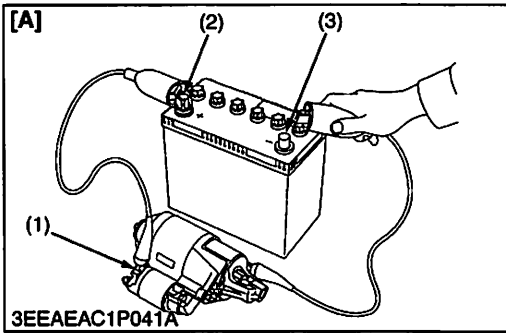
- **B terminal:** It is the terminal which connects the cable from the battery to the starter.
- **C terminal:** It is the terminal which connects the cable from the motor to the magnet switch.

- (1) C Terminal
- (2) Positive Terminal
- (3) Negative Terminal

[A] Electromagnetic Drive Type

[B] Planetary Gear Reduction Type

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Magnetic Switch Test

1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter B terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter S terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the pinion gear does not pop out, the magnetic switch is failure.
Repair or replace the starter.

■ **NOTE**

- **B terminal:** It is the terminal which connects the cable from the battery to the starter.
- **S terminal:** It is the terminal which connects the cable from the starter switch to the magnet switch.

- (1) S Terminal
- (2) Positive Terminal
- (3) Negative Terminal

- [A] Electromagnetic Drive Type
- [B] Planetary Gear Reduction Type

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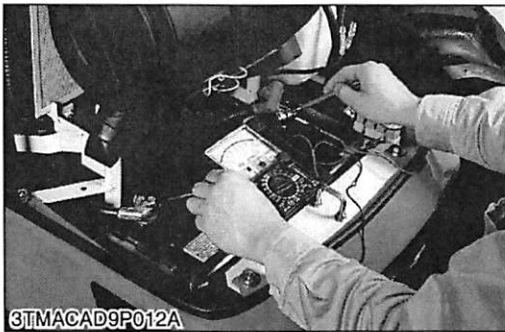
Magnet Switch Continuity Test

1. Check the continuity across the C terminal (1) and the B terminal (2) with a circuit tester, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the magnet switch.

- (1) C Terminal
- (2) B Terminal

- [A] Electromagnetic Drive Type
- [B] Gear Reduction Type

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Alternator on Unit Test

(Before testing)

- Before alternator on unit test, check the battery terminal connections, circuit connection, fan belt tension, charging indicator lamp, fuses on the circuit, and abnormal noise from the alternator.
- Prepare full charged battery for the test.

■ NOTE

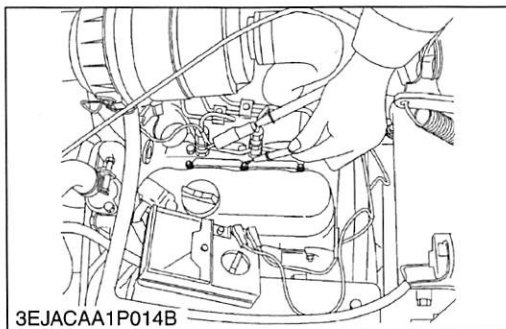
- **Be careful not to touch the rotating engine parts while engine is running.**

Keep safety distance from the engine rotating parts.

1. Start the engine.
2. When the engine is operating measure the voltage between two battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator is operating normally.
3. If the results of alternator on unit test are not within the specifications, disassemble the alternator and check the each component part for finding out the failure. See the "DISASSEMBLING AND ASSEMBLING" and "SERVICING" for alternator.

Regulating voltage at no load	Factory specification	13.8 to 14.8 V at 25 °C (77 °F)
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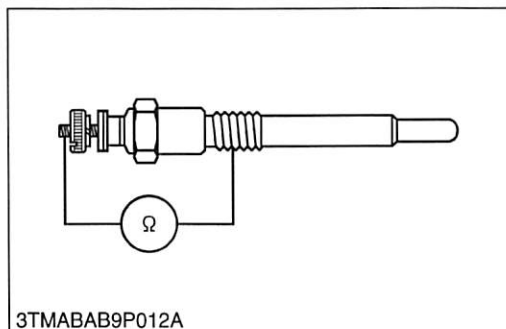


Glow Plug Lead Terminal Voltage

1. Turn the key switch to the "GLOW (or PREHEAT)" position, and measure the voltage with a circuit tester between the lead terminal and the engine body.
2. If the voltage differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage	Main switch key at GLOW (or PREHEAT)	Approx. battery voltage
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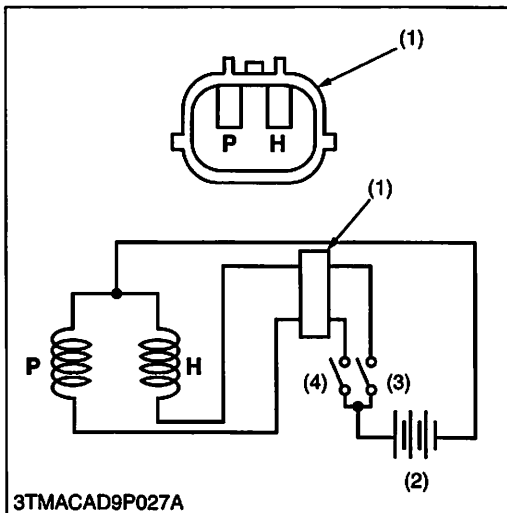


Glow Plug Continuity

1. Remove the glow plug.
2. Measure the resistance with a circuit tester between the glow plug terminal and the glow plug housing.
3. If the factory specification is not indicated, glow plug is faulty.

Resistance	Factory specification	Approx. 0.9 Ω
------------	-----------------------	---------------

9Y1210784ENS0025US0



Engine Stop Solenoid

1. Remove the engine stop solenoid from the engine.
2. Connect the jumper leads from the pulling coil P terminal to the switch (4), and from switch (4) to the battery positive terminal.
3. Connect the jumper leads from the holding coil H terminal to the switch (3), and from switch (3) to the battery positive terminal.
4. Connect the jumper leads from the engine stop solenoid body to the battery negative terminal.
5. When switch (4) is turned on, the plunger pulls into the solenoid body and then turn off the switch (4), the plunger comes out.
6. Turn on the switch (3) then turn on the switch (4), the plunger pulls into the solenoid body and it keeps in holding position after turning off the switch (4).
7. If the plunger is not attracted, the engine stop solenoid is faulty.

■ IMPORTANT

- Never apply the current for pulling coil more than two seconds when inspecting.

- (1) Connector
 (2) Battery
 (3) Switch for Holding Coil
 (4) Switch for Pulling Coil

- P: Terminal for Pulling Coil
 H: Terminal for Holding Coil

9Y1210784ENS0026US0

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Oil and Coolant

Draining Oil and Coolant

⚠ CAUTION

- Never remove radiator cap until coolant temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.

1. Prepare a bucket. Open the drain valve to drain coolant.
2. Prepare an oil pan. Remove the drain plug to drain engine oil in the pan.

9Y1210784ENS0027US0

(2) External Components

Air Cleaner and Muffler

1. Remove the air cleaner.
2. Remove muffler retaining nuts to remove the muffler.

(When reassembling)

- Install the muffler gasket so that its steel side face the muffler.

9Y1210784ENS0028US0

Alternator and Fan Belt

1. Remove the alternator (1).
2. Remove the fan belt (2).
3. Remove the starter (3).

(When reassembling)

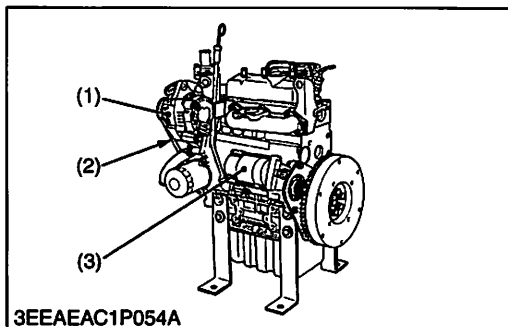
- Check to see that there are no cracks on the belt surface.

■ IMPORTANT

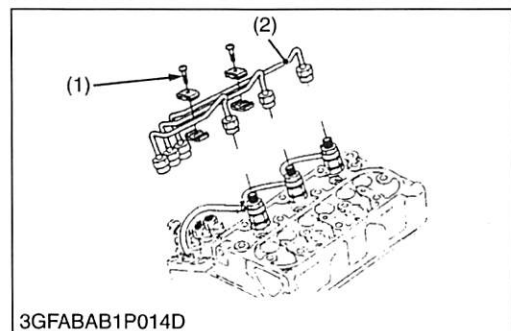
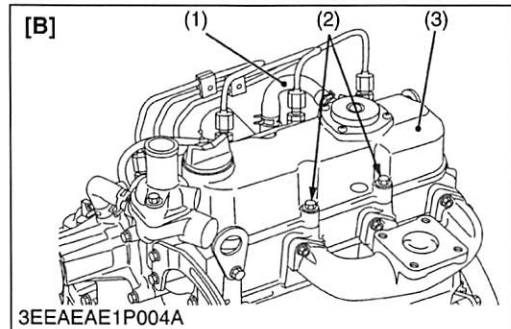
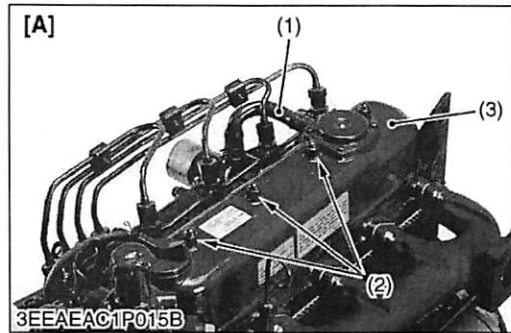
- After reassembling the fan belt, be sure to adjust the fan belt tension.

- (1) Alternator
 (2) Fan Belt
 (3) Starter

9Y1210784ENS0029US0



(3) Cylinder Head and Valve



Cylinder Head Cover

1. Disconnect the breather hose (1).
2. Remove the cylinder head cover screw (2).
3. Remove the cylinder head cover (3).

(When reassembling)

- Check to see if the cylinder head cover gasket is not damaged.

[D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]

Tightening torque	Cylinder head cover screw	7 to 8 N·m 0.7 to 0.9 kgf·m 5 to 6 lbf·ft
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[D1305-E4B/E4BG]

Tightening torque	Cylinder head cover screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
-------------------	---------------------------	---

- (1) Breather Hose
 (2) Cylinder Head Cover Screw
 (3) Cylinder Head Cover

- [A] D1005-E4B/E4BG,
 D1105-E4B/E4BG,
 V1505-E4B/E4BG
 [B] D1305-E4B/E4BG

9Y1210784ENS0030US0

Injection Pipes

1. Loosen the screws to the pipe clamp (1).
2. Detach the injection pipes (2).

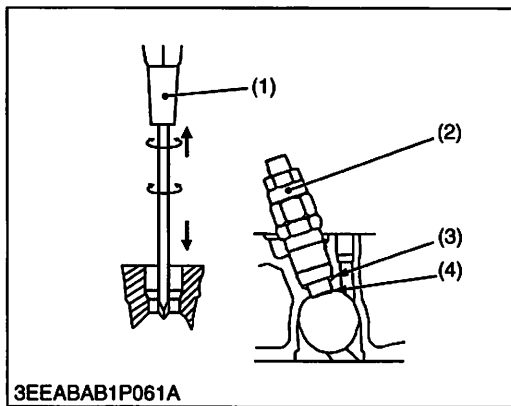
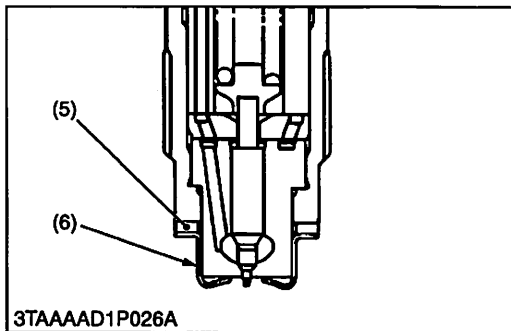
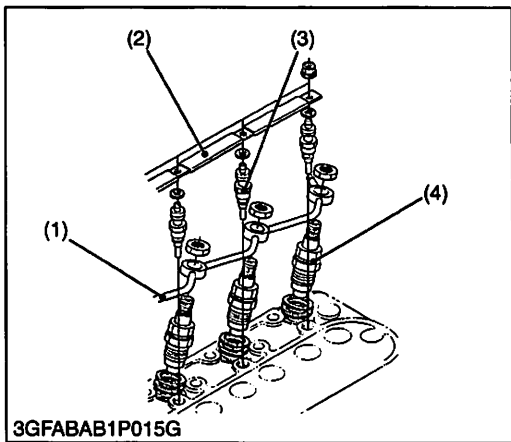
(When reassembling)

- Send compressed air into the pipes to blow out dust. Then, reassemble the pipes in the reverse order.

Tightening torque	Injection pipe retaining nut	25 to 34 N·m 2.5 to 3.5 kgf·m 18 to 25 lbf·ft
-------------------	------------------------------	---

- (1) Pipe Clamp (2) Injection Pipe

9Y1210784ENS0031US0



Nozzle Holder Assembly and Glow Plug

1. Remove the overflow pipe (1).
2. Remove the nozzle holder assemblies (4).
3. Remove the copper gasket (5) and heat seal (6).
4. Remove the lead (2) from the glow plugs (3).
5. Remove the glow plugs (3).

(When reassembling)

- Replace the copper gasket and heat seal with new one.

Tightening torque	Overflow pipe retaining nut (Serial No.: below BTZ999)	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Overflow pipe retaining nut (Serial No.: above BU0001)	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft
	Glow plug	7.9 to 14 N·m 0.80 to 1.5 kgf·m 5.8 to 10 lbf·ft

- | | |
|-------------------|----------------------------|
| (1) Overflow Pipe | (4) Nozzle Holder Assembly |
| (2) Lead | (5) Copper Gasket |
| (3) Glow Plug | (6) Heat Seal |

9Y1210784ENS0032US0

Nozzle Heat Seal Service Removal Procedure

■ IMPORTANT

- Use a plus (Phillips head) screw driver (1) that has a diameter which is bigger than the heat seal hole (Approx. 6 mm (1/4 in.)).

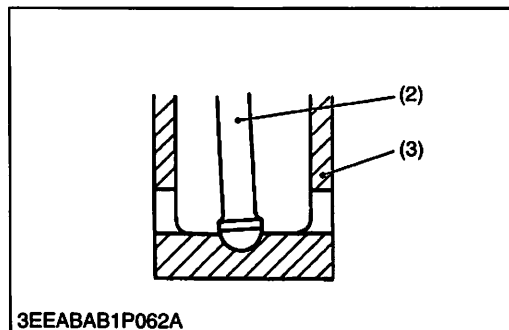
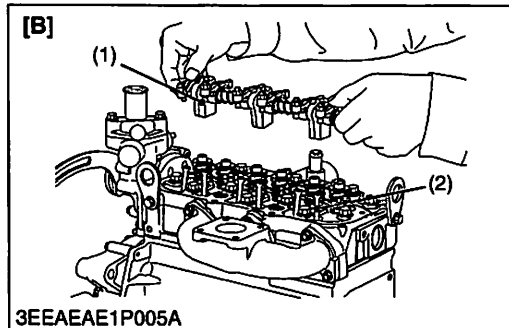
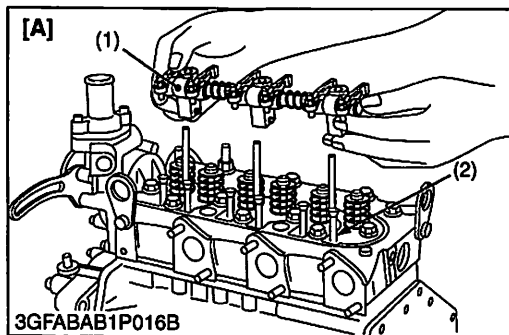
1. Drive screw driver (1) lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal (4) out together with the injection nozzle gasket (3).
4. If the heat seal drops, repeat the above procedure.

(When reassembling)

- Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

- | | |
|-----------------------|-----------------------------|
| (1) Plus Screw Driver | (3) Injection Nozzle Gasket |
| (2) Nozzle Holder | (4) Heat Seal |

9Y1210784ENS0033US0



Rocker Arm and Push Rod

1. Remove the rocker arm bracket screws / nuts.
2. Detach the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)

- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the dimples.

■ IMPORTANT

- After installing the rocker arm, be sure to adjust the valve clearance.

[D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]

Tightening torque	Rocker arm bracket nut	22 to 26 N·m 2.2 to 2.7 kgf·m 16 to 19 lbf·ft
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[D1305-E4B/E4BG]

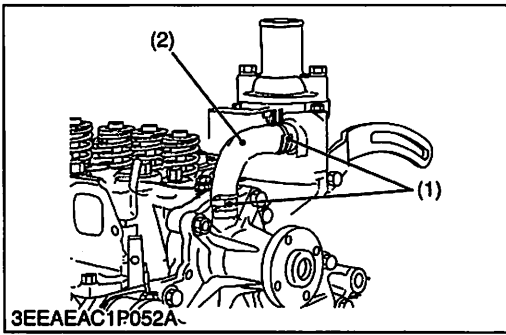
Tightening torque	Rocker arm bracket screw	22 to 26 N·m 2.2 to 2.7 kgf·m 16 to 19 lbf·ft
-------------------	--------------------------	---

- (1) Rocker Arm Assembly
(2) Push Rod
(3) Tappet

- [A] D1005-E4B/E4BG,
D1105-E4B/E4BG,
V1505-E4B/E4BG

- [B] D1305-E4B/E4BG

9Y1210784ENS0034US0



Cylinder Head and Cylinder Head Gasket

1. Loosen the pipe clamps (1), and remove the water return pipe (2).
2. Remove the cylinder head screw in the order of "n" or "r" to "a" and remove the cylinder head.
3. Remove the cylinder head gasket.

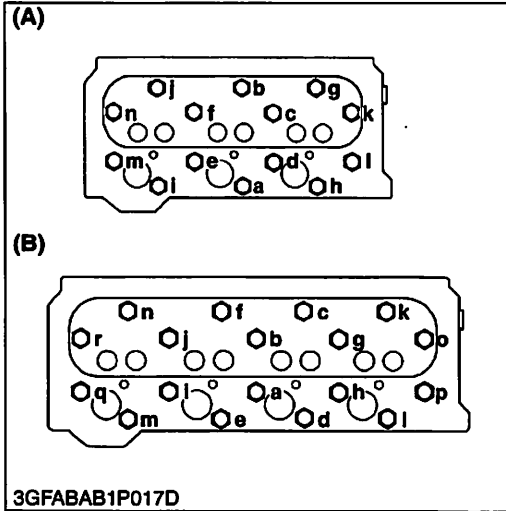
(When reassembling)

- Replace the cylinder head gasket with new one.
- When mounting the gasket, set it to the pin pipe holes. Take care not to mount it reversely.
- The cylinder head should be free of scratches and dust.
- Install the cylinder head, using care not to damage the gasket.
- After applying engine oil to the thread of screws, tighten them in several steps and specified sequence "a" to "n" or "r".

NOTE

- Do not use O-ring on the pin pipe.
- It is not necessary to retighten the cylinder head screw and to readjust valve clearance after engine warmed up.

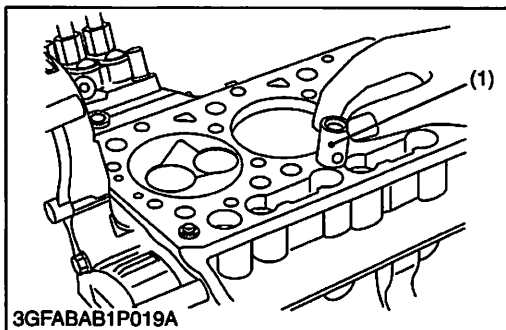
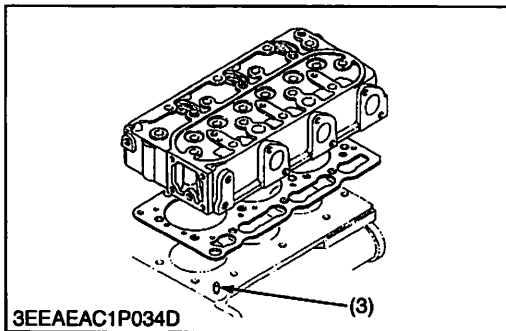
Tightening torque	Cylinder head screw	64 to 68 N·m 6.5 to 7.0 kgf·m 47 to 50 lbf·ft
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- (1) Clamp
- (2) Return Pipe
- (3) Pin Pipe

- (A) 3 Cylinder
- (B) 4 Cylinder
- n or r to a: To Loosen
- a to n or r: To Tighten

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Tappets

1. Remove the tappets (1) from the crankcase.

(When reassembling)

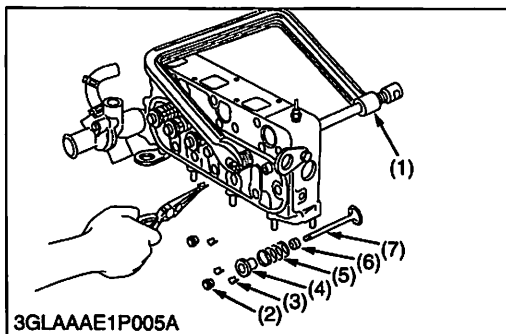
- Visually check the contact between tappets and cams for proper rotation. If problem is found, replace tappets.
- Before installing the tappets, apply engine oil thinly around them.

IMPORTANT

- Do not change the combination of tappet and tappet guide.

- (1) Tappet

9Y1210784ENS0036US0



Valves

1. Remove the valve caps (2).
2. Remove the valve spring collet (3), pushing the valve spring retainer (4) by valve spring replacer (1).
3. Remove the valve spring retainer (4), valve spring (5) and valve stem seal (6).
4. Remove the valve (7).

(When reassembling)

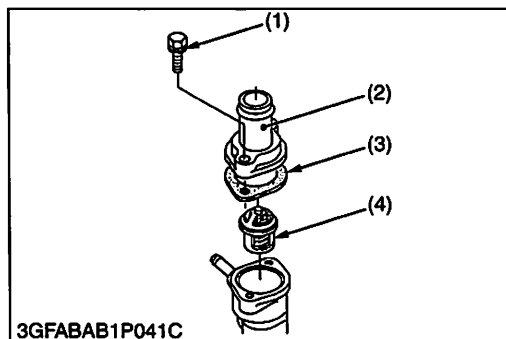
- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

■ IMPORTANT

- Don't change the combination of valve and valve guide.

- | | |
|---------------------------|---------------------|
| (1) Valve Spring Replacer | (5) Valve Spring |
| (2) Valve Cap | (6) Valve Stem Seal |
| (3) Valve Spring Collet | (7) Valve |
| (4) Valve Spring Retainer | |

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Thermostat Assembly

1. Remove the thermostat cover mounting screws (1), and remove the thermostat cover (2).
2. Remove the thermostat assembly (4).

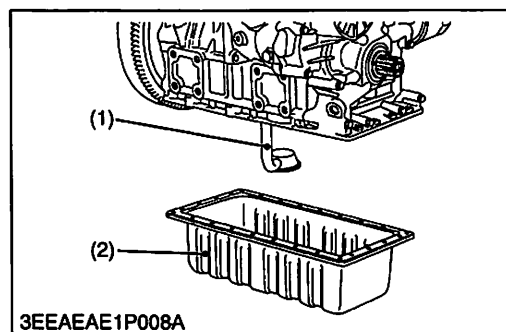
(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the gasket (3).

- | | |
|-------------------------------------|-----------------------------|
| (1) Thermostat Cover Mounting Screw | (3) Thermostat Cover Gasket |
| (2) Thermostat Cover | (4) Thermostat Assembly |

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(4) Gear Case and Timing Gears



Oil Pan and Oil Strainer (for Extended Oil Pan)

1. Remove the oil pan mounting screws.
2. Remove the oil pan (2).
3. Remove the oil strainer (1).

(When reassembling)

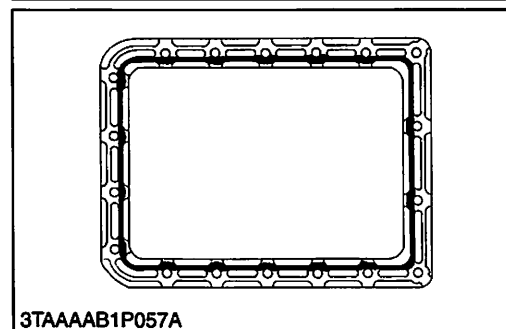
- After cleaning the oil strainer, check to see that the filter mesh is clean, and install it.
- Visually check the O-ring, apply engine oil, and install it.
- Securely fit the O-ring to the oil strainer.
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

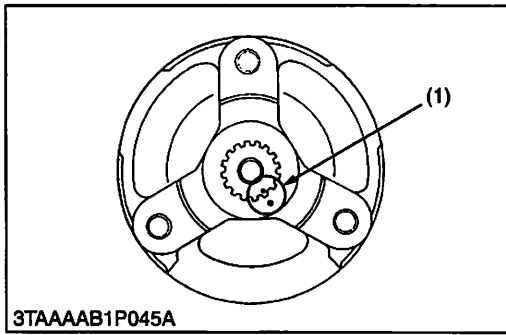
■ IMPORTANT

- **Scrape off the old adhesive completely. Wipe the sealing surface clean using waste cloth soaked with gasoline.**
- **Apply "liquid gasket" (Three Bond 1207D or equivalent) about 3.0 to 5.0 mm (0.12 to 0.19 in.) thick. Within 20 minutes after the application of liquid gasket, reassemble the components.**

- | | |
|------------------|-------------|
| (1) Oil Strainer | (2) Oil Pan |
|------------------|-------------|

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Fan Drive Pulley

1. Secure the flywheel to keep it from turning.
2. Remove the fan drive pulley screw.
3. Draw out the fan drive pulley with a puller.

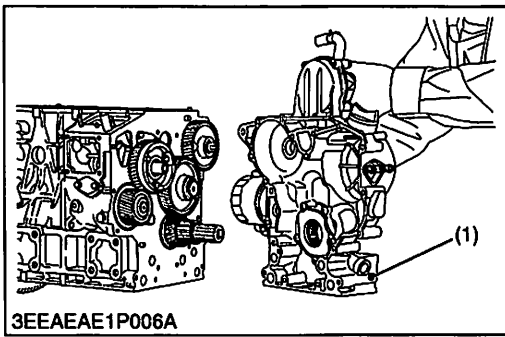
(When reassembling)

- Install the pulley to crankshaft, aligning the mark (1) on them (3-cylinder engine).
- Apply engine oil to the fan drive pulley retaining screw. And tighten it.

Tightening torque	Fan drive pulley screw	236 to 245 N·m 24.0 to 25.0 kgf·m 174 to 180 lbf·ft
-------------------	------------------------	---

(1) Aligning Mark

9Y1210784ENS0040US0



Gear Case

1. Remove the fuel feed pump.
2. Remove the gear case.

(When reassembling)

- Grease thinly to the oil seal, and install it, ensuring the lip does not come off.

(1) Gear Case

a: Bolt Length = 45 mm (1.8 in.)

b: Bolt Length = 50 mm (2.0 in.)

c: Bolt Length = 55 mm (2.2 in.)

d: Bolt Length = 65 mm (2.6 in.)

e: Bolt Length = 68 mm (2.7 in.)

f: Bolt Length = 70 mm (2.8 in.)

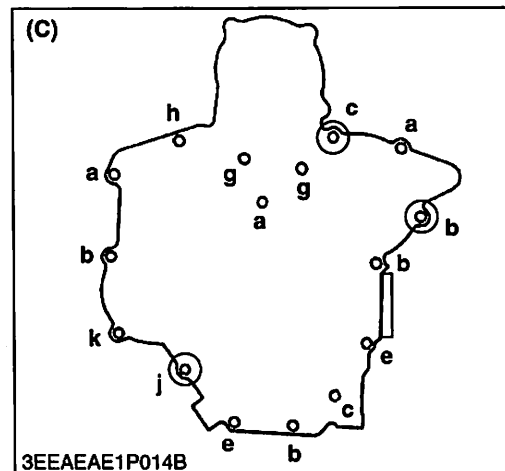
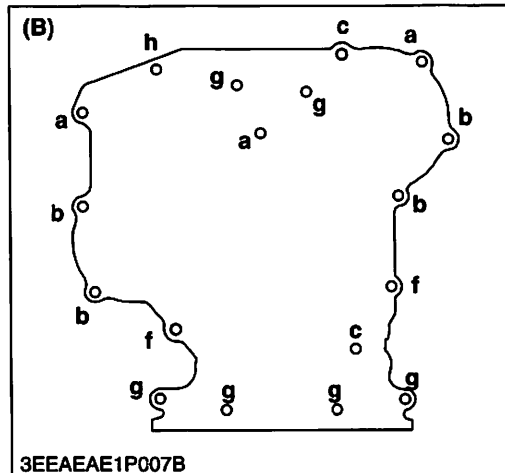
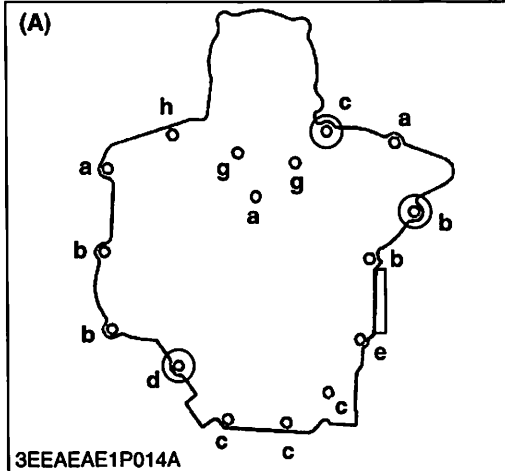
g: Bolt Length = 85 mm (3.3 in.)

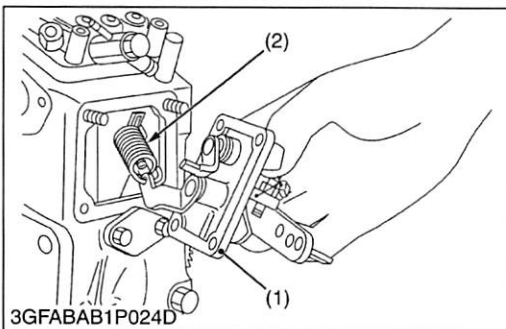
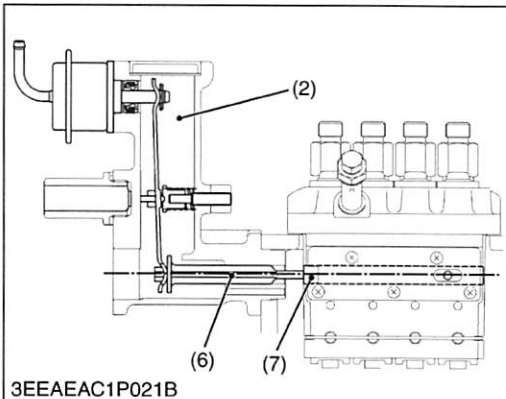
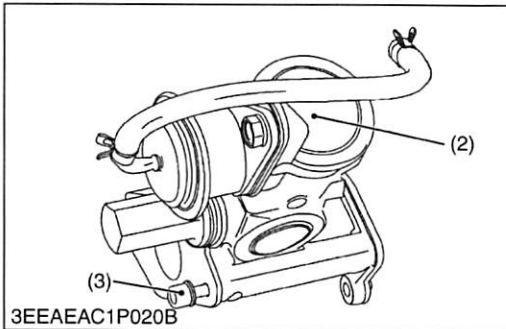
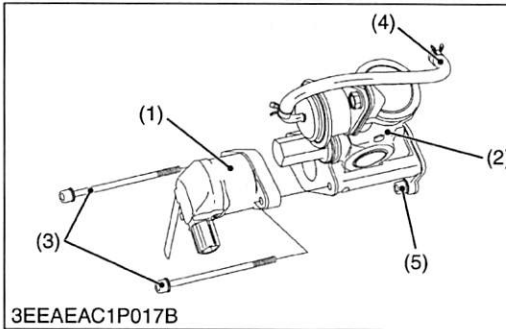
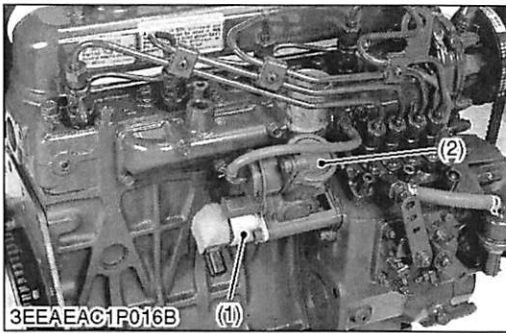
h: Nut

j: Bolt Length = 59 mm (2.3 in.)

k: Bolt Length = 82 mm (3.2 in.)

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Boost Compensator (equipped with R24 Model)

■ IMPORTANT

- Use the stop solenoid mounting bolt (3) for the dropout prevention of boost compensator (2) and the damage prevention of the guide (6) when detach the boost compensator.
- The guide (6) of boost compensator and the control rack (7) should be made the level when you install boost compensator assembly.

1. Disconnect the hose (4).
2. Remove the stop solenoid mounting bolt (M6 × 87 mm) (3).
3. Remove the stop solenoid (1).
4. Install the stop solenoid mounting bolt (3) in an original position again.
5. Remove the boost compensator mounting bolt (5).
6. Detach the boost compensator assembly (2).
7. Remove the stop solenoid mounting bolt (3) with boost compensator assembly (2).

(When reassembling)

1. Install the stop solenoid mounting bolt (3) in boost compensator assembly (2) and assemble it to the boost compensator installation position at the same time.
2. Tighten the boost compensator mounting bolt (5).
3. Remove the stop solenoid mounting bolt (3).
4. Install the stop solenoid (1) and tighten the mounting bolt (3).

■ NOTE

- Apply a liquid gasket (Three Bond 1217D or equivalent) to the boost compensator body.

- | | |
|---------------------------------|-------------------------------------|
| (1) Stop Solenoid | (5) Boost Compensator Mounting Bolt |
| (2) Boost Compensator Assembly | (6) Guide |
| (3) Stop Solenoid Mounting Bolt | (7) Control Rack |
| (4) Hose | |

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Speed Control Plate

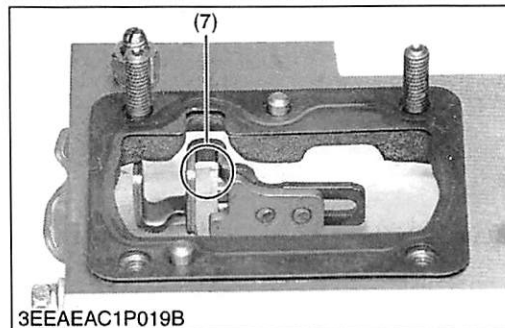
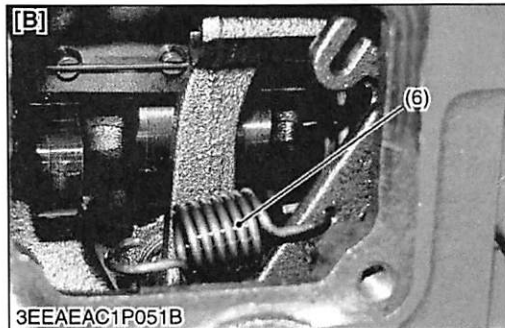
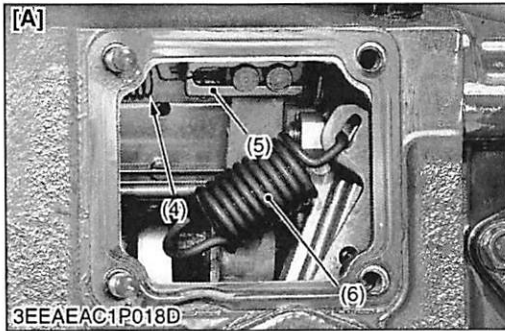
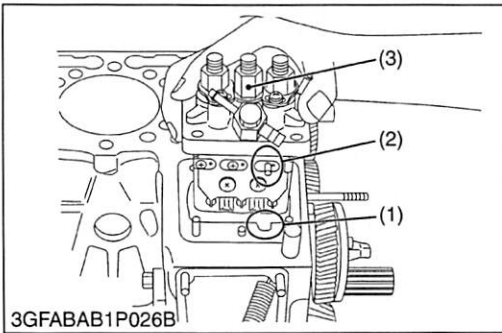
1. Remove the engine stop solenoid (without R24 model).
2. Remove the speed control plate (1).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the solenoid cover gasket and control plate gasket.
- Be careful not to drop the governor spring (2) into the crankcase.

- | | |
|-----------|---------------------|
| (1) Plate | (2) Governor Spring |
|-----------|---------------------|

9Y1210784ENS0042US0



Injection Pump

1. Disconnect the start spring (4) on the thrust lever side (5).
2. Align the control rack pin (2) with the notch (1) on the crankcase, and remove the injection pump (3).
3. Remove the injection pump shims.
4. In principle, the injection pump should not be disassembled.

(When reassembling)

- When installing the injection pump, insert the control rack pin (2) firmly into the groove (7) of the thrust lever of fork lever.

NOTE

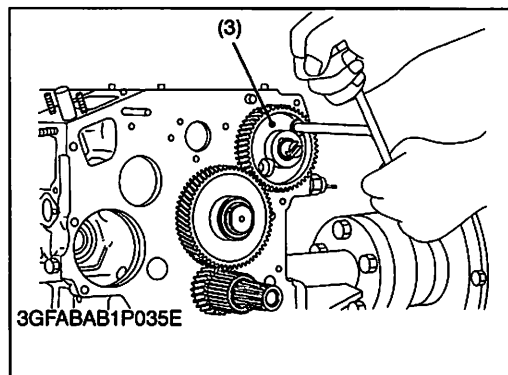
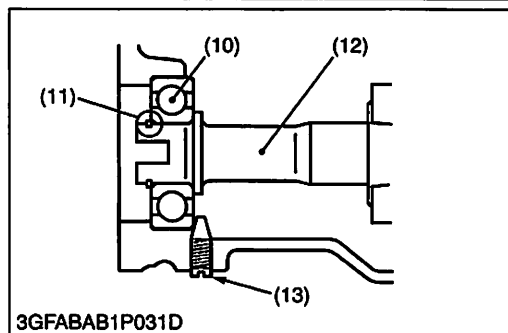
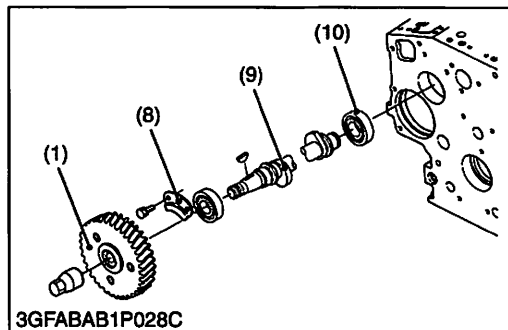
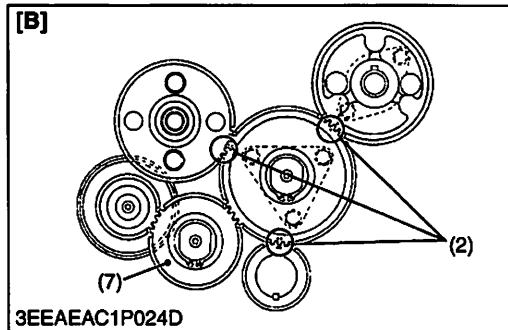
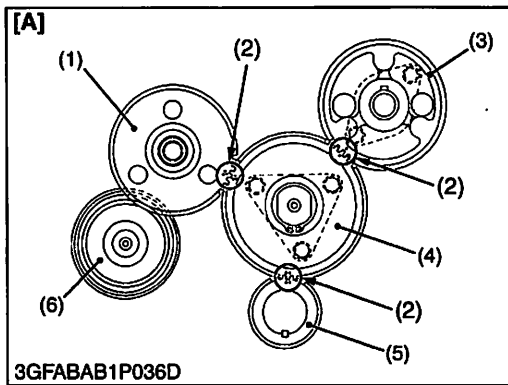
- Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).
- In disassembling and replacing, be sure to use the same number or new gasket shims with the same thickness.

- (1) Notch
 (2) Control Rack Pin
 (3) Injection Pump
 (4) Start Spring
 (5) Thrust Lever
 (6) Governor Spring
 (7) Groove

[A] Basic Model

[B] BG Model

9Y1210784ENS0043US0



Cam Gear, Idle Gear 1, 2 and Governor Gear

1. Remove the idle gear 2 (7) / idle gear 1 (4).
2. Remove the fuel camshaft stopper (8).
3. Draw out the fuel cam gear (1) with fuel camshaft (9).
4. Remove the camshaft stopper bolt.
5. Remove the cam gear (3) with camshaft.
6. Remove the external snap ring (11) from the governor shaft (12).
7. Remove the governor gear (6) with governor shaft (12).

NOTE

Three-lever type fork lever

To remove the governor shaft, follow the procedures in 5, 6 above and never remove fork lever and the max torque limiter.

(When reassembling)

- Apply engine oil thinly to the fuel camshaft before installation.
- Make sure to assemble the external snap ring of the governor shaft.
- Check the governor shaft for smooth rotation.

IMPORTANT

- There is a model of idle gear 1 (4) and idle gear 2 (7) by the difference of the method of transmission the power to the governor gear (6).
- When replacing the ball bearing of governor shaft, securely fit the ball bearing (10) to the crankcase, apply an adhesive (Three Bond 1324B or equivalent) to the set screw (13), and fasten the screw until its tapered part contacts the circumferential end of the ball bearing.
- When installing the idle gear, be sure to align the alignment marks on each gears.

- (1) Fuel Cam Gear
- (2) Alignment Mark
- (3) Cam Gear
- (4) Idle Gear 1
- (5) Crank Gear
- (6) Governor Gear
- (7) Idle Gear 2
- (8) Fuel Camshaft Stopper

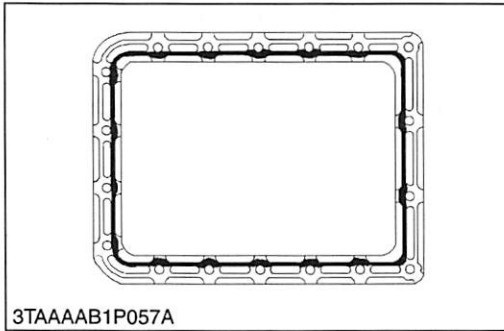
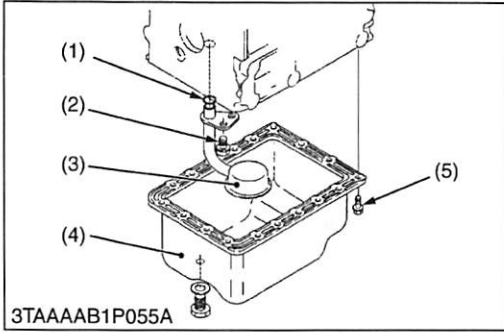
- (9) Fuel Camshaft
- (10) Ball Bearing
- (11) External Snap Ring
- (12) Governor Shaft
- (13) Set Screw

[A] One Idle Gear Type

[B] Two Idle Gear Type

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(5) Piston and Connecting Rod



Oil Pan and Oil Strainer (for Standard Oil Pan)

1. Remove the oil pan mounting screws (5).
2. Remove the oil pan (4).
3. Remove the oil strainer (3).

(When reassembling)

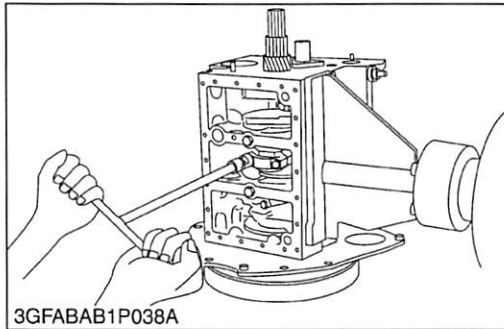
- After cleaning the oil strainer, check to see that the filter mesh is clean, and install it.
- Visually check the O-ring (1), apply engine oil, and install it.
- Securely fit the O-ring to the oil strainer.
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

■ IMPORTANT

- Scrape off the old adhesive completely. Wipe the sealing surface clean using waste cloth soaked with gasoline.
- Apply "liquid gasket" (Three Bond 1207D or equivalent) about 3.0 to 5.0 mm (0.12 to 0.19 in.) thick. Within 20 minutes after the application of liquid gasket, reassemble the components.

- | | |
|------------------|----------------------------|
| (1) O-ring | (4) Oil Pan |
| (2) Screw | (5) Oil Pan Mounting Screw |
| (3) Oil Strainer | |

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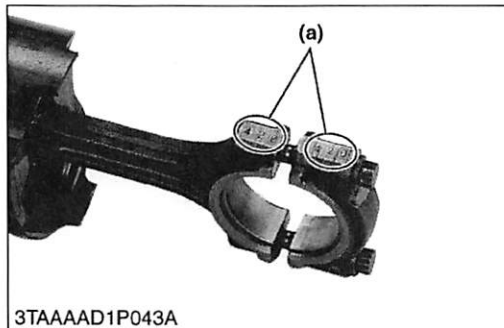


Connecting Rod

1. Remove the connecting rod cap.

(When reassembling)

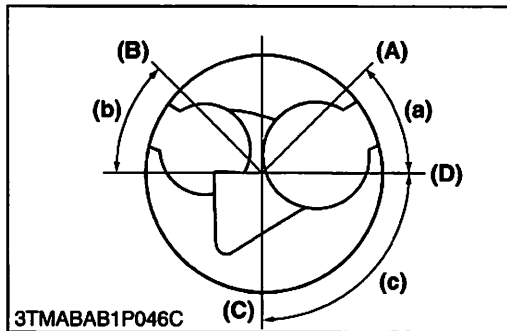
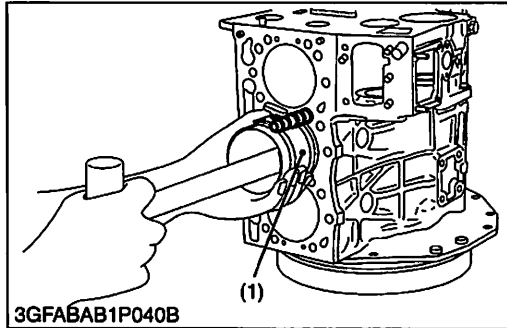
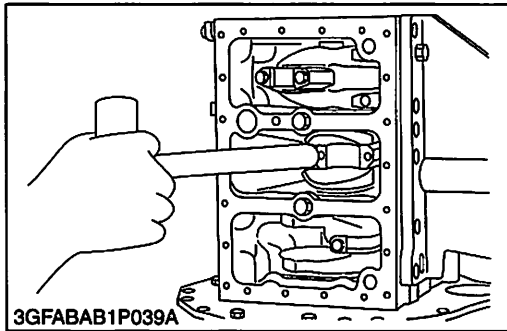
- Align the marks (a) with each other. (Face the marks toward the injection pump.)
- Apply engine oil to the connecting rod screws and lightly screw it in by hand, then tighten it to the specified torque.
If the connecting rod screw won't be screwed in smoothly, clean the threads.
If the connecting rod screw is still hard to screw in, replace it.



Tightening torque	Connecting rod screw	42 to 46 N·m 4.2 to 4.7 kgf·m 31 to 33 lbf·ft
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(a) Mark

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Pistons

1. Turn the flywheel and bring the piston to top dead center.
2. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
3. Draw out the other piston in the same method as above.

(When reassembling)

- Before inserting the piston into the cylinder, apply enough engine oil to the piston.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

■ IMPORTANT

- Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No.1 piston.
- When installing the piston into the cylinder, place the gaps of all the piston rings as shown in the figure.
- Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section may be scratched, causing trouble inside the cylinder.

(1) Piston Ring Compressor

(a) 0.79 rad (45 °)

(b) 0.79 rad (45 °)

(c) 1.6 rad (90 °)

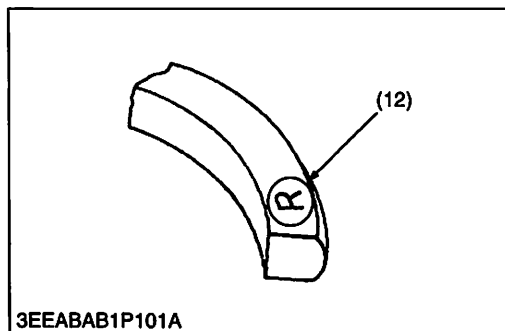
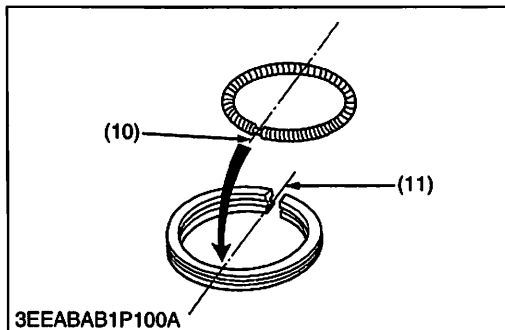
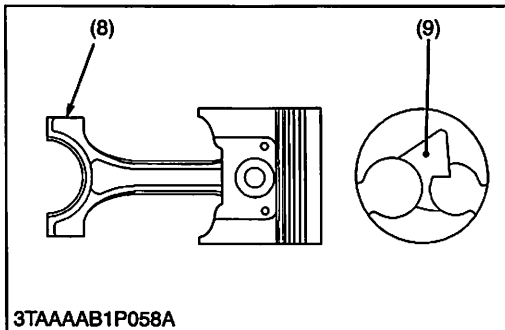
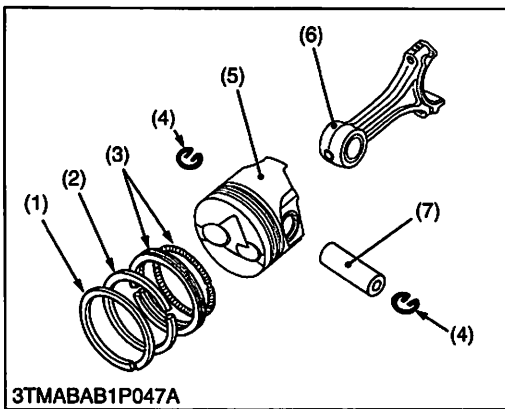
(A) Top Ring Gap

(B) Second Ring Gap

(C) Oil Ring Gap

(D) Piston Pin Hole

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Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (7), and separate the connecting rod (6) from the piston (5).

(When reassembling)

- When installing the ring, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin.
- When installing the connecting rod to the piston, immerse the piston in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin to the piston.
- When installing the connecting rod to the piston, align the mark (8) on the connecting rod to the fan-shaped concave (9).

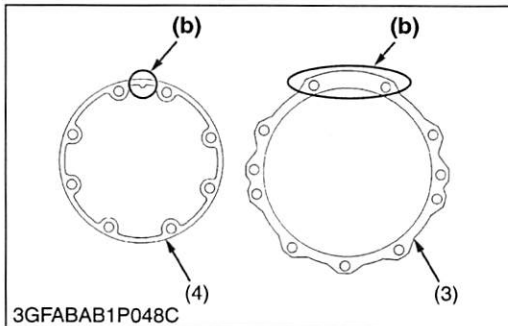
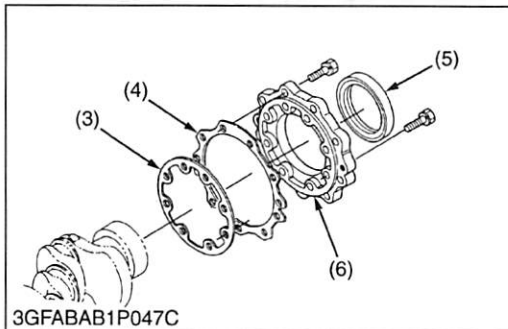
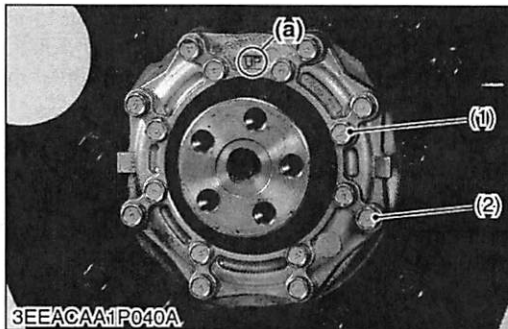
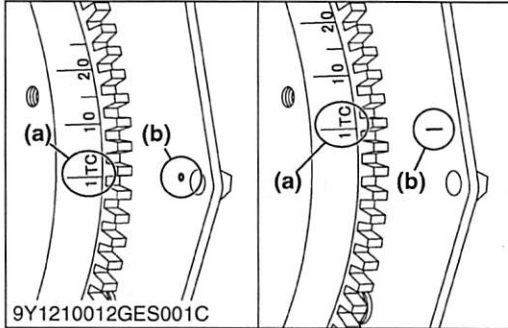
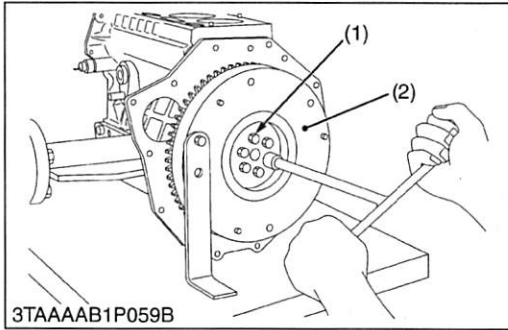
NOTE

- **Mark the same number on the connecting rod and the piston so as not to change the combination.**

- | | |
|--------------------------|--------------------------|
| (1) Top Ring | (7) Piston Pin |
| (2) Second Ring | (8) Mark |
| (3) Oil Ring | (9) Fan-shaped Concave |
| (4) Piston Pin Snap Ring | (10) Expander Joint |
| (5) Piston | (11) Oil Ring Gap |
| (6) Connecting Rod | (12) Manufacturer's Mark |

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(6) Flywheel and Crankshaft



Flywheel

1. Secure the flywheel to keep it from turning, using a flywheel stopper.
2. Remove all flywheel screws (1) and then remove the flywheel (2).

(When reassembling)

- Align the "1TC" mark (a) on the outer surface of the flywheel horizontally with the alignment mark (b) on the rear end plate. Now fit the flywheel in position.
- Apply engine oil to the threads and the undercut surface of the flywheel screw and fit the screw.

Tightening torque	Flywheel screw	54 to 58 N·m 5.5 to 6.0 kgf·m 40 to 43 lbf·ft
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- (1) Flywheel Screw
(2) Flywheel

- (a) 1TC Mark
(b) Alignment Mark

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Bearing Case Cover

1. Remove the bearing case cover mounting screws.
2. Remove the bearing case cover (6).

■ IMPORTANT

- The length of inside screws (1) and outside screws (2) are different. Do not teke a mistake using inside screws and outside screws.

(When reassembling)

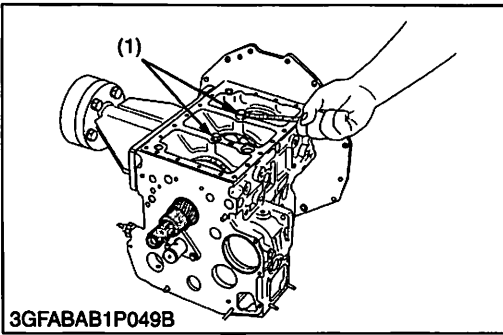
- Fit the bearing case gasket (3) and the bearing case cover gasket (4) with correct directions.
- Install the bearing case cover (6) to position the casting mark "UP" on it upward.
- Apply engine oil to the oil seal (5) lip and take care that it is not rolled when installing.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

Tightening torque	Bearing case cover mounting screw	10.8 to 12.2 N·m 1.10 to 1.25 kgf·m 7.96 to 9.04 lbf·ft
-------------------	-----------------------------------	---

- (1) Bearing Case Cover Mounting Screw (Inside) (Long)
(2) Bearing Case Cover Mounting Screw (Outside) (Short)
(3) Bearing Case Gasket
(4) Bearing Case Cover Gasket

- (5) Oil Seal
(6) Bearing Case Cover
(a) Top Mark "UP"
(b) Upside

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Crankshaft Assembly (except D1305-E4B/E4BG)

1. Remove the main bearing case screw 2 (1).
2. Pull out the crankshaft assembly.

■ **IMPORTANT**

- Take care to protect crankshaft bearing 1 from scratches, caused by the crank gear, etc.. (Wrap the gear in vinyl tape, etc.)

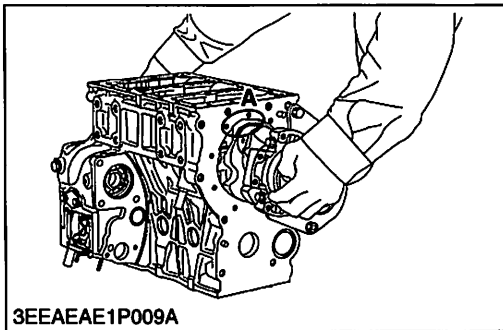
(When reassembling)

- Clean the oil passage of the crankshaft with compressed air.
- Apply oil to the main bearing case screw 2 (1).
- Install the crankshaft assembly, aligning the screw hole of main bearing case with the screw hole of crankcase.

Tightening torque	Main bearing case screw 2	49 to 53 N·m 5.0 to 5.5 kgf·m 37 to 39 lbf·ft
-------------------	---------------------------	---

(1) Main Bearing Case Screw 2

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Crankshaft Assembly (D1305-E4B/E4BG)

1. Remove the main bearing case screw 2.
2. Turn the crankshaft to set the crankpin of the third cylinder to the "A". Then draw out the crankshaft until the crankpin of the second cylinder comes to the center of the third cylinder.
3. Turn the crankshaft by 2.09 rad (120 °) counterclockwise to set the crankpin of the second cylinder to the "A". Draw out the crankshaft until the crankpin of the first cylinder comes to the center of third cylinder.
4. Repeat the above steps to draw out all the crankshaft.

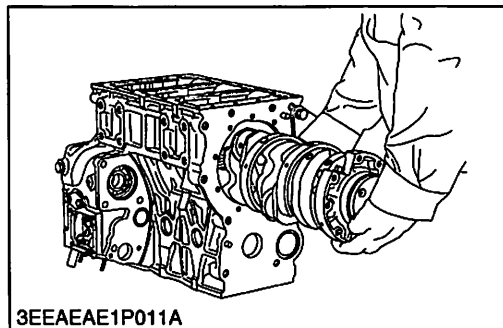
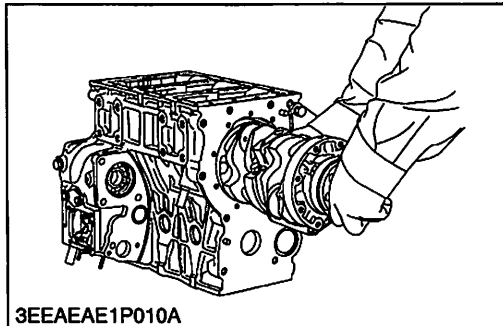
(When reassembling)

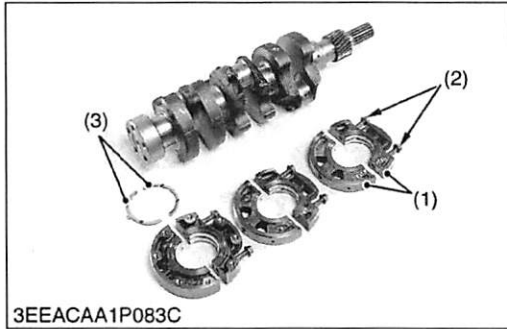
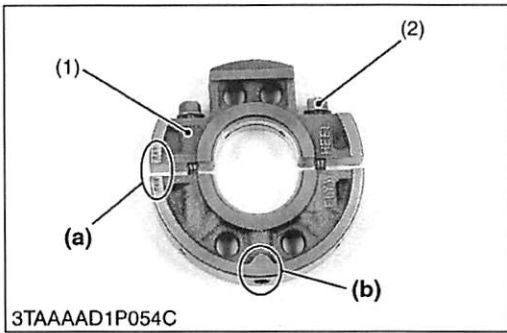
- Clean the oil passage of the crankshaft with compressed air.
- Install the crankshaft assembly, aligning the screw hole of main bearing case screw 2 with the screw hole of crankcase.
- When tightening the main bearing case 2, apply oil to the main bearing case screw 2 and screw by hand before tightening the specific torque. If not smooth to screw by hand, align the screw holes between the crankcase and the main bearing case.

Tightening torque	Main bearing case screw 2	49 to 53 N·m 5.0 to 5.5 kgf·m 37 to 39 lbf·ft
-------------------	---------------------------	---

A: Cut place for removing and installing the crankshaft

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Main Bearing Case Assembly

1. Remove the two main bearing case screws 1 (2) of each main bearing cases.
2. Remove the main bearing case from crankshaft.

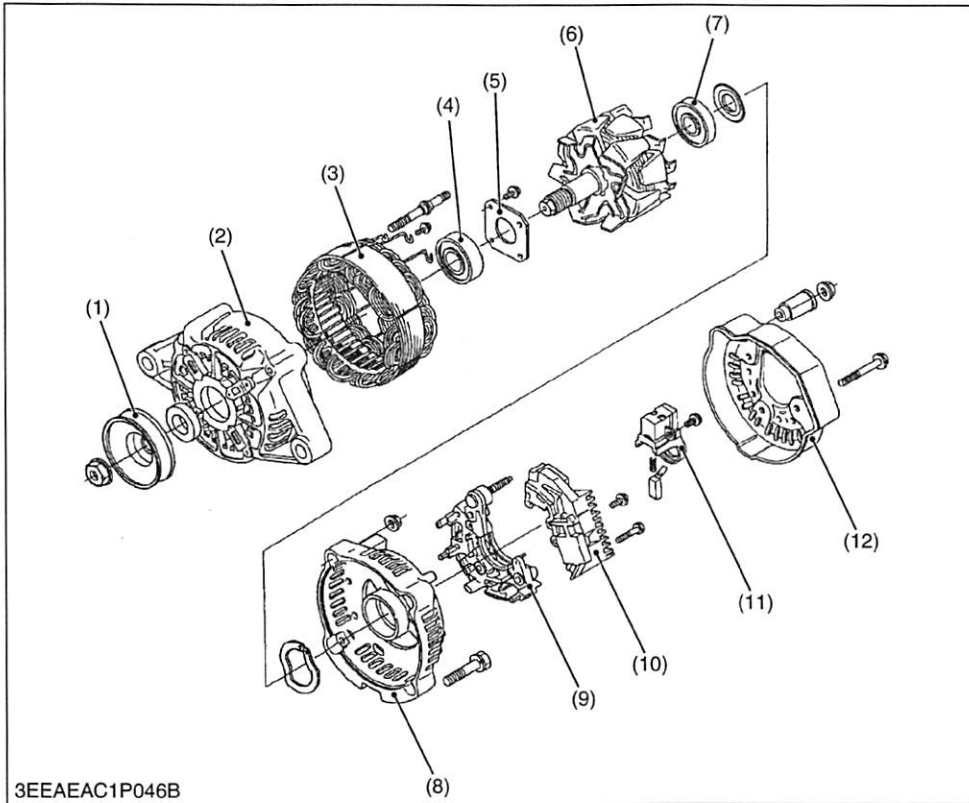
(When reassembling)

- Clean the oil passage in the main bearing cases.
- Apply clean engine oil on the bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of markings (b) (A, B, C) from the gear case side.
- Match the alignment numbers (a) on the main bearing case assembly 1.
- When installing the main bearing case 1 and 2, face the mark "FLYWHEEL" to the flywheel.
- Install the thrust bearing (3) with its oil groove facing outward.
- Confirm that the main bearing case moves smoothly after tightening the main bearing case screw 1 to the specified torque.

Tightening torque	Main bearing case screw 1	30 to 34 N·m
		3.0 to 3.5 kgf·m
		22 to 25 lbf·ft

- (1) Main Bearing Case Assembly 1 (a) Alignment Number
- (2) Main Bearing Case Screw 1 (b) Marking (A, B, C)
- (3) Thrust Bearing

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(7) Alternator

- (1) Pulley
- (2) Drive End Frame
- (3) Stator
- (4) Bearing
- (5) Retainer Plate
- (6) Rotor
- (7) Bearing
- (8) Rear End Frame
- (9) Rectifier
- (10) IC Regulator
- (11) Brush Holder
- (12) Rear End Cover

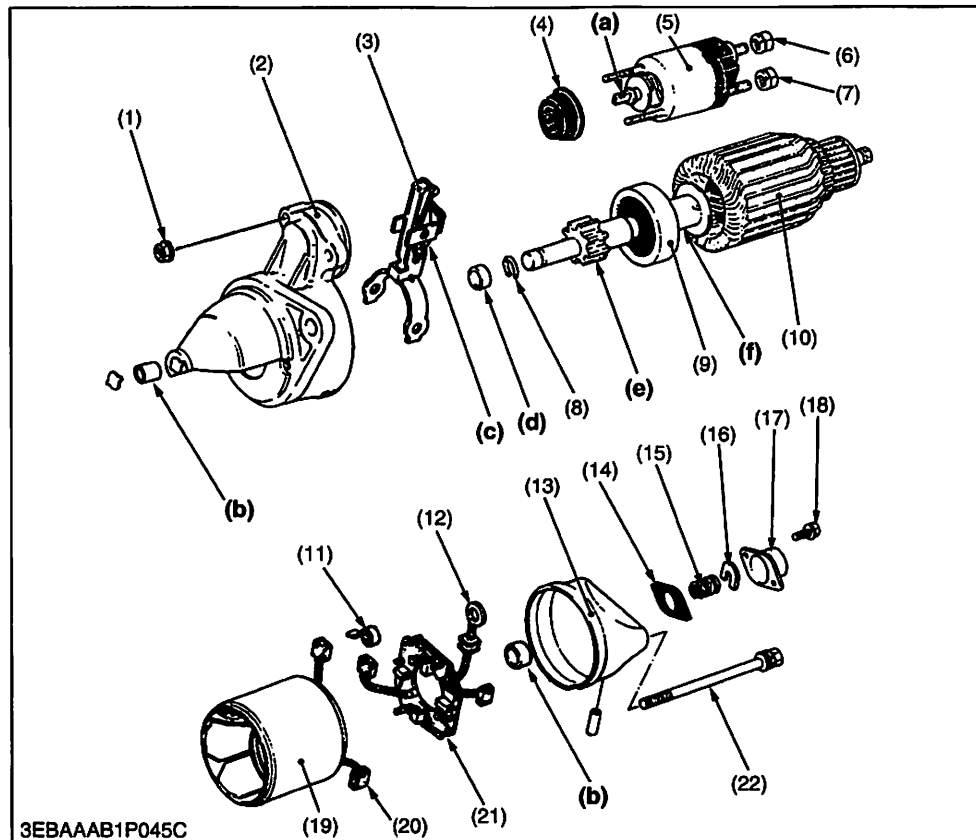
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1. Remove the pulley (1).
2. Remove the rear end cover (12).
3. Remove the brush holder (11).
4. Remove the IC regulator (10).
5. Remove the four screws holding the stator lead wires.
6. Remove the rectifier (9).
7. Remove the rear end frame (8).
8. Press out the rotor (6) from drive end frame (2).
9. Remove the retainer plate (5).
10. Press out the bearing (4) from drive end frame (2) with a press and jig.
11. Lightly secure the rotor with a vise to prevent damage, and remove the bearing (7) with a puller.

(When reassembling)

Tightening torque	Pulley nut	58.4 to 78.9 N·m 5.95 to 8.05 kgf·m 43.1 to 58.2 lbf·ft
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(8) Starter**Electromagnetic Drive Type**

- (1) Solenoid Switch Mounting Nut
- (2) Starter Drive Housing
- (3) Drive Lever
- (4) Gasket
- (5) Solenoid Switch
- (6) B Terminal Nut
- (7) C Terminal Nut
- (8) Snap Ring
- (9) Overrunning Clutch
- (10) Armature
- (11) Brush Spring
- (12) Connecting Lead
- (13) Rear End Frame
- (14) Gasket
- (15) Brake Spring
- (16) Brake Shoe
- (17) End Frame Cap
- (18) Screw
- (19) Yoke
- (20) Brush
- (21) Brush Holder
- (22) Through Bolt

3EBAAAB1P045C

1. Unscrew the C terminal nut (7), and disconnect the connecting lead (12).
2. Unscrew the solenoid switch mounting nuts (1), and remove the solenoid switch (5).
3. Remove the end frame cap (17).
4. Remove the brake shoe (16), brake spring (15) and gasket (14).
5. Unscrew the through bolts (22), and remove the rear end frame (13).
6. Remove the brush from the brush holder while holding the spring up.
7. Remove the brush holder (21).
8. Draw out the yoke (19) from the starter drive housing (2).
9. Draw out the armature (10) with the drive lever (3).

NOTE

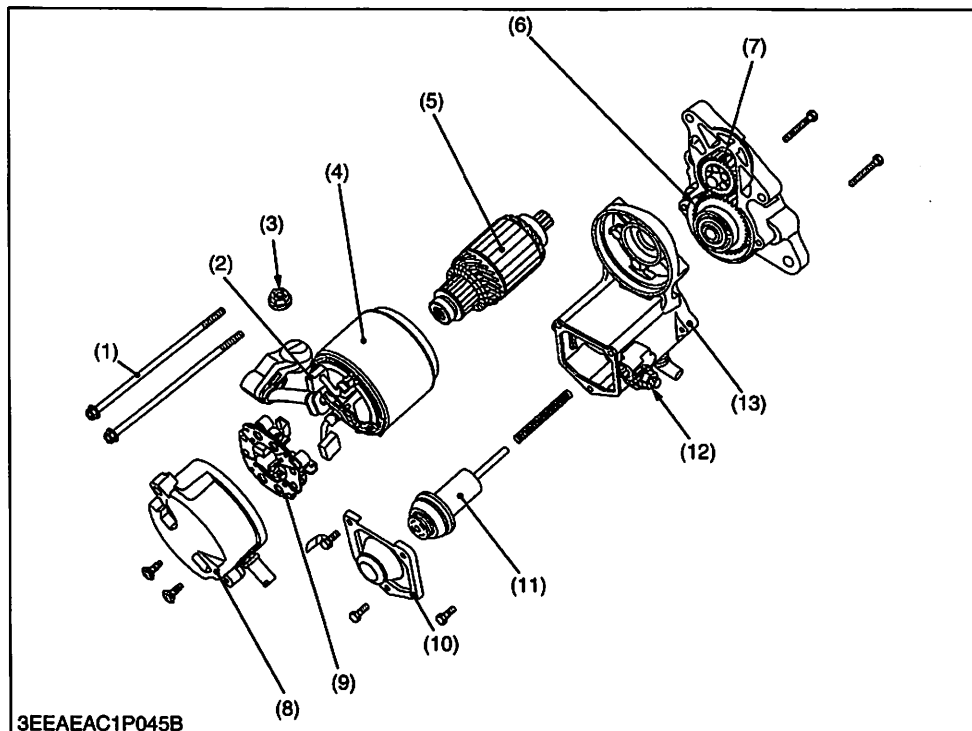
- Do not damage to the brush and commutator.

(When reassembling)

- Apply grease (DENSO.CO.LTD. No. 50 or equivalent) to the parts indicated in the figure.
 - Joint of solenoid switch (a)
 - Bushing (b)
 - Drive lever (c)
 - Collar (d)
 - Teeth of pinion gear (e)
 - Armature shaft (f)

Tightening torque	B terminal nut	5.88 to 11.8 N·m 0.600 to 1.20 kgf·m 4.34 to 8.70 lbf·ft
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Gear Reduction Type

- (1) Through Bolt
- (2) Brush
- (3) C Terminal Nut
- (4) Yoke
- (5) Armature
- (6) Overrunning Clutch
- (7) Idle Gear
- (8) End Frame
- (9) Brush Holder
- (10) Magnet Switch Cover
- (11) Plunger
- (12) B Terminal Nut
- (13) Housing

1. Unscrew the C terminal nut (3), and disconnect the connecting lead.
2. Remove the two through bolts (1).
3. Detach the motor.
4. Remove the end frame (8).
5. Remove the brush from the brush holder while holding the spring up.
6. Remove the brush holder (9).
7. Draw out the armature (5) from the yoke (4).
8. Remove the housing (13).
9. Remove the idle gear (7) and the overrunning clutch (6).
10. Remove the magnet switch cover (10).
11. Remove the plunger (11).

■ **NOTE**

- Do not damage to the brush and commutator.

(When reassembling)

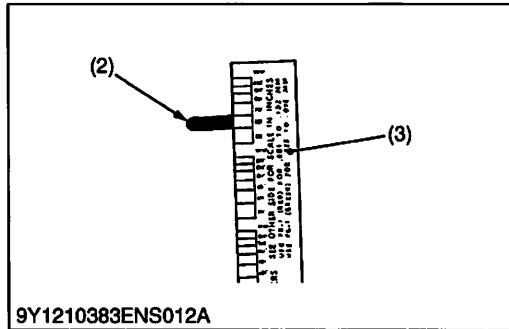
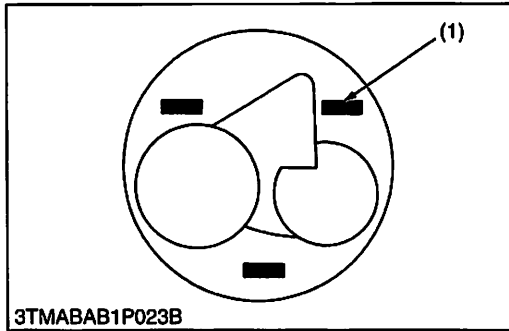
- Apply grease (DENSO No. 50 or equivalent) to the idle gear and overrunning clutch portions.

Tightening torque	B terminal nut	5.88 to 11.8 N·m 0.600 to 1.20 kgf·m 4.34 to 8.70 lbf·ft
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[3] SERVICING

(1) Cylinder Head and Valves



Top Clearance

1. Remove the cylinder head.
2. With the piston at TDC, use grease to affix three or four plastigauges (1) of a diameter 1.5 mm (0.059 in.) × 5.0 to 7.0 mm (0.20 to 0.27 in.) long to the crown of the piston; keep the gauges away from the intake valve and combustion chamber fittings.
3. Take the piston to an intermediate position, install the cylinder head and tighten the head bolts to the specified torque.
4. Turn the crankshaft so the piston goes through TDC.
5. Remove the cylinder head and compare the width of the crushed plastigauges (2) with the scale.
6. If they are out of spec, check the oil clearance of the crank pin, journals and piston pins.

■ **NOTE**

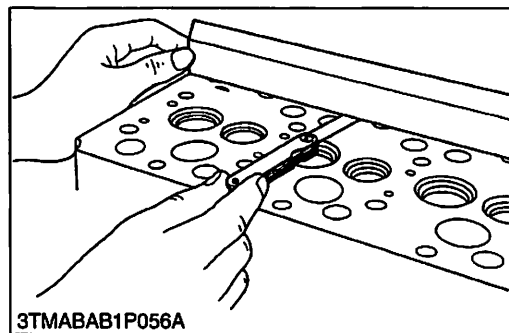
- Top clearance = Width of the crushed plastigauge (2).

Top clearance	Factory specification	D1005-E4B/ E4BG D1105-E4B/ E4BG V1505-E4B/ E4BG	0.55 to 0.75 mm 0.022 to 0.029 in.
		D1305-E4B/ E4BG	0.80 to 1.0 mm 0.032 to 0.039 in.

Tightening torque	Cylinder head screw	64 to 68 N·m 6.5 to 7.0 kgf·m 47 to 50 lbf·ft
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- (1) Plastigauge (3) Scale
(2) Crushed Plastigauge

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Cylinder Head Surface Flatness

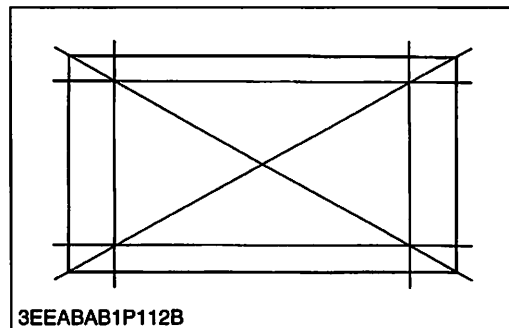
1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure.
3. Measure the clearance with a thickness gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

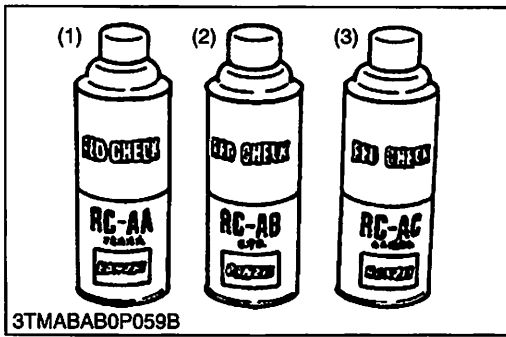
■ **IMPORTANT**

- Do not place the straightedge on the combustion chamber.
- Be sure to check the valve recessing after correcting.

Cylinder head surface flatness	Allowable limit	0.05 mm 0.002 in.
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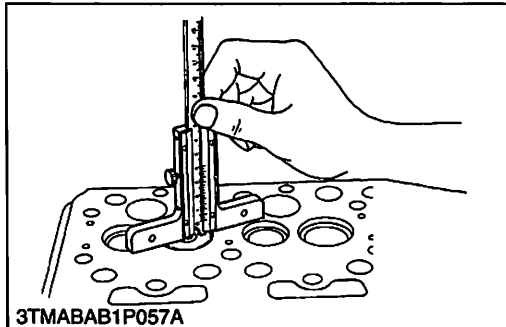


Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with white developer (3).
6. If flawed, it can be identified as red marks.

- (1) Red Permeative Liquid (3) White Developer
 (2) Detergent

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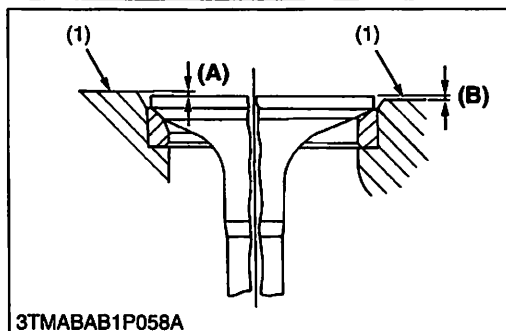
Valve Recessing

1. Clean the cylinder head surface, valve face and valve seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

Valve recessing	Factory specification	0.050 (protrusion) to 0.25 (recessing) mm 0.0020 (protrusion) to 0.0098 (recessing) in.
	Allowable limit	0.40 (recessing) mm 0.016 (recessing) in.

- (1) Cylinder Head Surface (A) Recessing
 (B) Protrusion

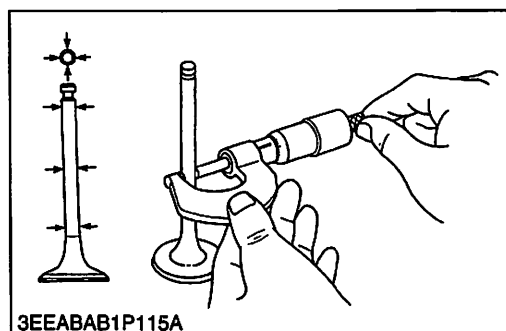
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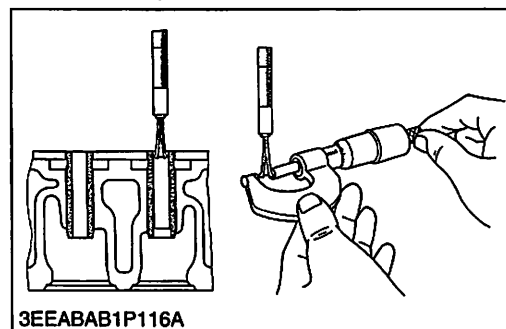
Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

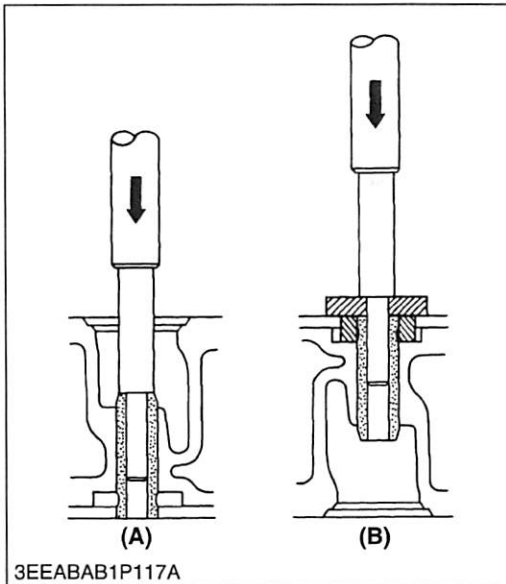
Clearance between valve stem and valve guide	Factory specification	0.035 to 0.065 mm 0.0014 to 0.0025 in.
	Allowable limit	0.10 mm 0.0039 in.



Valve stem O.D.	Factory specification	6.960 to 6.975 mm 0.2741 to 0.2746 in.
Valve guide I.D.	Factory specification	7.010 to 7.025 mm 0.2760 to 0.2765 in.



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Replacing Valve Guide

(When removing)

1. Press out the used valve guide using a valve guide replacing tool. (See page "SPECIAL TOOLS".)

(When installing)

1. Clean a new valve guide and valve guide bore, and apply engine oil to them.
2. Press fit a new valve guide using a valve guide replacing tool.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

Valve guide I.D. (Intake and exhaust)	Factory specification	7.010 to 7.025 mm 0.2760 to 0.2765 in.
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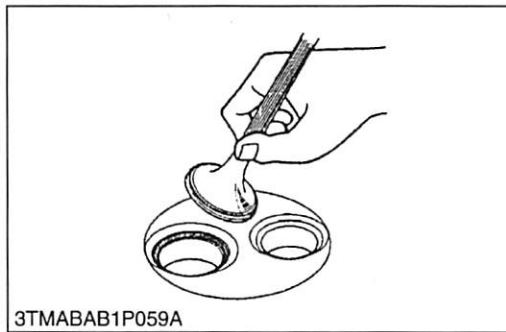
NOTE

- Do not hit the valve guide with a hammer during replacement.

(A) When Removing

(B) When Installing

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Valve Seating

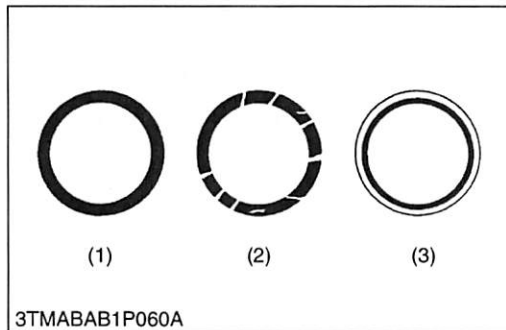
1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact.
2. If the valve does not seat all the way around the valve seat or the valve contact is less than 70 %, correct the valve seating as follows.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.

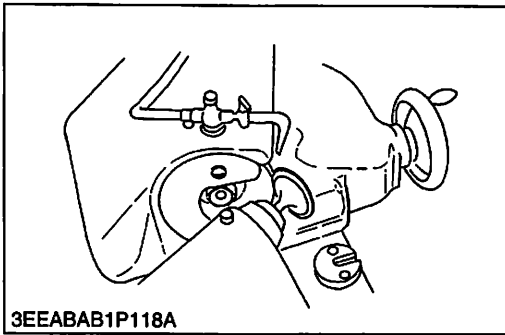
Valve seat width	Factory specification	2.12 mm 0.0835 in.
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- (1) Correct
(2) Incorrect

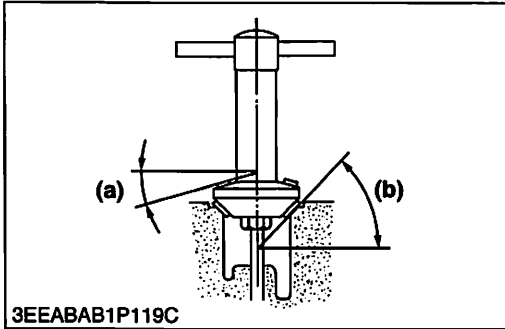
(3) Incorrect

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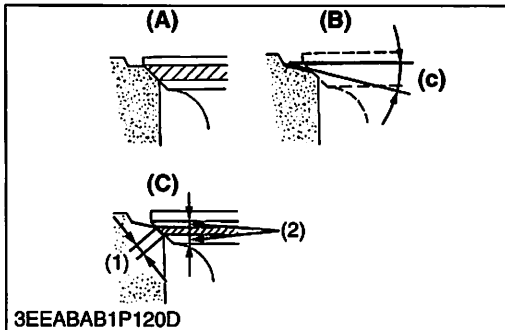




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3EEABAB1P119C



3EEABAB1P120D

Correcting Valve and Valve Seat

NOTE

- Before correcting the valve and seat, check the valve stem and the I.D. of valve guide section, and repair them if necessary.
- After correcting the valve seat, be sure to check the valve recessing.

(1) Correcting Valve

1. Correct the valve with a valve refacer.

Valve face angle	Factory specification	IN.	1.0 rad 60°
		EX.	0.79 rad 45°

(2) Correcting Valve Seat

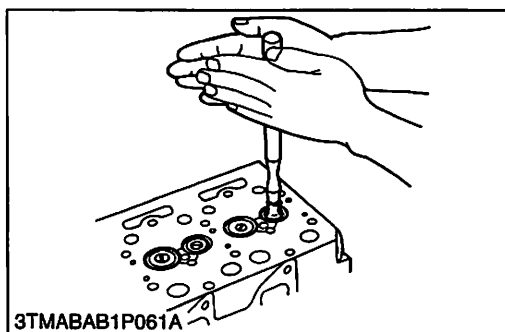
1. Slightly correct the seat surface with a 1.0 rad (60°) (intake valve) or 0.79 rad (45°) (exhaust valve) valve seat cutter.
2. Resurface the seat surface with a 0.52 rad (30°) valve seat cutter to intake valve seat and with a 0.26 rad (15°) valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width (2.12 mm, 0.0835 in.)
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

Valve seat angle	Factory specification	IN.	1.0 rad 60°
		EX.	0.79 rad 45°

- (1) Valve Seat Width
(2) Identical Dimensions

- (A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.26 rad (15°) or 0.52 rad (30°)
(b) 0.79 rad (45°) or 1.0 rad (60°)
(c) 0.52 rad (30°) or 0.26 rad (15°)

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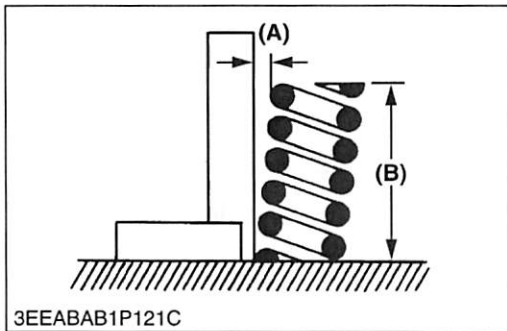
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the seated rate. If it is less than 70 %, repeat valve lapping again.

IMPORTANT

- When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.

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Free Length and Tilt of Valve Spring

1. Measure the free length (B) of valve spring with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the valve spring on a surface plate, place a square on the side of the valve spring.
3. Check to see if the entire side is in contact with the square. Rotate the valve spring and measure the maximum tilt (A). If the measurement exceeds the allowable limit, replace it.
4. Check the entire surface of the valve spring for scratches. If there is any problem, replace it.

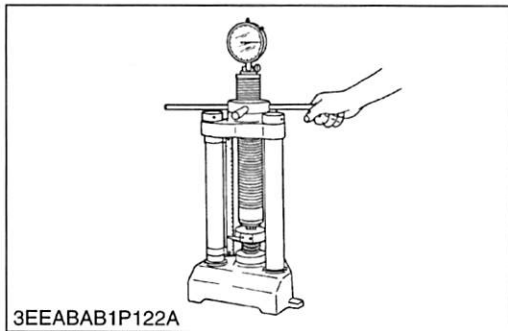
Tilt (A)	Allowable limit	1.0 mm 0.039 in.
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Free length (B)	Factory specification	37.0 to 37.5 mm 1.46 to 1.47 in.
	Allowable limit	36.5 mm 1.44 in.

(A) Tilt

(B) Free Length

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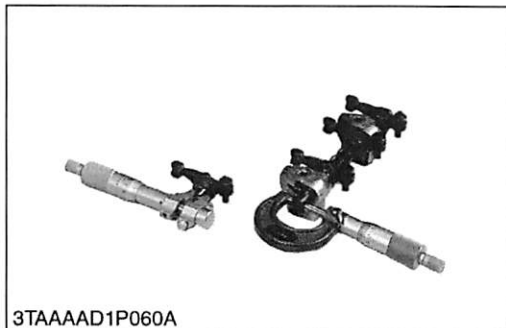
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Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / Setting length	Factory specification	117.4 N / 31.0 mm 11.97 kgf / 31.0 mm 26.39 lbf / 1.22 in.
	Allowable limit	100.0 N / 31.0 mm 10.20 kgf / 31.0 mm 22.48 lbf / 1.22 in.

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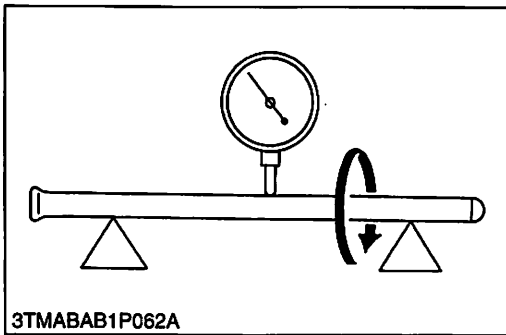
Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm I.D. with an inside micrometer, and then calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory specification	0.016 to 0.045 mm 0.00063 to 0.0017 in.
	Allowable limit	0.10 mm 0.0039 in.

Rocker arm shaft O.D.	Factory specification	11.973 to 11.984 mm 0.47138 to 0.47181 in.
Rocker arm I.D.	Factory specification	12.000 to 12.018 mm 0.47244 to 0.47314 in.

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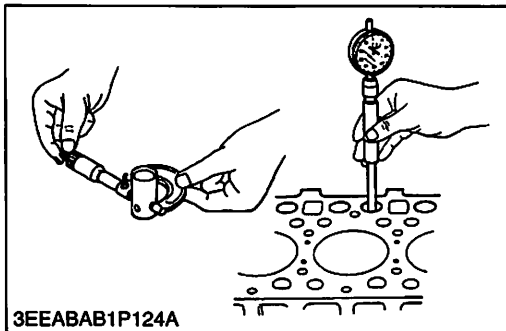


Push Rod Alignment

1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.
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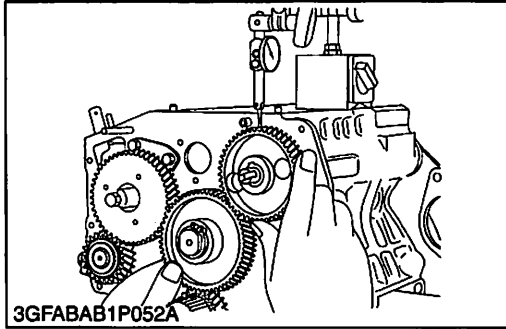
Oil Clearance between Tappet and Tappet Guide Bore

1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil Clearance between tappet and tappet guide bore	Factory specification	0.020 to 0.062 mm 0.00079 to 0.0024 in.
	Allowable limit	0.07 mm 0.003 in.

Tappet O.D.	Factory specification	19.959 to 19.980 mm 0.78579 to 0.78661 in.
Tappet guide bore I.D.	Factory specification	20.000 to 20.021 mm 0.78740 to 0.78822 in.

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(2) Timing Gears, Camshaft and Governor Gear**Timing Gear Backlash**

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

Backlash between idle gear 1 and crank gear	Factory specification	0.0320 to 0.115 mm 0.00126 to 0.00452 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear 1 and cam gear	Factory specification	0.0360 to 0.114 mm 0.00142 to 0.00448 in.
	Allowable limit	0.15 mm 0.0059 in.

Backlash between idle gear 1 and injection pump gear	Factory specification	0.0340 to 0.116 mm 0.00134 to 0.00456 in.
	Allowable limit	0.15 mm 0.0059 in.

(equipped with idle gear 2) Backlash between idle gear 1 and idle gear 2	Factory specification	0.0330 to 0.117 mm 0.00130 to 0.00460 in.
	Allowable limit	0.15 mm 0.0059 in.

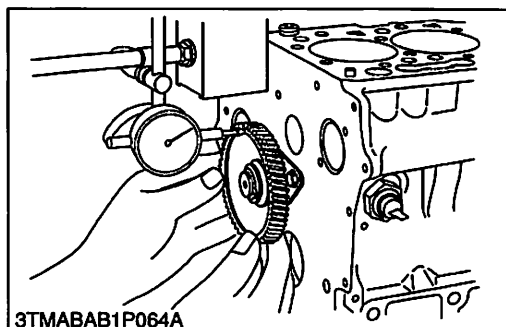
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Governor Gear Backlash

Backlash between injection pump gear and governor gear	Factory specification	0.0300 to 0.117 mm 0.00119 to 0.00460 in.
	Allowable limit	0.15 mm 0.0059 in.

(equipped with idle gear 2) idle gear 2 and governor gear	Factory specification	0.030 to 0.117 mm 0.0012 to 0.00460 in.
	Allowable limit	0.15 mm 0.0059 in.

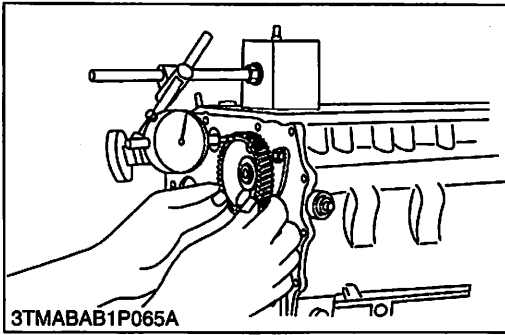
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**Idle Gear 1 and 2 Side Clearance**

1. Set a dial indicator with its tip on the idle gear.
2. Measure the side clearance by moving the idle gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear collar

Idle gear 1 and 2 side clearance	Factory specification	0.20 to 0.51 mm 0.0079 to 0.020 in.
	Allowable limit	0.80 mm 0.031 in.

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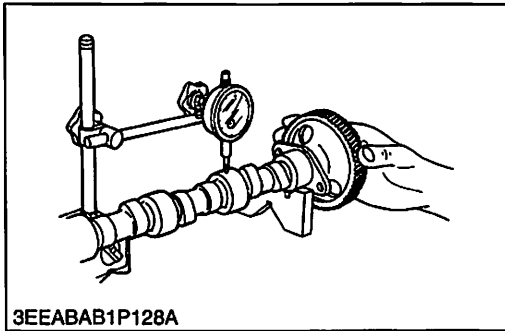


Camshaft Side Clearance

1. Set a dial indicator with its tip on the camshaft.
2. Measure the side clearance by moving the cam gear to the front to rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper

Camshaft side clearance	Factory specification	0.070 to 0.22 mm 0.0028 to 0.0086 in.
	Allowable limit	0.30 mm 0.012 in.

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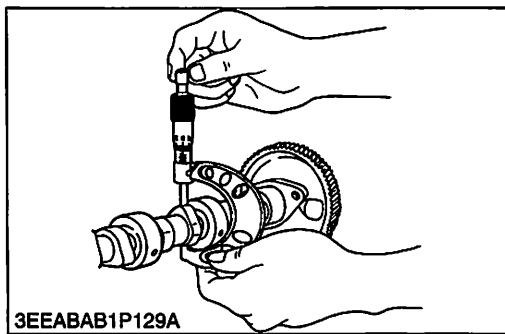


Camshaft Alignment

1. Support the camshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the camshaft alignment.
4. If the measurement exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.
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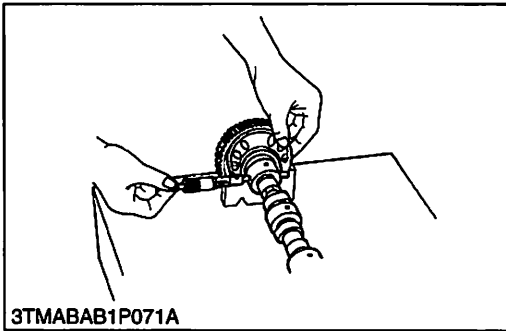
Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

Cam height of intake	Factory specification	28.80 mm 1.134 in.
	Allowable limit	28.75 mm 1.132 in.

Cam height of exhaust	Factory specification	29.00 mm 1.142 in.
	Allowable limit	28.95 mm 1.140 in.

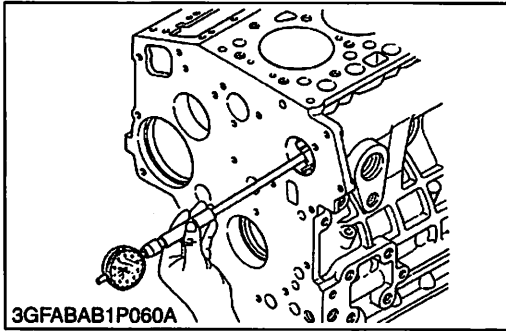
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Oil Clearance of Camshaft Journal

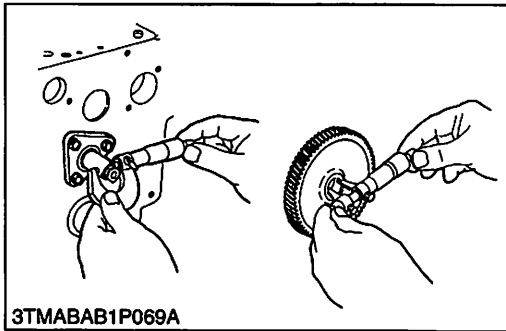
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory specification	0.050 to 0.091 mm 0.0020 to 0.0035 in.
	Allowable limit	0.15 mm 0.0059 in.



Camshaft journal O.D.	Factory specification	35.934 to 35.950 mm 1.4147 to 1.4153 in.
Camshaft bearing I.D. (Cylinder block bore I.D.)	Factory specification	36.000 to 36.025 mm 1.4173 to 1.4183 in.

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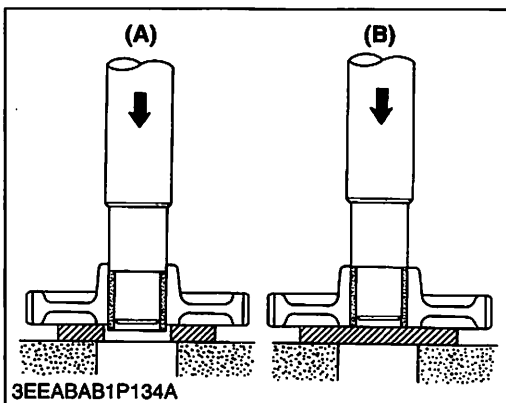
Oil Clearance between Idle Gear Shaft 1 and 2 and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.
If it still exceeds the allowable limit, replace the idle gear shaft.

Oil clearance between idle gear shaft (1 and 2) and idle gear bushing	Factory specification	0.020 to 0.054 mm 0.00079 to 0.0021 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft 1 and 2 O.D.	Factory specification	25.967 to 25.980 mm 1.0223 to 1.0228 in.
Idle gear bushing 1 and 2 I.D.	Factory specification	26.000 to 26.021 mm 1.0237 to 1.0244 in.

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Replacing Idle Gear Bushing

(When removing)

1. Press out the used idle gear bushing using an idle gear bushing replacing tool. (See page "SPECIAL TOOLS".)

(When installing)

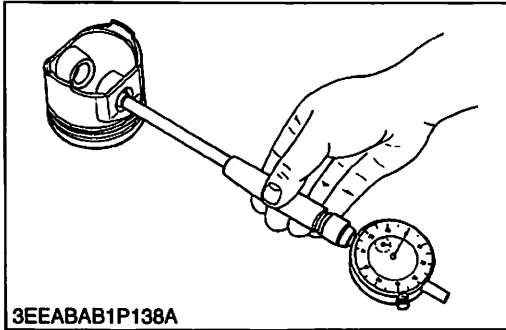
1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Press fit a new bushing using an idle gear bushing replacing tool, until it is flush with the end of the idle gear.

(A) When Removing

(B) When Installing

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(3) Piston and Connecting Rod

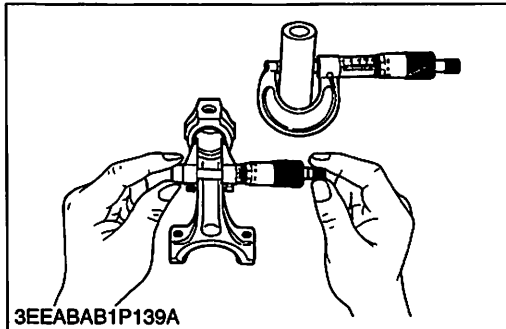


Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin bore I.D.	Factory specification	22.000 to 22.013 mm 0.86615 to 0.86665 in.
	Allowable limit	22.03 mm 0.8673 in.

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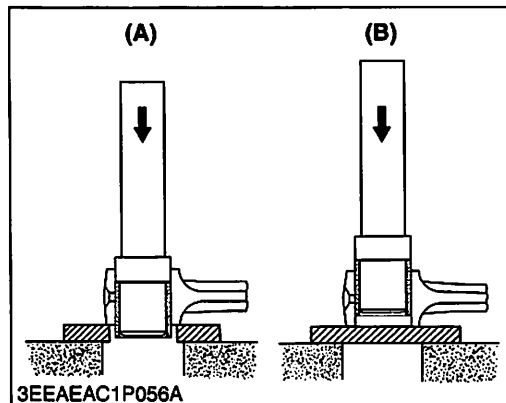
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. where it contacts the bushing with an outside micrometer.
2. Measure the small end bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory specification	0.014 to 0.038 mm 0.00055 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory specification	22.002 to 22.011 mm 0.86622 to 0.86657 in.
Small end bushing I.D.	Factory specification	22.025 to 22.040 mm 0.86713 to 0.86771 in.

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Replacing Small End Bushing

(When removing)

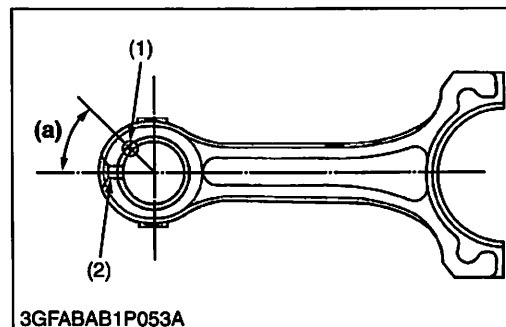
1. Press out the used bushing using a small end bushing replacing tool. (See page "SPECIAL TOOLS".)

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Using a small end bushing replacing tool, press fit a new bushing (service parts) taking due care to see that the connecting rod oil hole matches the bushing hole.

Oil clearance between piston pin and small end bushing (Spare parts)	Factory specification	0.014 to 0.038 mm 0.00056 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

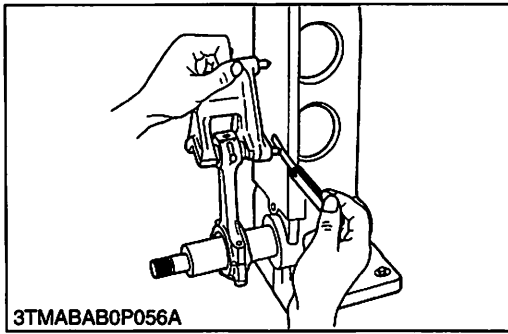
Small end bushing I.D. (Spare parts)	Factory specification	22.025 to 22.040 mm 0.86713 to 0.86771 in.
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- (1) Seam
- (2) Oil Hole

- (A) When Removing
- (B) When Installing
- (a) 0.79 rad (45°)

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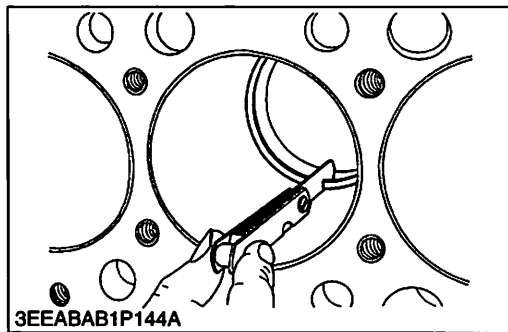
Connecting Rod Alignment

■ **NOTE**

- Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.
1. Install the piston pin into the connecting rod.
 2. Install the connecting rod on the connecting rod alignment tool.
 3. Put a gauge over the piston pin, and move it against the face plate.
 4. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
 5. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.002 in.
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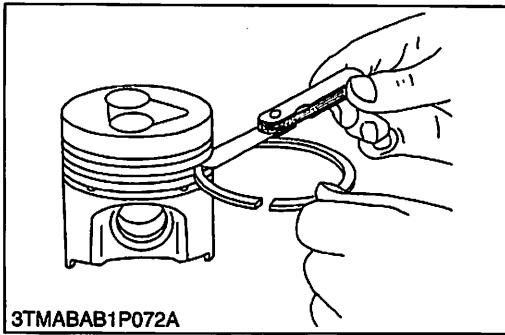


Piston Ring Gap

1. Insert the piston ring into the lower part of the cylinder (the least worn out part) with a piston.
2. Measure the ring gap with a thickness gauge.
3. If the measurement exceeds the allowable limit, replace the piston ring.

Piston ring gap [D1005-E4B/E4BG]	Top ring	Factory specification	0.30 to 0.45 mm 0.012 to 0.017 in.
		Allowable limit	1.25 mm 0.0492 in.
	Second ring	Factory specification	0.30 to 0.45 mm 0.012 to 0.017 in.
		Allowable limit	1.25 mm 0.0492 in.
	Oil ring	Factory specification	0.25 to 0.45 mm 0.0099 to 0.017 in.
		Allowable limit	1.25 mm 0.0492 in.
Piston ring gap [D1105-E4B/E4BG] [D1305-E4B/E4BG] [V1505-E4B/E4BG]	Top ring	Factory specification	0.15 to 0.25 mm 0.0059 to 0.0098 in.
		Allowable limit	1.20 mm 0.0472 in.
	Second ring	Factory specification	0.40 to 0.55 mm 0.016 to 0.021 in.
		Allowable limit	1.20 mm 0.0472 in.
	Oil ring	Factory specification	0.25 to 0.45 mm 0.0099 to 0.017 in.
		Allowable limit	1.25 mm 0.0492 in.

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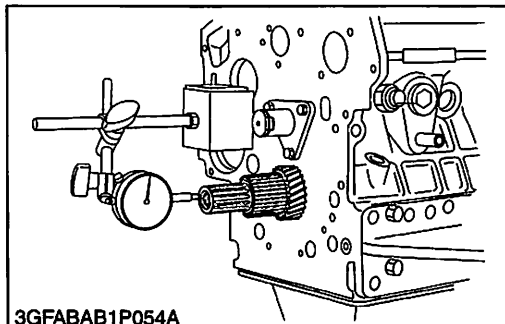
Clearance between Piston ring and Piston Ring Groove

1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

Clearance between piston ring and piston ring groove [D1005-E4B/E4BG]	Second ring	Factory specification	0.0850 to 0.112 mm 0.00335 to 0.00440 in.
		Allowable limit	0.2 mm 0.008 in.
	Oil ring	Factory specification	0.02 to 0.06 mm 0.0008 to 0.002 in.
		Allowable limit	0.15 mm 0.0059 in.
Clearance between piston ring and piston ring groove [D1105-E4B/E4BG] [D1305-E4B/E4BG] [V1505-E4B/E4BG]	Second ring	Factory specification	0.0850 to 0.122 mm 0.00335 to 0.00480 in.
		Allowable limit	0.2 mm 0.008 in.
	Oil ring	Factory specification	0.02 to 0.06 mm 0.0008 to 0.002 in.
		Allowable limit	0.15 mm 0.0059 in.

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(4) Crankshaft



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Crankshaft Side Clearance

1. Set a dial indicator with its point on the end of the crankshaft.
2. Move the crankshaft to the front and rear to measure the side clearance.
3. If the measurement is more than the allowable limit, replace the thrust bearings.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

Crankshaft side clearance	Factory specification	0.15 to 0.31 mm 0.0059 to 0.012 in.
	Allowable limit	0.50 mm 0.020 in.

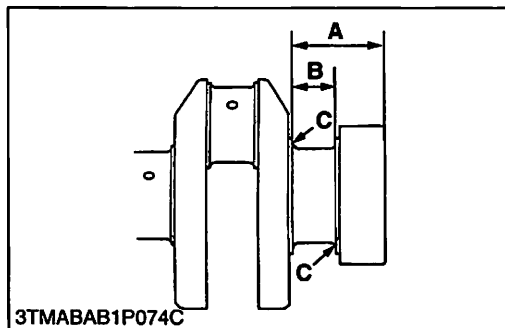
(Reference)

- Oversize dimensions of crankshaft journal

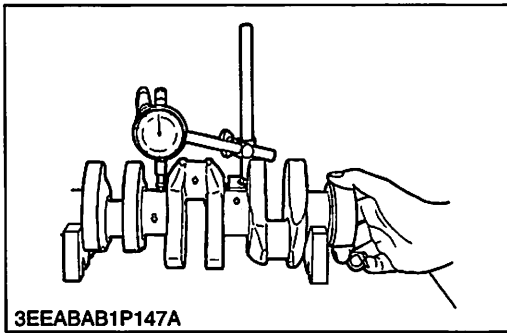
Oversize	0.2 mm 0.0079 in.	0.4 mm 0.016 in.
Dimension A	51.50 to 51.70 mm 2.028 to 2.035 in.	51.60 to 51.80 mm 2.032 to 2.039 in.
Dimension B	28.20 to 28.25 mm 1.111 to 1.112 in.	28.40 to 28.45 mm 1.119 to 1.120 in.
Dimension C	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius

The crankshaft journal must be fine-finished to higher than Rmax = 0.8S

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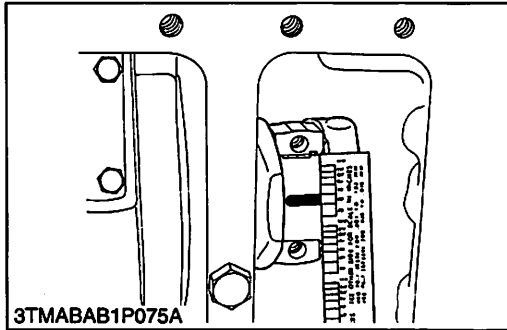


Crankshaft Alignment

1. Support the crankshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the crankshaft alignment.
4. If the measurement exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.0008 in.
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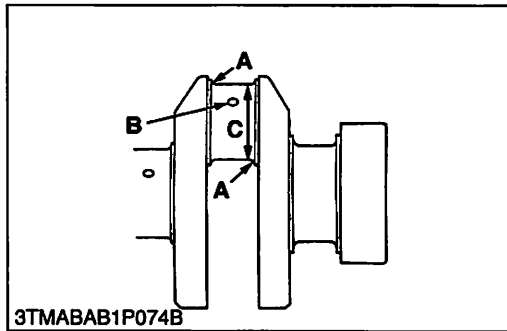


Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing.
6. If the same size bearing is useless because of the crankpin wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**

- Never insert the plastigage into the crankpin oil hole.
- Be sure not to move the crankshaft while the connecting rod screws are tightened.



Oil clearance between crankpin and crankpin bearing	Factory specification	0.029 to 0.091 mm 0.0011 to 0.0036 in.
	Allowable limit	0.20 mm 0.0079 in.

Crank pin O.D.	Factory specification	39.959 to 39.975 mm 1.5732 to 1.5738 in.
Crank pin bearing I.D.	Factory specification	40.040 to 40.050 mm 1.5764 to 1.5767 in.

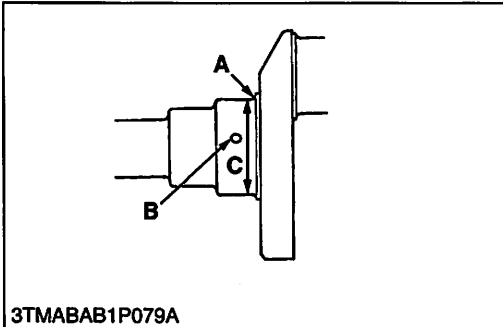
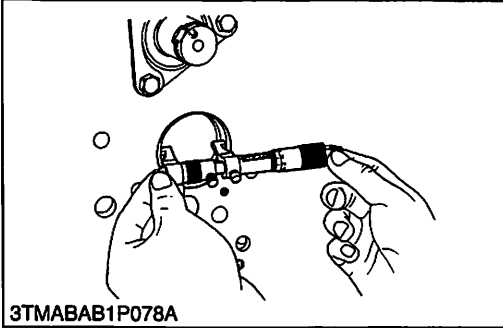
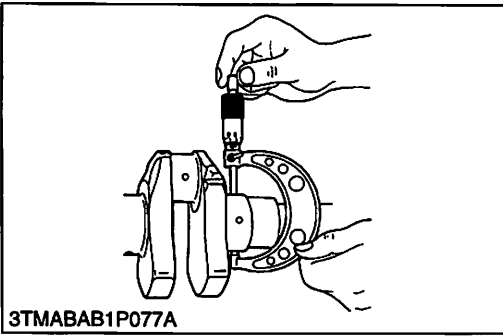
(Reference)

- Undersize dimensions of crank pin

Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	39.759 to 39.775 mm dia. 1.5654 to 1.5659 in. dia.	39.559 to 39.575 mm dia. 1.5575 to 1.5580 in. dia.

The crank pin must be fine-finished to higher than Rmax = 0.8S
 *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm
 (0.040 to 0.059 in.) relief.

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft front journal with an outside micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer, and calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

[D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory specification	0.0340 to 0.114 mm 0.00134 to 0.00448 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory specification	47.934 to 47.950 mm 1.8872 to 1.8877 in.
Crankshaft bearing 1 I.D.	Factory specification	47.984 to 48.048 mm 1.8892 to 1.8916 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	47.734 to 47.750 mm dia. 1.8793 to 1.8799 in. dia.	47.534 to 47.550 mm dia. 1.8715 to 1.8720 in. dia.

The crankshaft journal must be fine-finished to higher than Rmax = 0.8S
 *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm
 (0.040 to 0.059 in.) relief.

[D1305-E4B/E4BG]

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory specification	0.0340 to 0.119 mm 0.00134 to 0.00468 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory specification	51.921 to 51.940 mm 2.0442 to 2.0448 in.
Crankshaft bearing 1 I.D.	Factory specification	51.974 to 52.040 mm 2.0463 to 2.0488 in.

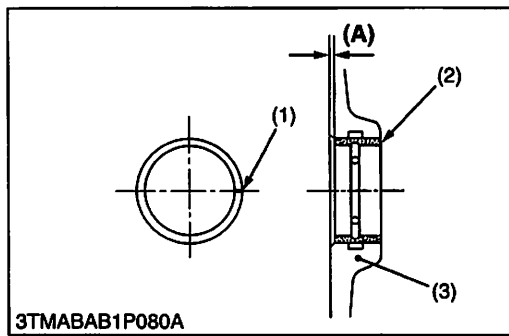
(Reference)

- Undersize dimensions of crankshaft journal

Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	51.721 to 51.740 mm dia. 2.0363 to 2.0370 in. dia.	51.521 to 51.540 mm dia. 2.0284 to 2.0291 in. dia.

The crankshaft journal must be fine-finished to higher than Rmax = 0.8S
 *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm
 (0.040 to 0.059 in.) relief.

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Replacing Crankshaft Bearing 1

(When removing)

1. Press out the used crankshaft bearing 1 using a crankshaft bearing 1 replacing tool. (See page "SPECIAL TOOLS".)

(When installing)

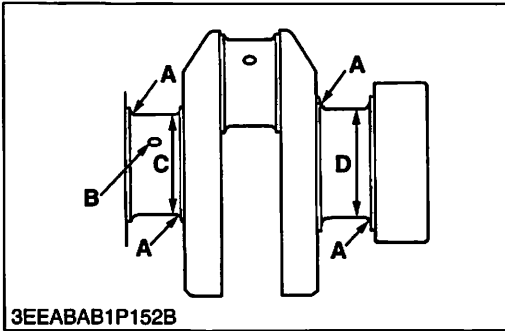
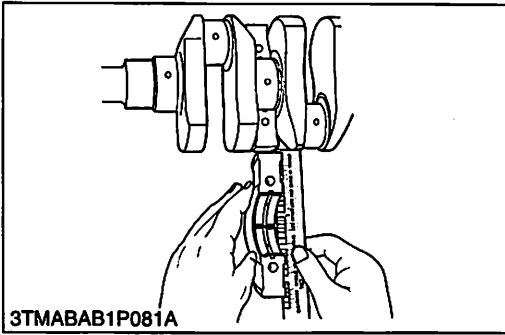
1. Clean a new crankshaft bearing 1 and crankshaft journal bore, and apply engine oil to them.
2. Using a crankshaft bearing 1 replacing tool, press fit a new bearing 1 (2) so that its seam (1) directs toward the exhaust manifold side. (See figure.)

Dimension (A)	Factory specification	0 to 0.3 mm 0 to 0.01 in.

- (1) Seam
 (2) Crankshaft Bearing 1
 (3) Cylinder Block

(A) Dimension

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2 (Crankshaft Bearing 3)

1. Put a strip of plastigage on the center of the journal.
2. Install the bearing case and tighten the bearing case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the clearance exceeds the allowable limit, replace the crankshaft bearing 2 (1) and crankshaft bearing (3).
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

NOTE

- Be sure not to move the crankshaft while the bearing case screws are tightened.

[D1005-E4B/E4BG, D1105-E4B/E4BG, V1505-E4B/E4BG]

Oil clearance between crankshaft journal and crankshaft bearing 2	Factory specification	0.034 to 0.095 mm 0.0014 to 0.0037 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D. (Intermediate)	Factory specification	47.934 to 47.950 mm 1.8872 to 1.8877 in.
Crankshaft bearing 2 I.D.	Factory specification	47.984 to 48.029 mm 1.8892 to 1.8909 in.

Oil clearance between crankshaft journal and crankshaft bearing 3	Factory specification	0.0340 to 0.103 mm 0.00134 to 0.00405 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D. (Flywheel side)	Factory specification	51.921 to 51.940 mm 2.0442 to 2.0448 in.
Crankshaft bearing 3 I.D.	Factory specification	51.974 to 52.024 mm 2.0463 to 2.0481 in.

(Reference)

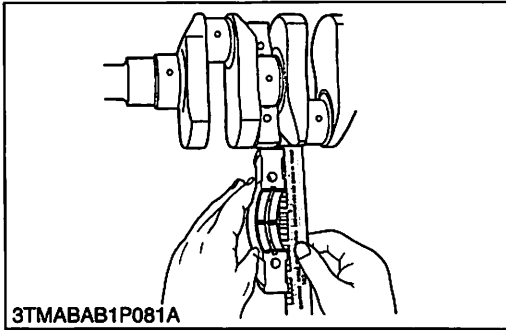
- Undersize dimensions of crankshaft journal

Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	47.734 to 47.750 mm dia. 1.8793 to 1.8799 in. dia.	47.534 to 47.550 mm dia. 1.8715 to 1.8720 in. dia.
Dimension D	51.721 to 51.740 mm dia. 2.0362 to 2.0370 in. dia.	51.521 to 51.540 mm dia. 2.0284 to 2.0291 in. dia.

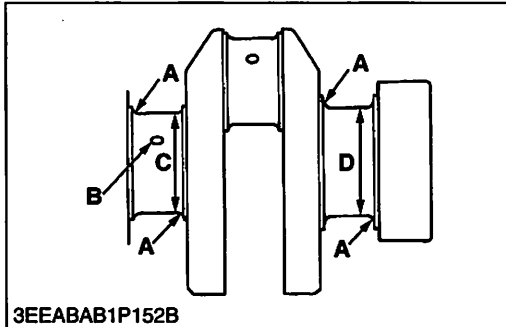
The crank pin must be fine-finished to higher than Rmax = 0.8S
 *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm
 (0.040 to 0.059 in.) relief.

(To be continued)

(Continued)



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[D1305-E4B/E4BG]

Oil clearance between crankshaft journal and crankshaft bearing 2	Factory specification	0.0340 to 0.103 mm 0.00134 to 0.00405 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D. (Intermediate)	Factory specification	51.921 to 51.940 mm 2.0442 to 2.0448 in.
Crankshaft bearing 2 I.D.	Factory specification	51.974 to 52.024 mm 2.0463 to 2.0481 in.

Oil clearance between crankshaft journal and crankshaft bearing 3	Factory specification	0.0340 to 0.103 mm 0.00134 to 0.00405 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D. (Flywheel side)	Factory specification	51.921 to 51.940 mm 2.0442 to 2.0448 in.
Crankshaft bearing 3 I.D.	Factory specification	51.974 to 52.024 mm 2.0463 to 2.0481 in.

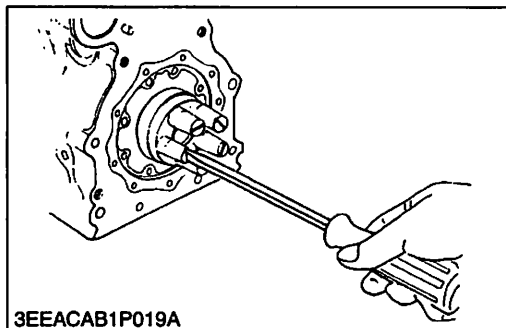
(Reference)

- Undersize dimensions of crankshaft journal

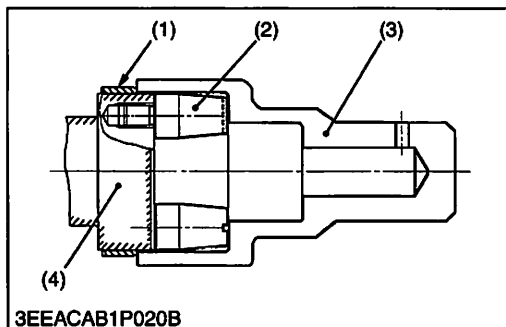
Undersize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension A	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius	2.3 to 2.7 mm radius 0.091 to 0.10 in. radius
*Dimension B	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension C	51.721 to 51.740 mm dia. 2.0363 to 2.0370 in. dia.	51.521 to 51.540 mm dia. 2.0284 to 2.0291 in. dia.

The crank pin must be fine-finished to higher than Rmax = 0.8S
 *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm
 (0.040 to 0.059 in.) relief.

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Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve.
2. Set the sleeve guide (2) to the crankshaft.
3. Heat a new sleeve to a temperature between 150 and 200 °C (302 and 392 °F), and fix the sleeve to the crankshaft as shown in figure.
4. Press fit the sleeve using the auxiliary socket for pushing (3).

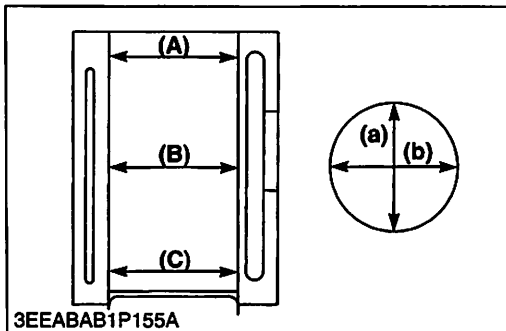
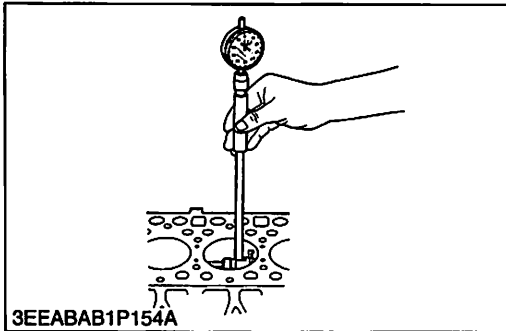
■ **NOTE**

- Mount the sleeve with its largely chamfered surface facing outward.
- Should heating is not enough, a sleeve might stop halfway, so careful.

- (1) Crankshaft Sleeve
- (2) Sleeve Guide
- (3) Auxiliary Socket for Pushing
- (4) Crankshaft

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(5) Cylinder



Cylinder Wear

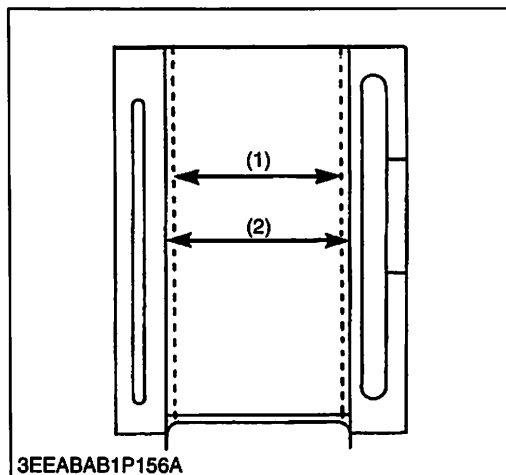
1. Measure the I.D. of the cylinder at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to "Correcting Cylinder".)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to "Correcting Cylinder".)

Cylinder I.D.	Factory specification	D1005-E4B/E4BG	76.000 to 76.019 mm 2.9922 to 2.9929 in.
		D1105-E4B/E4BG D1305-E4B/E4BG V1505-E4B/E4BG	78.000 to 78.019 mm 3.0709 to 3.0716 in.
	Allowable limit	D1005-E4B/E4BG	76.15 mm 2.998 in.
		D1105-E4B/E4BG D1305-E4B/E4BG V1505-E4B/E4BG	78.15 mm 3.077 in.

- (A) Top
- (B) Middle
- (C) Bottom (Skirt)

- (a) Right-angled to Piston Pin
- (b) Piston Pin Direction

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Correcting Cylinder

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Oversized cylinder liner I.D.	Factory specification	D1005-E4B/E4BG	76.500 to 76.519 mm 3.0119 to 3.0125 in.
		D1105-E4B/E4BG D1305-E4B/E4BG V1505-E4B/E4BG	78.500 to 78.519 mm 3.0906 to 3.0912 in.
	Allowable limit	D1005-E4B/E4BG	76.65 mm 3.018 in.
		D1105-E4B/E4BG D1305-E4B/E4BG V1505-E4B/E4BG	78.65 mm 3.096 in.
Finishing	Hone to 1.2 to 2.0 µm R max. (48 to 78 µin. R max.)		

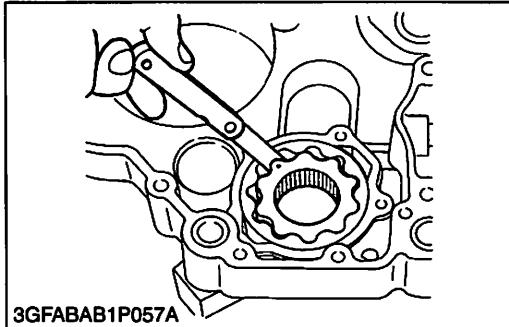
2. Replace the piston and piston rings with oversize one.
Oversize: 0.5 mm (0.02 in.)

■ **NOTE**

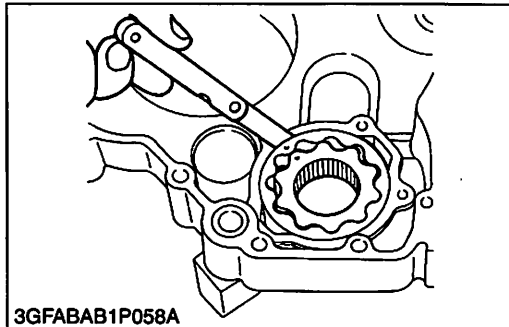
- When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.

- (1) Cylinder I.D. (Before Correction) (2) Cylinder I.D. (Oversize)

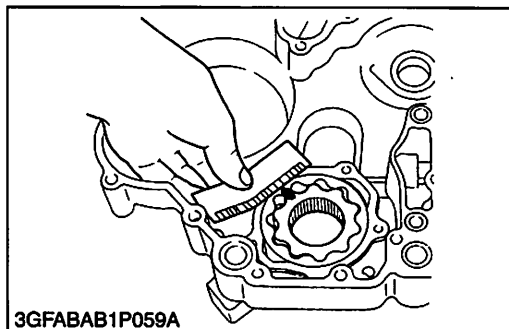
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(6) Oil Pump

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Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Rotor lobe clearance	Factory specification	0.060 to 0.18 mm 0.0024 to 0.0071 in.
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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory specification	0.100 to 0.180 mm 0.00394 to 0.00708 in.
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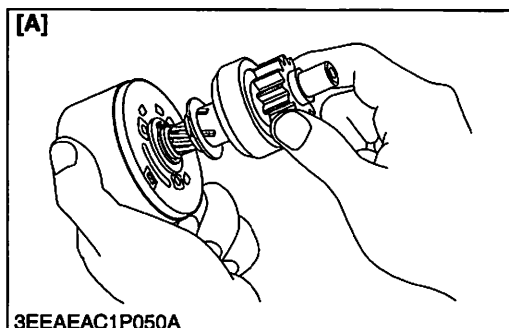
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Clearance between Rotor and Cover

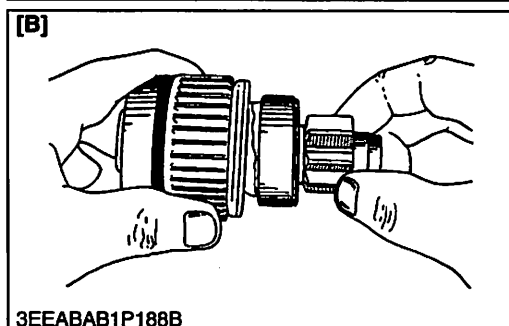
1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the amount of the flattening with the scale and get the clearance.
4. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between rotor and cover	Factory specification	0.025 to 0.075 mm 0.00099 to 0.0029 in.
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(7) Starter

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Overrunning Clutch

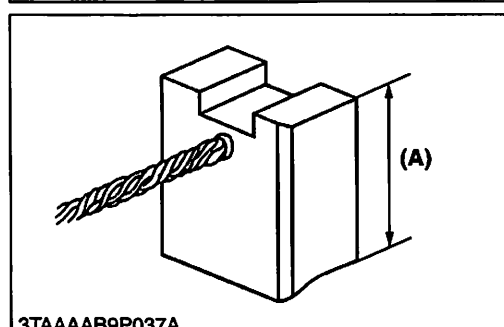
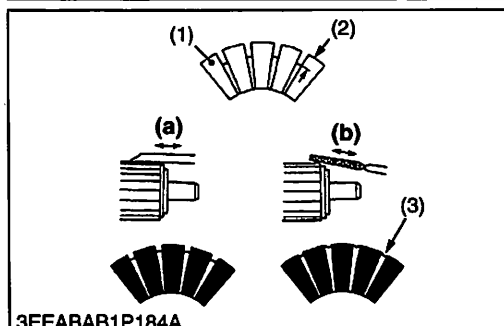
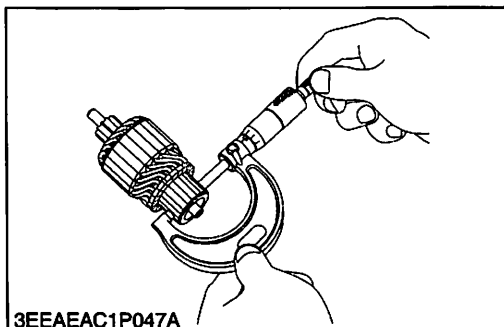
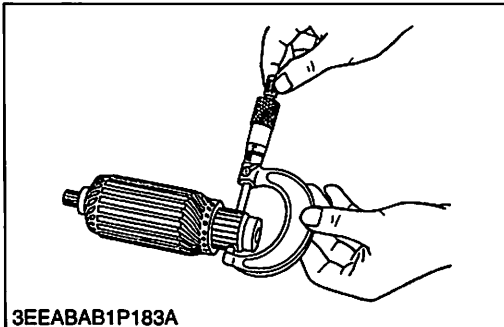
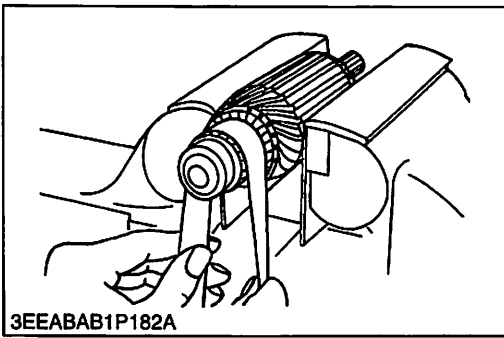
1. Check the pinion and if worn or damaged, replace the clutch assembly.
2. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
3. If the pinion slips or does not turn in both directions, replace the overrunning clutch assembly.

■ NOTE

- Do not wash off the grease in the overrunning clutch with the chemicals or oils.

[A] Electromagnetic Drive Type**[B] Planetary Gear Reduction Type**

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Commutator and Mica

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory specification	Electromagnetic drive type	28.0 mm 1.10 in.
		Gear reduction type	30.0 mm 1.18 in.
	Allowable limit	Electromagnetic drive type	27.0 mm 1.06 in.
		Gear reduction type	29.0 mm 1.14 in.

Difference of O.D.'s	Factory specification	Electromagnetic drive type	Less than 0.05 mm 0.002 in.
		Gear reduction type	Less than 0.02 mm 0.0008 in.
	Allowable limit	Electromagnetic drive type	0.4 mm 0.02 in.
		Gear reduction type	0.05 mm 0.002 in.

Mica under cut	Factory specification	0.50 to 0.80 mm 0.020 to 0.031 in.
	Allowable limit	0.20 mm 0.0079 in.

- (1) Segment
- (2) Depth of Mica
- (3) Mica
- (a) Correct
- (b) Incorrect

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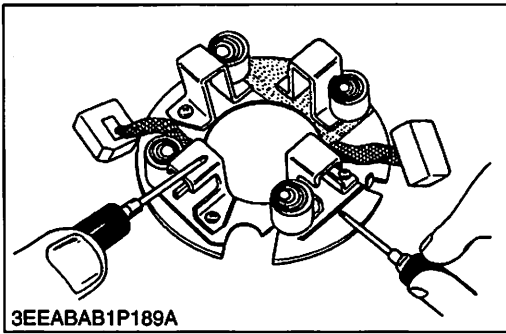
Brush Wear

1. If the connect face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length (A) with vernier caliper.
3. If the length is than the allowable limit, replace the yoke assembly and brush holder.

Brush length (A)	Factory specification	16.0 mm 0.630 in.
	Allowable limit	10.5 mm 0.413 in.

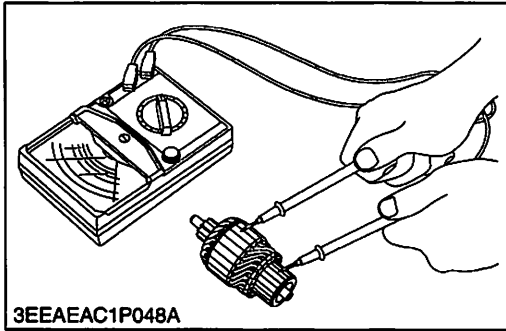
(A) Brush Length

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**Brush Holder**

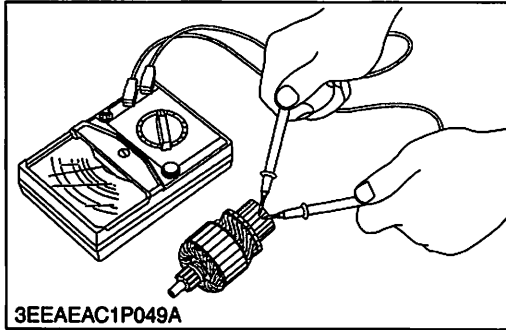
1. Check the continuity across the brush holder and the holder support with a circuit tester.
2. If it conducts, replace the brush holder.

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**Armature Coil**

1. Check the continuity across the commutator and armature coil core with resistance range of circuit tester.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with resistance range of circuit tester.
4. If it dose not conduct, replace the armature.

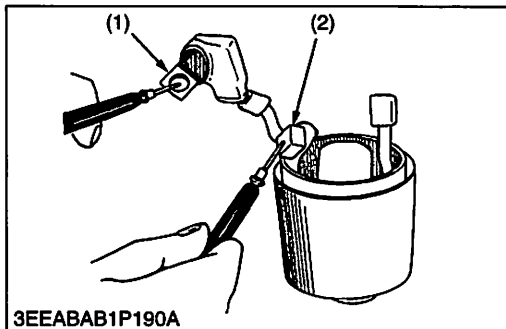
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**Field Coil**

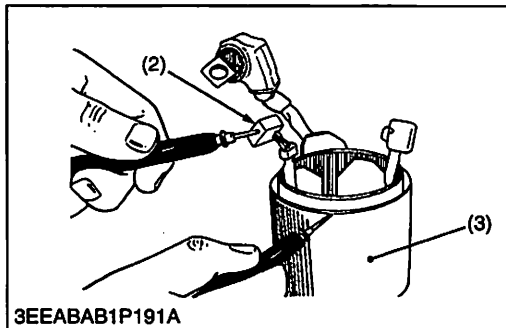
1. Check the continuity across the lead (1) and brush (2) with a circuit tester.
2. If it dose not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with a circuit tester.
4. If it conducts, replace the yoke assembly.

(1) Lead
(2) Brush

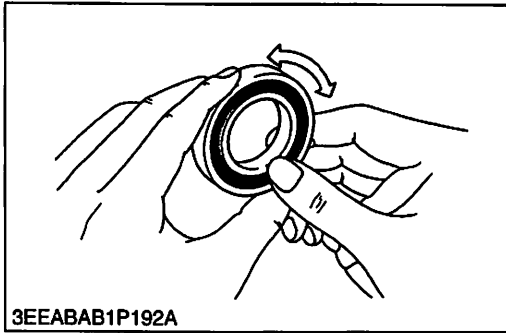
(3) Yoke



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(8) Alternator

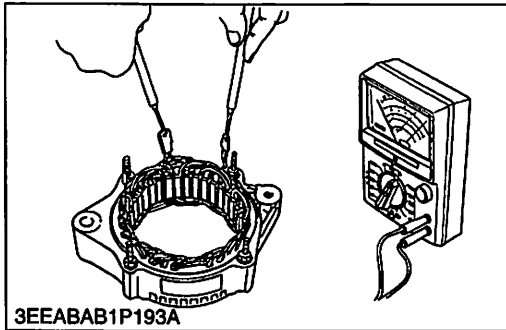


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Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

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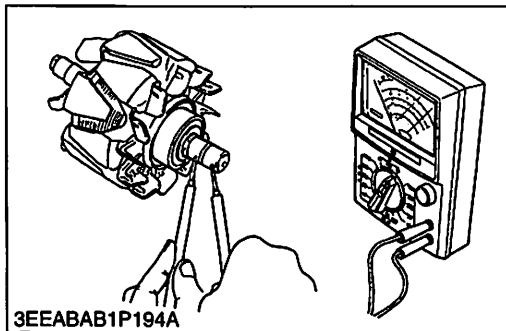
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Stator

1. Measure the resistance across each lead of the stator coil with resistance range of circuit tester.
2. If the measurement is not within factory specification, replace it.
3. Check the continuity across each stator coil lead and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory specification	Less than 1.0 Ω
------------	-----------------------	-----------------

9Y1210784ENS0105US0



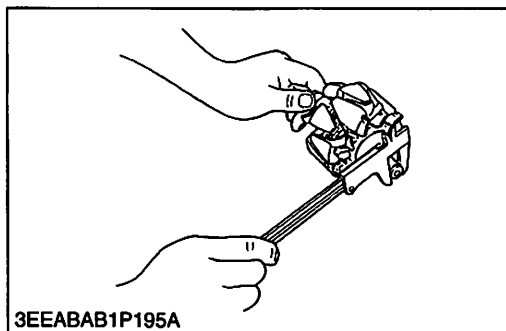
3EEABAB1P194A

Rotor

1. Measure the resistance across the slip rings.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip ring and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory specification	2.9 Ω
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9Y1210784ENS0106US0



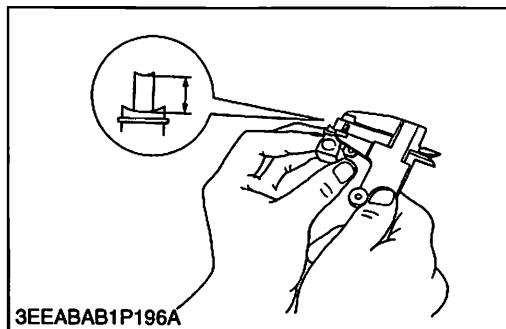
3EEABAB1P195A

Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an emery paper or on a lathe.
3. Measure the O.D. of slip ring with vernier calipers.
4. If the measurement is less than the allowable limit, replace it.

Slip ring O.D.	Factory specification	14.4 mm 0.567 in.
	Allowable limit	14.0 mm 0.551 in.

9Y1210784ENS0107US0



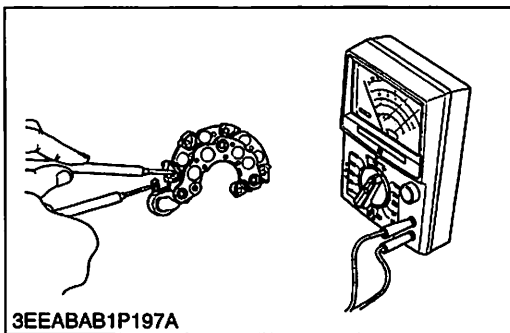
3EEABAB1P196A

Brush Wear

1. Measure the brush length with vernier calipers.
2. If the measurement is less than allowable limit, replace it.
3. Make sure that the brush moves smoothly.
4. If the brush is damaged, replace it.

Brush length (A)	Factory specification	10.0 mm 0.394 in.
	Allowable limit	8.4 mm 0.33 in.

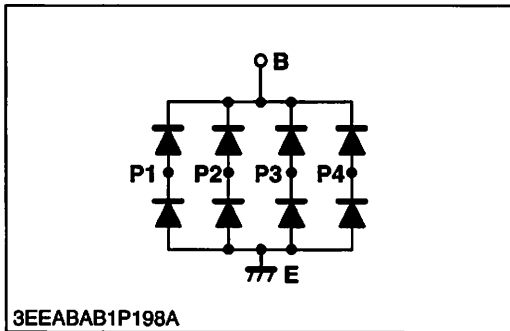
9Y1210784ENS0108US0



Rectifier

1. Check the continuity across each diode of rectifier with resistance range of circuit tester.
2. The rectifier is normal if the diode in the rectifier conducts in one direction and does not conduct in the reverse direction.

9Y1210784ENS0109US0



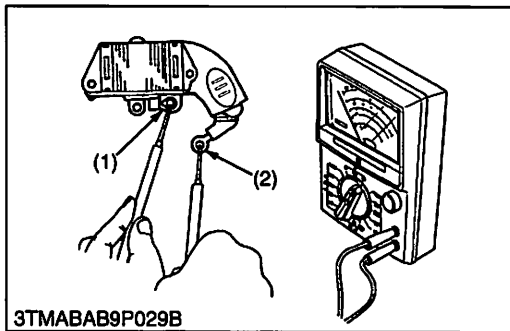
IC Regulator

1. Check the continuity across the B terminal (2) and the F terminal (1) of IC regulator with resistance range of circuit tester.
2. The IC regulator is normal if the conducts in one direction and does not conduct in the reverse direction.

(1) F Terminal

(2) B Terminal

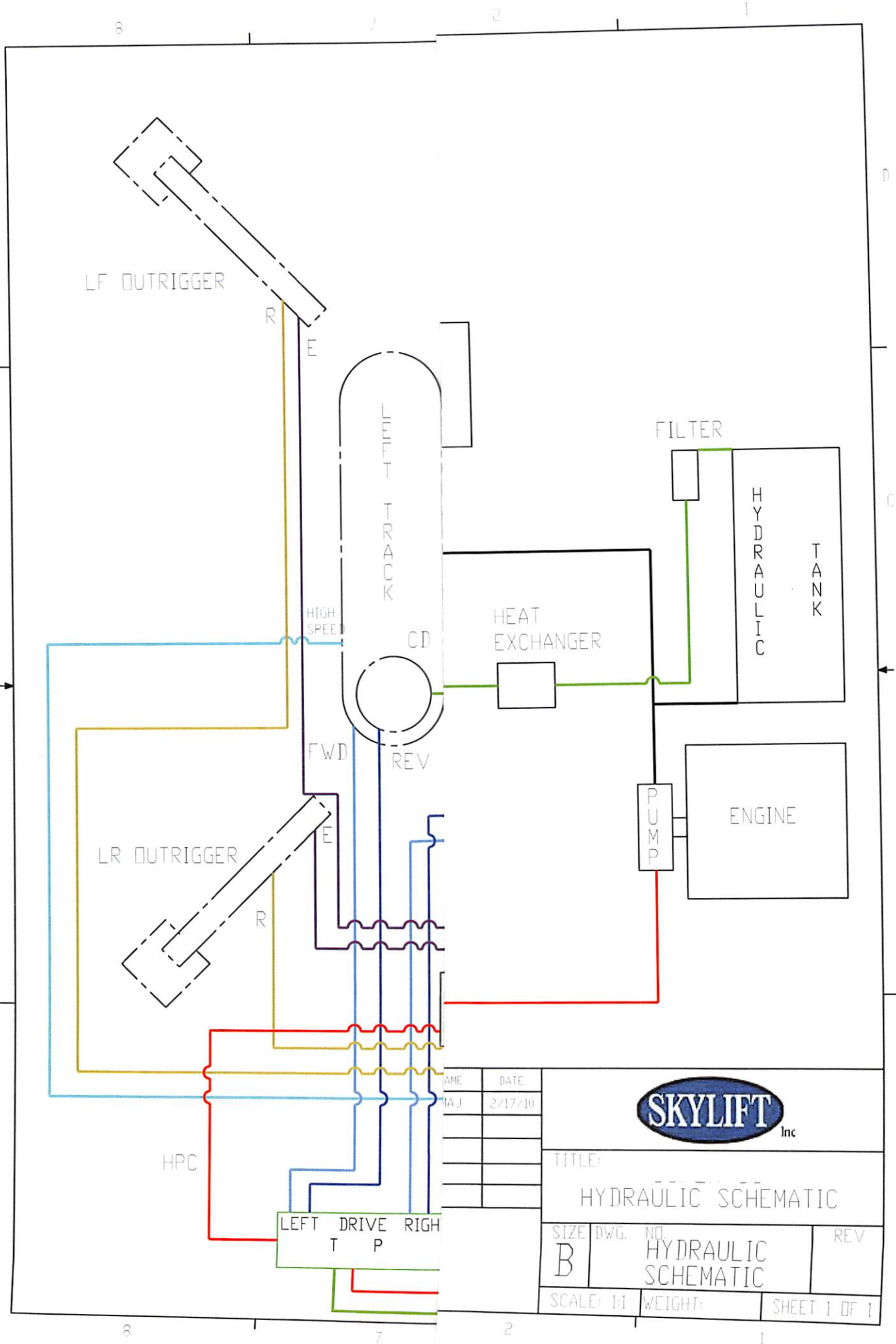
9Y1210784ENS0110US0



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**C
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6



NAME	DATE
MAJ	2/17/10



TITLE:
HYDRAULIC SCHEMATIC

SIZE	DWG. NO.	REV
B	HYDRAULIC SCHEMATIC	

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

**C
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7



DIRECTIONS FOR OMNEX REMOTE OPERATIONS

TO POWER THE TRANSMITTER

- 1) Ensure all switches are in neutral off.
- 2) Using ignition switch start the machine.
- 3) Toggle any function switch to activate. Yellow active light will flash fast.
- 4) Twist the E-Stop button clockwise. The button will pop out. Yellow active light will flash slowly.

TO OPERATE THE MACHINE

- 1) Toggle a desired function.
- 2) Pull trigger slowly to start function operation.
- 3) Function operation will increase proportionally with trigger movement.



OMNEX
TRUSTED WIRELESS

Mini Linesman

Installation / Configuration Manual

T150 Transmitter R160 Receiver

November 3, 2011

Revision 4

DM-R160-0664A

#74-1833 Coast Meridian Road, Port Coquitlam, BC, Canada • V3C 6G5

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Tdl Free 1-800-663-8806

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NOTE: These instructions are intended only for installing and operating the remote control equipment described here. This is not a complete Operator's Manual. For complete operating instructions, please read the Operator's Manual appropriate for your particular machine.

Safety Precautions

READ ALL INSTRUCTIONS

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Failure to follow the SAFETY PRECAUTIONS may result in radio equipment failure and serious personal injury

Installation

PROVIDE A SAFETY CUTOFF SWITCH. If maintenance is required, the radio must be disconnected from power
USE PROPER WIRING. Loose or frayed wires can cause system failure, intermittent operation, machine damage, etc.
DO NOT INSTALL IN HOT AREAS. This apparatus can be damaged by heat in excess of 158° F (70° C)

Personal Safety

MAKE SURE MACHINERY AND SURROUNDING AREA IS CLEAR BEFORE OPERATING. Do not activate the remote system unless it is safe to do so.

TURN OFF THE RECEIVER POWER BEFORE WORKING ON MACHINERY. Always disconnect the remote system before doing any maintenance to prevent accidental operation of the machine

Care

KEEP DRY. Do not clean the transmitter / receiver under high pressure. If water or other liquids get inside the transmitter battery or receiver compartment, immediately dry the unit. Remove the case and let the unit air dry

CLEAN THE UNIT AFTER OPERATION. Remove any mud, dirt, concrete, etc. from the unit to prevent clogging of buttons, switches, etc. by using a damp cloth.

Maintenance / Welding

DISCONNECT THE RADIO RECEIVER BEFORE WELDING on this machine. Failure to disconnect will result in the destruction of the radio receiver.

System Overview

The **ORIGA T150 / R160** is a portable, long range, programmable radio remote control system. Designed as a compact and easy-to-use product, this member of the **ORIGA** family puts complete control of your crane where it's needed most, with the operator. It's robust, easy to install and has complete self-diagnostics. This system can be a simple cable replacement or add intelligence to make it a total crane control package. It's a radio, a PLC and a valve driver all in one.

The **ORIGA T150 / R160** system uses Frequency Hopping Spread Spectrum (FHSS) technology. FHSS devices concentrate their full power into a very narrow signal that randomly hops from frequency to frequency within a designated band. This transmission pattern, along with CRC-16 error-checking techniques, enables signals to overcome interference that commonly affects licensed radios.

The **R160 receiver** is designed to be powered from a 12VDC or 24VDC system. It features 19 solid state, high-side driver input / output controls and a reliable E-Stop control.

The **T150 transmitter** comes with 4 to 6 switches and an optional proportional trigger control. It uses standard, long lasting AA batteries. Each T150 transmitter uses a unique ID code to ensure that no two systems will conflict at a job site.

Features

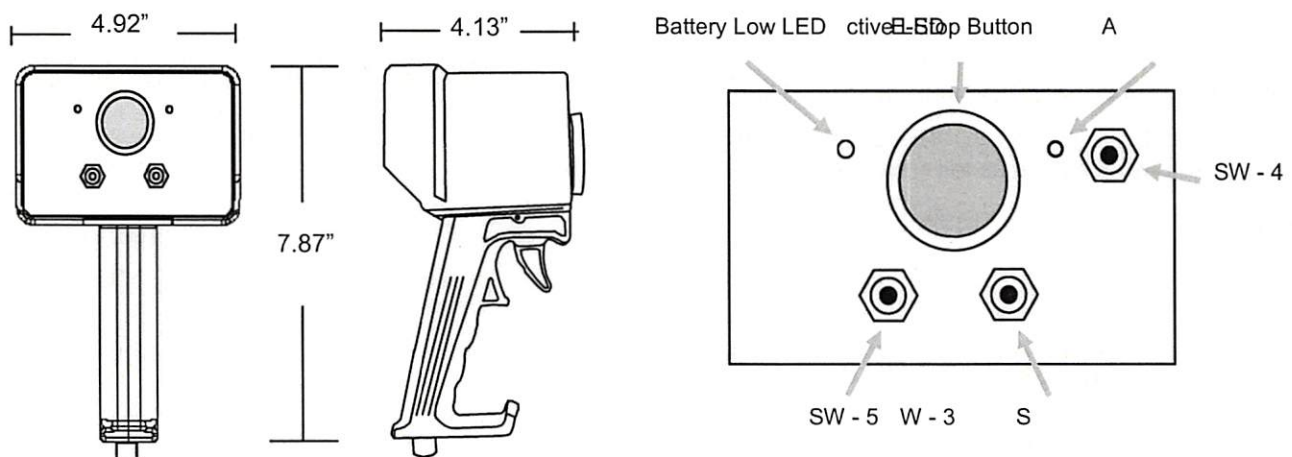
- FCC, ISC, CE approved
- License free
- 1200 foot range @ 900 MHz (900 ft. @ 2.4 GHz)
- Hand held / weatherproof / ergonomic
- Simple "wire-and-use" installation
- Resilient to impact and shock
- Available in both 900 MHz and 2.4 GHz
- Available with optional trigger for proportional control
- Available with E-Stop for ensured operator safety
- Available with an optional tether cable
- Factory configurable for all custom applications.



R160 Receiver

T150 Transmitter

T150 Dimensions and Controls



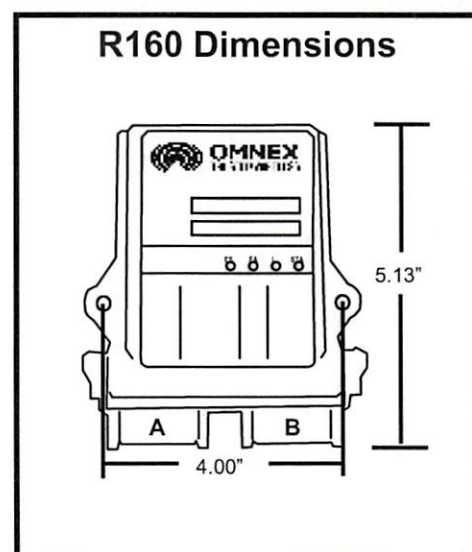
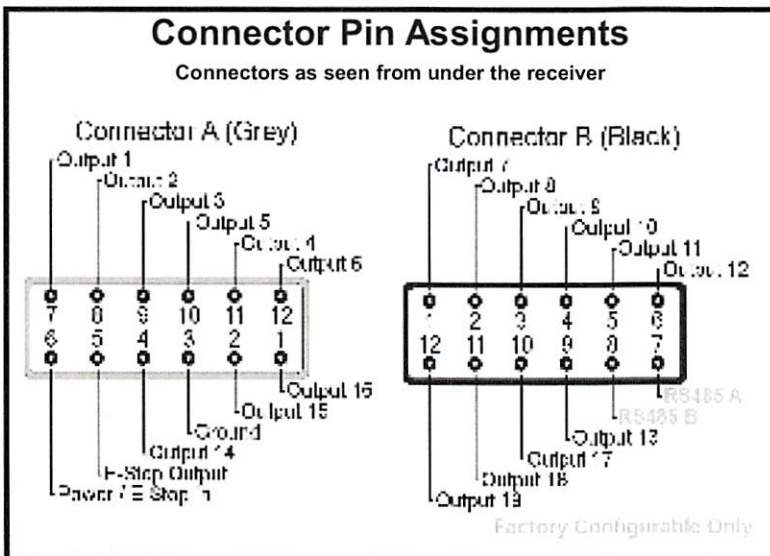
Installing the Receiver

Use the **Wiring Diagram** and the **Connector Diagram** below to connect the receiver pins directly to the appropriate contacts of the machine electronics. R160 Output Cables can be provided with every system to simplify the wiring process. The Wire Color column below only applies to the OMNEX Output Cable configuration. Tips on mounting, power connections and filtering are also provided under **Installation Considerations**.

Wiring Diagram

Pin-Output	Wire Colors	Functions
B7		Factory Configurable Only
B8		Factory Configurable Only
B12 - 19		Input / Output
B11 - 18		Engine Kill Output
B10 - 17		Input / Output
A1 - 16	Brown	Input / Output
A2 - 15		Input / Output
A4 - 14	Green	Trigger Output (Proportional Current)
B9 - 13		Input / Output
B6 - 12		Input / Output
B5 - 11		Input / Output
B4 - 10		Input / Output
B3 - 9		Input / Output
B2 - 8		Input / Output
B1 - 7		Input / Output
A12 - 6	White/Black	Hi Speed On
A10 - 5	Blue	Enable Output (on with any track outputs)
A11 - 4	Grey	Right Track Reverse
A9 - 3	White	Right Track Forward
A8 - 2	Yellow	Left Track Reverse
A7 - 1	Orange	Left Track Forward
A5		Switches to Power with Link
A6	Red	Power Input (+9V to 30VDC)
A3	Black	Ground

Outputs: 19 solid state, high-side driver outputs, 5A max. each, total combined current 15A
Inputs: All output pins can be factory configured as inputs.



Special Functions

Estop & Out of range:

The ENGINE KILL output will be on for **five** seconds after the transmitters E-Stop button is pressed.

Other:

Enable output is high (battery voltage) when any track functions are activated.

Installation Considerations

Mounting and Installation

The receiver can be mounted by fastening two ..." bolts through the two mounting holes in the unit's enclosure. When mounting, ensure that the receiver is oriented so that the text is reading right.

When selecting a mounting point for the receiver, it is recommended that the location require only a minimal length of wiring to connect it to the control panel, that it will be in a visible area where it has good exposure to the operator and that it is mounted on a surface that is protected from the weather and sustains minimal vibration. It is also recommended that the receiver have the best possible line of sight with the transmitter

Power Connections and Wiring

Whenever a power connection is made to an electronic device, it is a good practice to make both the Power (+) and Ground (-) connections directly to the Battery and avoid connecting the power from the charging side of existing wiring or making use of existing "ACC" or other peripheral connection points.

Make sure that wire of sufficient gauge and insulator type is used when connecting the outputs of the receiver to the control panel. Observe any component manufacturer's instructions and recommendations for proper integration of their product. This includes the power ratings and requirements of such components as relays, valves, solenoids, etc.

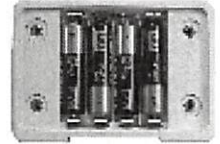
Be sure to test each of the outputs with a multi-meter prior to connecting the outputs to your end devices. This will ensure that each output has been programmed to operate in the manner required by each end device.

Filtering and Noise Suppression

Whenever a solenoid or electromagnetic switch is controlled by the receiver, it is a good practice to install a Diode across its terminals to ensure that surges and spikes do not continue back into the circuit. Appropriate 36V Bi-directional Diodes kits can be ordered under the OMNEX part number "AKIT-2492-01".

Power the Transmitter

When the receiver has been installed, install batteries into the transmitter and turn it on as explained below.



T150 Battery Housing

1. Install Batteries

Remove the battery cover on the back of the transmitter using a slotted screwdriver and insert 4 "AA" alkaline batteries. Orientation of the batteries is embossed inside the battery housing. No batteries are required when the transmitter is connected to the receiver by a Tether Cable.

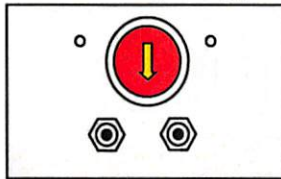
NOTE: For operation at temperatures below -10°C to -40°C , lithium batteries are recommended. Low temperatures reduce battery performance for both alkaline and lithium types. Refer to the battery manufacturer's specifications for detailed information on low temperature performance.

2. Turn on the Transmitter

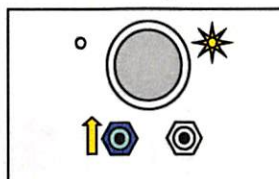
Refer to the **Light Legend** below for diagram details.

WARNING: do not install batteries backwards, charge, put in fire, or mix with other battery types. May explode or leak causing injury. **Replace all batteries at the same time as a fresh set and do not mix and match battery types.**

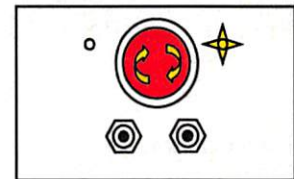
1. Press [E-Stop]



2. Press any switch



3. Twist Clockwise & Release [E-Stop]



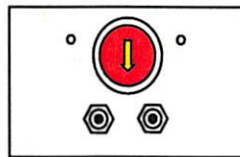
If the transmitter's (Active) light does not flash, check the battery orientation.

To turn off the transmitter, press the [E-Stop] button.

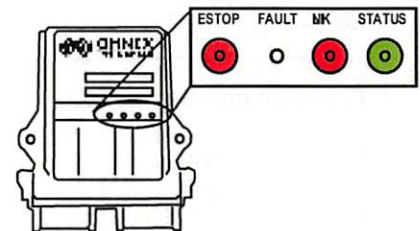
Test the Transmitter / Receiver Link

Follow these steps to ensure that there is a radio link between the transmitter and receiver. Refer to the **Light Legend** below for diagram details.

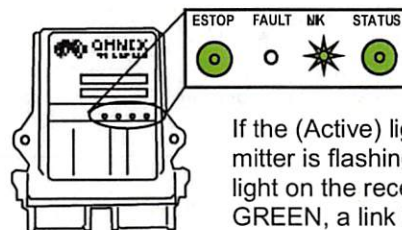
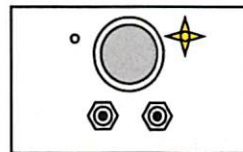
1. Press [E-Stop]



2. Power the R160



3. Power the T150



If the (Active) light on the transmitter is flashing and the (Link) light on the receiver is flashing GREEN, a link between the two exists.

If the receiver's (Link) light does not flash GREEN, follow the steps under **Download ID Code** below.

The ORIGA system is now ready for use.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Download ID Code (Use in case of Link Test failure)

Follow these steps to download the transmitter's unique ID Code into the receiver. This will allow the receiver to establish a radio link with that transmitter.

Refer to the **Light Legend** below for diagram details. Refer to **Trouble Shooting Chart #4** for Tips and Considerations

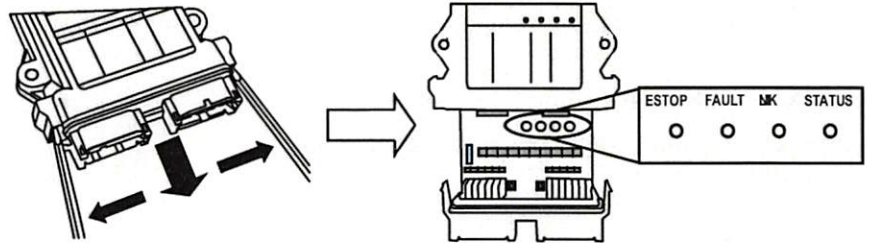
NOTE: It is necessary to download the ID Code when replacing either the transmitter or the receiver.

NOTE: If the transmitter is connected to the receiver with a Tether Cable, completing **only steps 3 and 5** is necessary (it is not necessary to open the R160 case and press the Setup button).

1. Opening the R160 Case

The cap is held on by two plastic tabs at opposing sides, which can be unlatched as shown using a screwdriver. Once the cap is free, the R160 can slide open.

Use a small slotted screwdriver to press the Side Tabs inward.

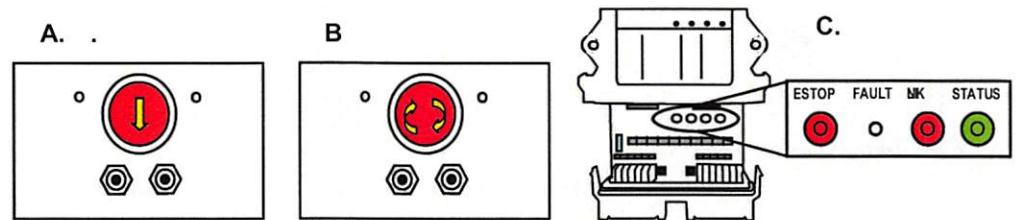


2. Prepare T150, Power R160

A. Press [E-Stop]

B. Twist clockwise & release [E-Stop]

C. Supply power to the receiver



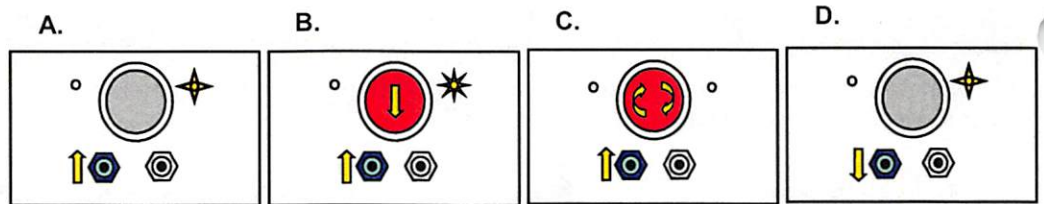
3. Power T150 into Configuration Mode

A. Hold [SW-5] switch UP

B. Press [E-Stop]

C. Twist clockwise & release [E-Stop]

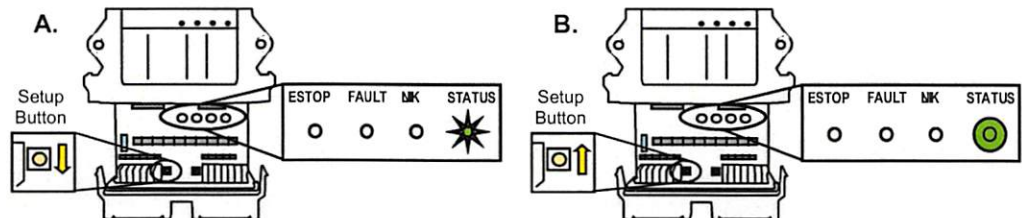
D. Release [SW-5] Switch



4. Put R160 into Setup Mode

A. Press & hold [Setup] button until (Status) light goes from slow flash to fast flash

B. Release [Setup] button. (Status) light goes to solid GREEN, (Link) light turns off

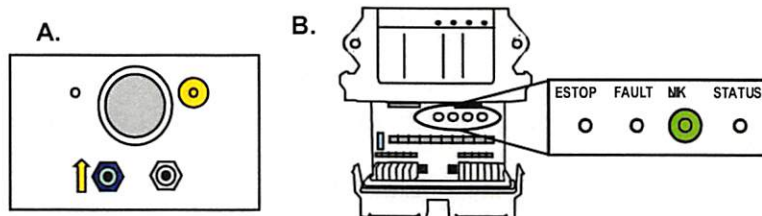


NOTE: If left idle in Setup Mode for over 30 seconds, the receiver will time out. The (Link) light and (Status) light will flash RED rapidly. To return to Setup Mode, repeat step 4.

5. Download ID Code

A. Press [SW-5] switch UP

B. (Link) light goes to GREEN. Once complete, (Link) light goes to RED as the transmitter turns off



NOTE: When replacing the receiver cover, ensure the cover snaps completely into place to create a weather proof seal around the base of the receiver.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Calibrating Proportional Controls

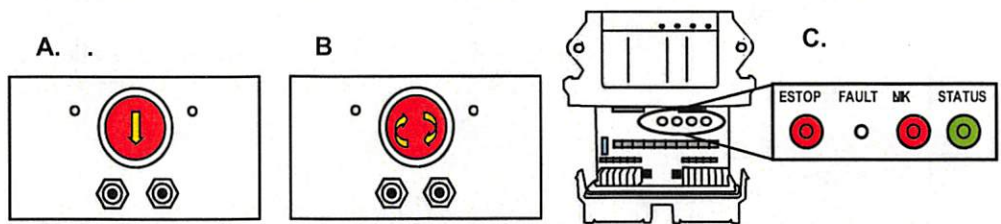
The transmitter's trigger controls the receiver's proportional output. The trigger is used in conjunction with any of the transmitter's switches. The proportional output can be activated when a switch is held UP or DOWN; it will become active at an increasingly high level as the trigger is pulled. The minimum and maximum levels of the proportional output can be calibrated by following these steps.

Refer to the **Light Legend** below for diagram details.

NOTE: Calibration settings can be reset to factory default in steps 4 & 5 by holding the [SW-5] switch UP or DOWN for 5 seconds.

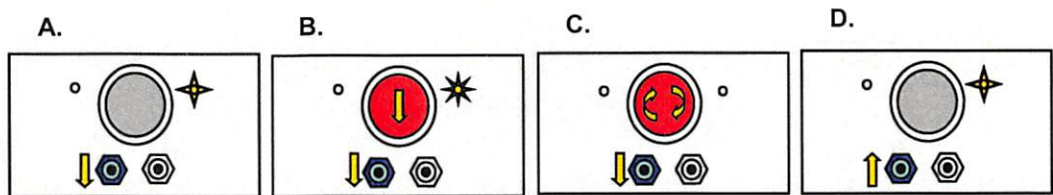
1. Prepare T150, Power R160

- A. Press [E-Stop]
- B. Twist clockwise & Release [E-Stop]
- C. Supply power to the receiver



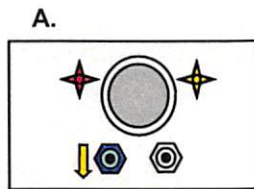
2. Power T150 into Configuration Mode

- A. Hold [SW-5] switch DOWN
- B. Press [E-Stop]
- C. Twist clockwise & release [E-Stop]
- D. Release [SW-5] Switch



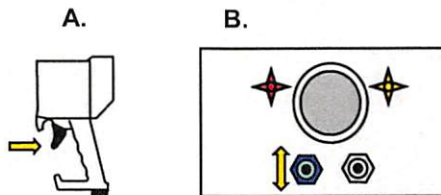
3. Setup T150

- A. Press [SW-5] switch DOWN



4. Set Minimum Level

- A. Keep Trigger released to set minimum level
- B. Press [SW-5] switch UP to increase minimum level or DOWN to decrease it

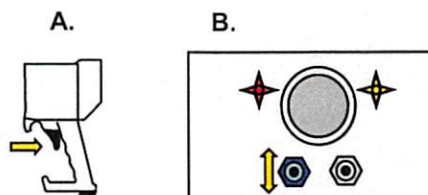


NOTE: All switches, except the [SW-5] switch, remain active in Calibration Mode.

A switch can be activated during calibration to help determine the desired levels.

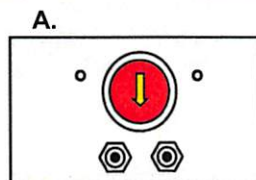
5. Set Maximum Level

- A. Keep Trigger fully engaged to set maximum level
- B. Press [SW-5] switch UP to increase maximum level or DOWN to decrease it






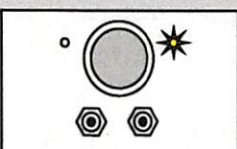
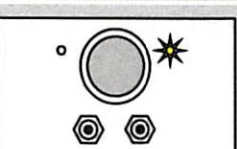
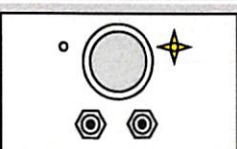

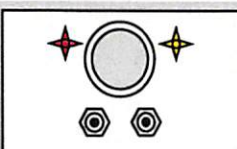
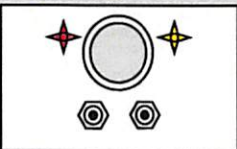
6. Power Off



- A. Press [E-Stop]



Light Legend							
Solid		Slow Flash		Fast Flash		Red Light	
Green Light		Yellow Light		Alternating Red & Green Light			

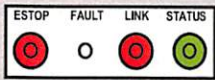
Diagnostics—T150 Transmitter

	Tether connection detected
	Low battery. Unit will run approximately 10 hours after Battery light starts flashing.
	Flashing rapidly for 10 seconds indicates a transmitter failure.
	Normal Operation The Active light will flash several times per second, indicating that the transmitter is sending signals to the receiver. The Active light will remain on momentarily whenever a function changes
	On Power Up Release the E-Stop button within 10 seconds to power up the transmitter, or the unit will power down.
	Normal Operation The transmitter is in Download Mode.
	On Power Up Press and release the E-Stop button within 10 seconds to power up the transmitter, or the unit will power down.
	Stuck switch detected. Ensure that all switches are in a centered position. The transmitter will not power up when a function is ON.
	On Power Down Unit is still powered. Check for stuck switches, as the transmitter will not power down when a function is ON. Alternating flash means that the transmitter is in Calibration Mode.

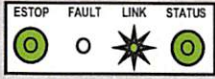
Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light
							

Diagnostics - R160 Receiver

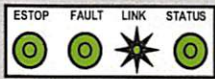
Normal Operation



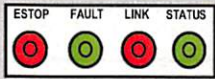
Transmitter is OFF
If the transmitter is off, the receiver is operating properly.



Transmitter is ON
When the transmitter is turned on, the Link light (fast flashing) and E-Stop (GREEN) indicates the receiver is operating properly



Transmitter is in Operation
When a function is activated on the transmitter, the Fault light will turn on GREEN. This indicates the receiver is operating properly



Transmitter is OFF
When a latched function is activated then the transmitter is turned off, the Fault light will stay on GREEN. If the system was intentionally designed this way, the receiver is operating properly, if not call for service.

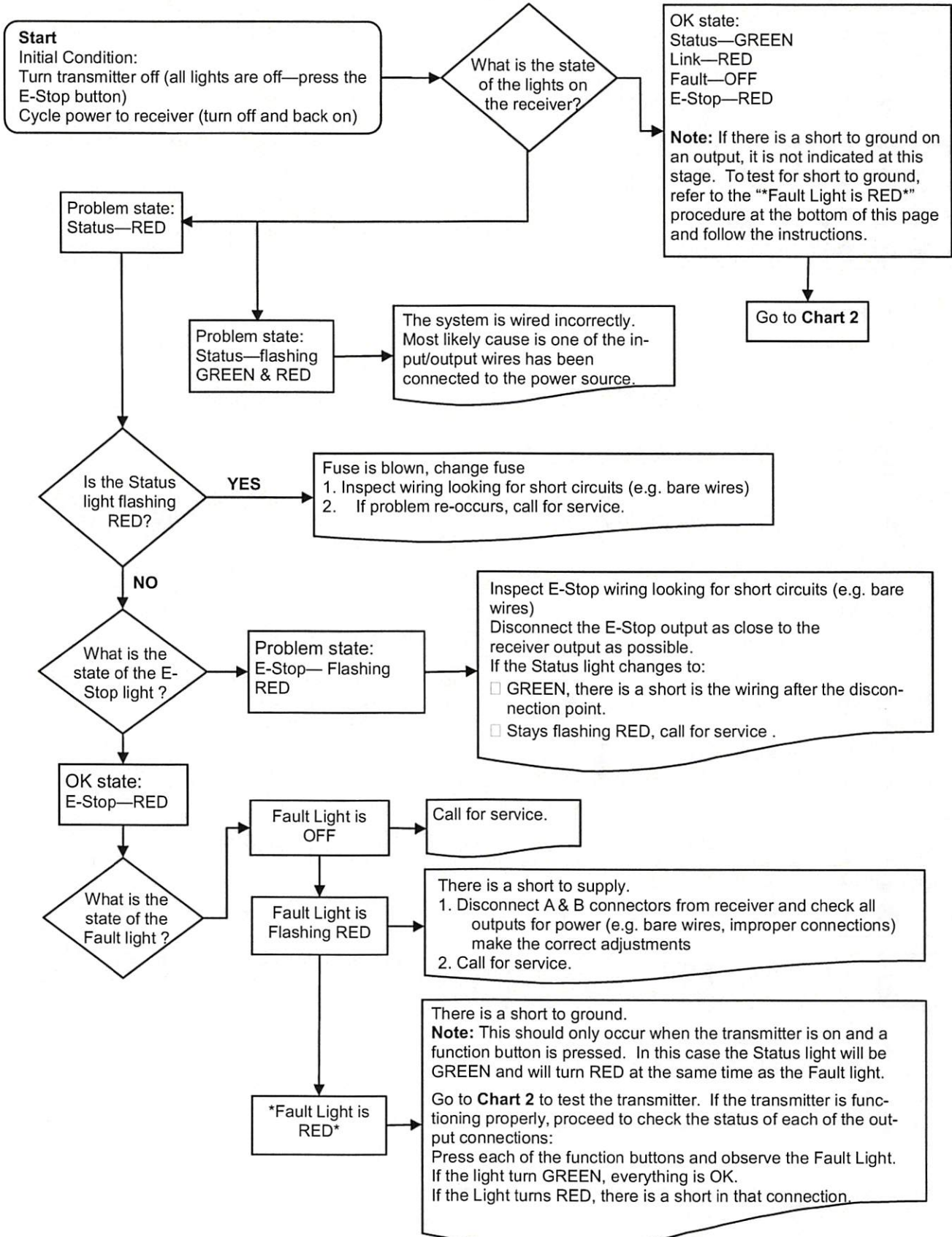
Trouble Indicators

Note: In some cases, the indicator lights will be different depending on whether the transmitter is on or off. Please note the transmitter status in the "Description" column for each case.

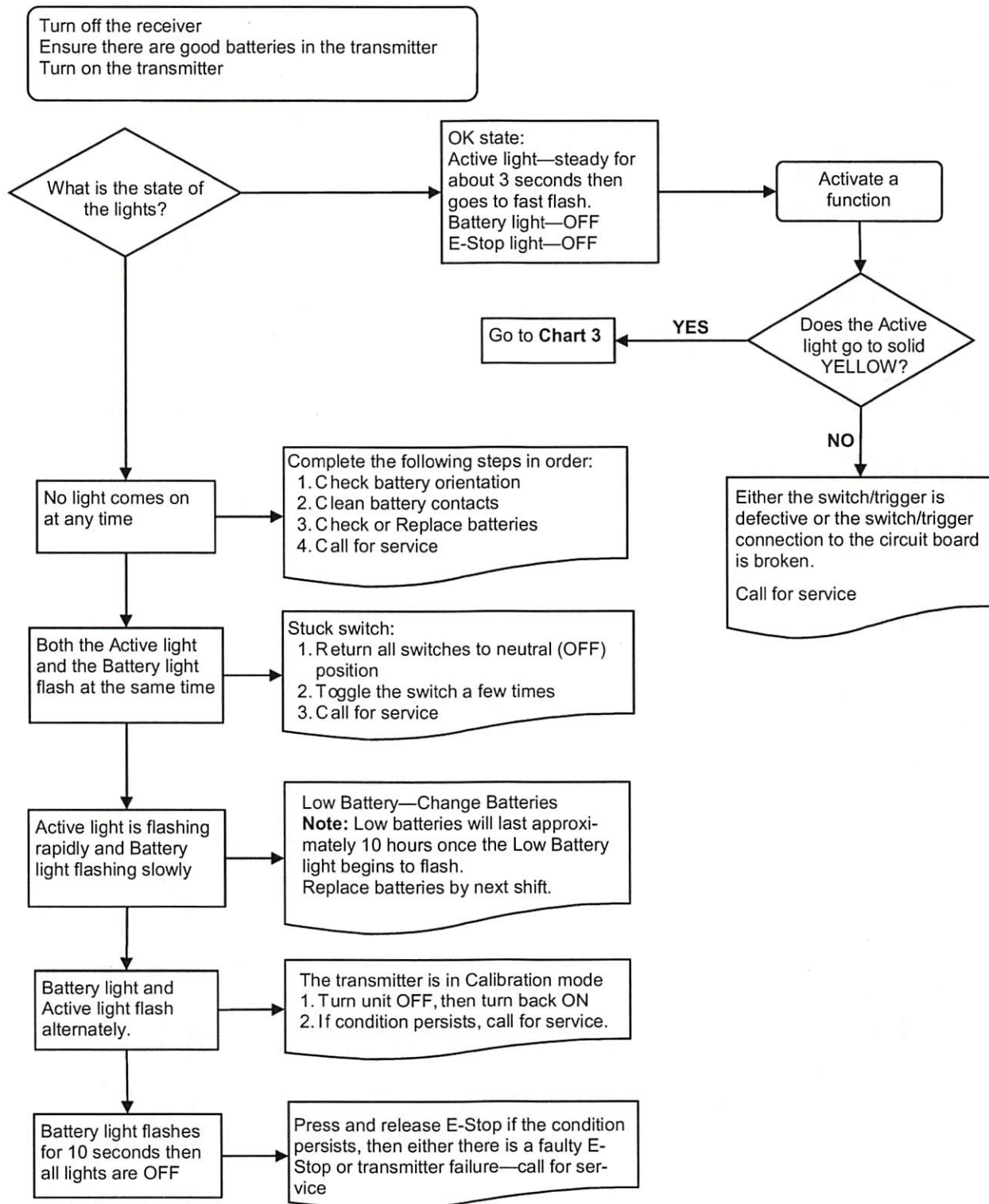
Indicator Lights	Description	Solution
	Transmitter is ON The reason is the transmitter is not communicating with the receiver.	Refer to Trouble Shooting Chart #3 for solutions
	Transmitter is ON A low battery condition has been detected.	To detect intermittent conditions caused by poor or corroded ground or power circuits, the GREEN light will continue to flash for 30 seconds after the condition has been removed.
	Transmitter is ON An internal fault with the E-Stop has been detected.	Inspect E-Stop wiring for short circuit. Disconnect E-Stop wire as close to the receiver output as possible. If the Status light changes to: <input type="checkbox"/> GREEN, a short occurs after disconnection point. <input type="checkbox"/> Stays flashing RED, send it in for service .
	Transmitter is ON A short to ground or excessive current draw on an output. It is most likely caused by a wiring fault.	Ensure transmitter is functioning properly, check status of each output connection: Press each function button and observe Fault Light. <input type="checkbox"/> If GREEN, everything is OK. <input type="checkbox"/> If RED, there is a short in that connection.
	Transmitter is ON The E-Stop output has been connected with one of the other outputs	Follow the wire and check for connections with other wires, disconnect to see if condition clears. If not, call for service.
	Transmitter is OFF A wiring short to the battery has been detected.	Refer to Trouble Shooting Chart #1 for solutions
	Transmitter is OFF The receiver has detected an internal fault.	Refer to Trouble Shooting Chart #1 for solutions
	Transmitter is OFF Blown fuse detected.	Refer to Page 8 for instructions on how to open the receiver case to access fuse. Check wiring for shorts or bare spots. If fuses continue to blow, call for service.
	Transmitter is ON A setup failure has occurred.	Either hold the Setup button for 5 seconds to return to Setup mode or cycle power to return to the normal operating mode.
	Transmitter is OFF The receiver is powered incorrectly.	Most likely cause of this condition is that an output wire or the E-Stop wire has been connected to the power supply while the power wire is disconnected from the power supply.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

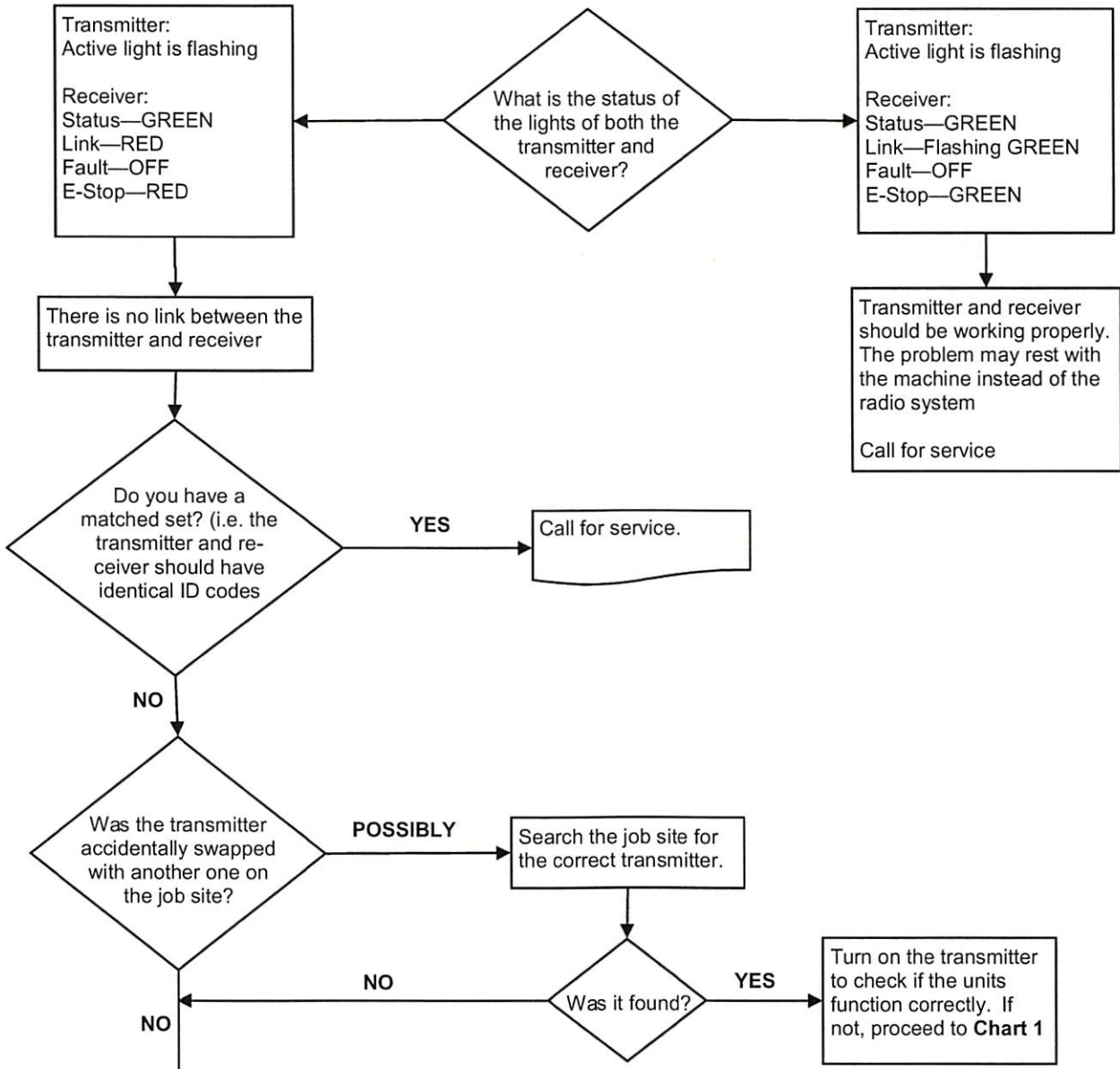
Test the Receiver—R160



Test the Transmitter—T150



Testing the Transmitter / Receiver Communication



!!Caution!!

Note: Before you proceed with the Download ID procedure located on **Page 8**, great care and caution must be adhered to. Also, refer to **Chart #4** for Tips and Considerations.

If by accident, the transmitters have been switched with another unit, by downloading the ID code to a new receiver, it is possible for the transmitter to operate 2 units at the same time (if the original receiver unit is still on the job site). Therefore it must be certain that the transmitter / receiver pair are the correct set.

Secondly, once the download procedure is completed, ensure all other units on the job site are stopped. Test the operation of the newly configured set to ensure no other machines on the site work with the same transmitter.

Once you are certain that the transmitter / receiver pair are a unique set, continue normal operations.

Considerations when Downloading the ID

Potential downloading issues

If testing of the receiver and transmitter both show the system as working (Chart 1 & 2), then the transmitter and receiver will both go into Download/Configuration mode.

Possible issues could arise during Step 4, the download phase of reprogramming. In this case there are 2 symptoms to look for:

1. The Link light on the receiver will not turn GREEN when the power switch is toggled on the transmitter to download
2. The receiver will "time out" indicating that it didn't receive a signal from the transmitter within the 30 seconds from the time the receiver was put into Setup Mode.

If all indications appear normal during the download phase, test the link by turning on the transmitter (note: the transmitter shuts off after transmitting the ID code in Step 4)

1. If the Link light on the receiver doesn't turn GREEN, the receiver didn't receive all of the information that was sent from the transmitter.

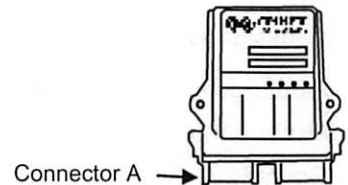
Possible Solutions

1. Try the Downloading steps again
2. If this doesn't correct the problem, send both the transmitter and receiver in for service.

Note: you could try to determine whether the fault lies with the transmitter or receiver by completing the downloading procedure with a different transmitter. If this step works, then the fault lies with the original transmitter. If not, the fault may lie with the receiver.

!!Caution!!

Note: Before attempting downloading with another transmitter, understand that reprogramming the receiver with another transmitter, could result in two receivers on the job site responding to the one transmitter. If the original transmitter was sent in for repair, Disconnect the receiver (disconnect connector A) to continue using the machine without remote capability and without fear of inadvertently operating the machine with the other transmitter.



Reprogramming Tips:

1. Use a pointy instrument to depress the Setup button on the receiver (i.e. a pen) as the button is relatively small
2. Follow each step as laid out in the procedure
3. Never lay the receiver circuit board down on anything metallic (there are contact points on the back which could contact the metal and damage the receiver)

Parts & Accessories

Part	Part Number	Description
Batteries	B0010	4 x AA alkaline
R160 Output Cables	ACAB-2493-01	Generic Output Cable- see illustration
	ACAB-2493-03	Output Cable with Tether connection
T150 Tether Cable (8 m. / 25 ft.)	ACAB-2455-02	see illustration
Toggle Switch	AKIT-1504-04	Keywell 1TL1-7
E-Stop Button	AKIT-1821-02	RAFIX16, 25mm, C&K 1.30074.2810300 See illustration
Magnet Back	AKIT-2498-02	see illustration
Bipolar Diode Kit	AKIT-2492-01	36V, Bi-directional, Motorola P6KE36CA
Fuse	F0039	Busman ATC-15
Socket Connectors	J0418	Grey, 12-pin, Deutsch DTM06-12SA
	J0419	Black, 12-pin, Deutsch DTM06-12SB
Wedge	J0420	12 pos., Deutsch WM12S
Pin	J0417	Female, Size 20, Deutsch 0462-201-20141
Sealing Plug	J0421	Size 20, Deutsch 0413-204-2005
R160 Connector Kit	AKIT-2337-01	Includes Deutsch socket connectors, wedges, pins and sealing plugs.



R160 Output Cable



Tether Cable



E-Stop



Magnet Back

Specifications

	R160 Receiver	T150 Transmitter
Size	5.1" x 4.7" x 1.4" (130mm x 119mm x 36mm)	7.9" x 4.2" x 4.1" (200mm x 125mm x 105mm)
Weight	0.65lbs (0.295kg)	1.8lbs (0.817kg)
Construction	High impact plastic, weatherproof	High impact, low temperature plastic, weatherproof
Input Power	+9V to 30VDC	4AA alkaline batteries
Battery Life	N/A	>120 hours (continuous use)
Operating Temperature Range	-40F to 158F (-40C to 70C)	-40F to 158F (-40C to 70C)
Outputs	3A (max) each (sourcing), 10A (max) each (combined)	N/A
Antenna	Internal	Internal
Approvals	USA- FCC part 15.247 Canada- ISC RSS 2210 Europe- EN 440 Australia- C-Tick	

FCC Rules and Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.

FCC part 15.247
ISC SS 219

Warranty

OMNEX Control Systems Inc. warrants to the original purchaser that the OMNEX products are free from defects in materials and workmanship under normal use and service for a period of ONE YEAR, parts (EXCLUDING: SWITCHES, CRYSTALS, OR PARTS SUBJECT TO UNAUTHORIZED REPAIR OR MODIFICATION) and labor from the date of delivery as evidenced by a copy of the receipt. OMNEX's entire liability and your exclusive remedy shall be, at OMNEX's option, either the (a) repair or (b) replacement of the OMNEX product which is returned within the warranty period to OMNEX freight collect by the OMNEX APPROVED carrier with a copy of the purchase receipt and with the return authorization of OMNEX. If failure has resulted from accident, abuse or misapplication, OMNEX shall have no responsibility to repair or replace the product under warranty. In no event shall OMNEX be responsible for incidental or consequential damage caused by defects in its products, whether such damage occurs or is discovered before or after replacement or repair and whether or not such damage is caused by the negligence of OMNEX Control Systems Inc.

OMNEX Control Systems Inc.

74-1833 Coast Meridian Road
Port Coquitlam, BC, Canada
V3C 6G5

Tel: 604-944-9247
Fax: 604-944-9267

Toll Free: 1-800-663-8806

www.omnexcontrols.com

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8



25' 24,000 LB. G.V.W.R.

Specifications of Sure-Trac Trailer - for transport of: SKYLIFT, INC. MINI-LINESMAN

- Total Length:** 31'
- Total Width:** 8-6"
- Front Deck:** 93" long x 72" wide with 2" x 6" pressure treated wood deck
- Empty Weight:** 4,175 lbs
- Cargo Deck:** 158" long x 67.5" wide with 2" x 6" pressure treated wood deck
- Tongue Length:** 6'
 - Dovetail:** 40" long with 6 degree slope
 - Axle:** (2) Two 12K oil bath slipper spring axles with electric brakes – 67.5" spring centers and 89.5" hub face
 - Tires:** (4) 215/75R-17.5
- Safety Chain:** 3/8" grade 70 – 36" overall length
 - Lights:** Rubber mounted sealed LED
 - Wiring:** Sealed wire harness
- Brake/Battery:** Breakaway switch / LED battery box
- Pintle Eye:** 21 ton 3" pintle ring with vertical adjustment of 18" to 32"
- Trailer Jack:** 12K drop leg jack
 - Ramps:** Spring assist ramps – 20" x 60"
 - Tool Box:** Tongue mounted 48"W x 19"D x 17"H

SURE-TRAC

Sure-Trac™ Brand Trailers and Accessories One Year Limited Warranty

Novae Corp. warrants to the original owner that your Sure-Trac trailer will be free from defects in material and workmanship for the one (1) year period commencing with the date of purchase, except as herein limited. The obligation of this warranty is limited to repairing or replacing any part or parts which, in the opinion of Novae Corp. is/are defective in material or workmanship under normal use and service.

90 Day Limited Warranty

Excluded from this One Year Limited Warranty are electrical components and lights, jacks, sealants, seals, locks, and couplers, which are warranted for a 90 day period commencing with the date of purchase.

Warranty Validation

Your new trailer must be registered with Novae Corp within ten (10) days of the original purchase. This purchaser record is required by Federal Law. Warranty registration forms are available on the web at www.novaeCorp.com or by calling customer service at 800-372-1755, one will be mailed to you.

How to Obtain Service

1. All warranty claims must be presented to Novae Corp. and proper arrangements must be made and approved by Novae Corp. prior to any work being done.
2. All warranty repairs must be performed at Novae Corp. unless prior approval is obtained from Novae Corp. In certain cases, Novae Corp may, at its sole discretion, elect to have warranty work performed by a qualified repair facility.
3. Novae Corp. will not be obligated in any way to pay for: repairs made without specific advance approval, labor charges in excess of those deemed reasonable by Novae Corp., or for any part costs in excess of the cost if Novae Corp. had supplied the parts. The cost of any replacement items will be limited to the amount of the original cost of that item as installed and sold by Novae Corp.
4. Any charges for: overtime labor, service calls, towing charges, expediting, freight or transportation costs are the sole responsibility of the consumer and will not be paid by Novae Corp.

Items Not Covered In This Warranty

1. Wheels and Tires. Contact the tire manufacturer for warranty information
2. Running Gear including axle and suspension assemblies. Present all claims directly to the axle manufacturer or their authorized dealers.
3. Paint finish and durability are not covered under this warranty.
4. Damage or defects resulting from misuse (including, but not limited to, overloading as determined by the gross vehicle weight rating as shown on the vehicle identification label, improper loading, negligence, alteration, accident or lack of maintenance.)
5. Maintenance items that are worn through normal use.
6. Damage caused by loose nuts, bolts or screws including improperly torqued wheel lug nuts.
7. Damage caused by the use of incorrect hitch ball, pintle, or improper hitching.
8. Loss of time, inconvenience, loss of trailer use, rental or substitute equipment, loss of revenues, or any other losses.
9. Damage or loss resulting from towing a trailer that exceeds the tow vehicle manufacturer's specific towing limitations.
10. Any travel time or expenses, such as food, fuel, lodging, etc., incurred to obtain service.

Any express warranty not provided herein, and any remedy for breach of contract which, but for this provision, might arise by implication or operation of law, is hereby excluded and disclaimed. The implied warranties for merchantability and of fitness for a particular purpose are expressly limited to a term of one (1) year. Under no circumstances will Novae Corp. be liable to purchaser or any other person for any special, incidental, or consequential damages, whether arising out of a breach of warranty, breach of contract or otherwise. This warranty gives you specific legal rights and you may have other rights which vary from state to state.

Novae Corp. neither assumes nor authorizes any other person to give any other warranty on its behalf. This warranty is not transferable from the original owner.

TIRE SAFETY

Everything Rides On It

The National Traffic Safety Administration (NHTSA) has published a brochure (DOT HS 809 361) that discusses all aspects of Tire safety, as required by CFR 575.6. This brochure is reproduced in part below. It can be obtained and downloaded from NHTSA, free of charge, from the following web site:

http://www.nhtsa.gov/cars/rules/tiresafety/ridesonit/tires_index.html

Studies of tire safety show that maintaining proper tire pressure, observing tire and vehicle load limits (not carrying more weight in your vehicle than your tires or vehicle can safely handle), avoiding road hazards, and inspecting tires for cuts, slashes, and other irregularities are the most important things you can do to avoid tire failure, such as tread separation or blowout and flat tires. These actions, along with other care and maintenance activities, can also:

- Improve vehicle handling
- Help protect you and others from avoidable breakdowns and accidents
- Improve fuel economy
- Increase the life of your tires

The following information presents a comprehensive overview of tire safety, including information on the following topics:

- Basic tire maintenance
- Uniform Tire Quality Grading System
- Fundamental characteristics of tires
- Tire safety tips

Use this information to make tire safety a regular part of your vehicle maintenance routine. Recognize that the time you spend is minimal compared with the inconvenience and safety consequences of a flat tire or other tire failure.

Safety First—Basic Tire Maintenance

Properly maintained tires improve the steering, stopping, traction, and load-carrying capability of your vehicle. Underinflated tires and overloaded vehicles are a major cause of tire failure. Therefore, as mentioned above, to avoid flat tires and other types of tire failure, you should maintain proper tire pressure, observe tire and vehicle load limits, avoid road hazards, and regularly inspect your tires.

Finding Your Vehicle's Recommended Tire Pressure and Load Limits

Tire information placards and vehicle certification labels contain information on tires and load limits. These labels indicate the vehicle manufacturer's information including:

- Recommended tire size
- Recommended tire inflation pressure
- Vehicle capacity weight (VCW—the maximum occupant and cargo weight a vehicle is designed to carry)
- Front and rear gross axle weight ratings (GAWR—the maximum weight the axle systems are designed to carry).

Both placards and certification labels are permanently attached to the trailer near the left front.

Understanding Tire Pressure and Load Limits

Tire inflation pressure is the level of air in the tire that provides it with load-carrying capacity and affects the overall performance of the vehicle. The tire inflation pressure is a number that indicates the amount of air pressure—measured in pounds per square inch (psi)—a tire requires to be properly inflated. (You will also find this number on the vehicle information placard expressed in kilopascals (kPa), which is the metric measure used internationally.)

Manufacturers of passenger vehicles and light trucks determine this number based on the vehicle's design load limit, that is, the greatest amount of weight a vehicle can safely carry and the vehicle's tire size. The proper tire pressure for your vehicle is referred to as the "recommended cold inflation pressure." (As you will read below, it is difficult to obtain the recommended tire pressure if your tires are not cold.)

Because tires are designed to be used on more than one type of vehicle, tire manufacturers list the "maximum permissible inflation pressure" on the tire sidewall. This number is the greatest amount of air pressure that should ever be put in the tire under normal driving conditions.



Checking Tire Pressure

It is important to check your vehicle's tire pressure at least once a month for the following reasons:

- Most tires may naturally lose air over time.
- Tires can lose air suddenly if you drive over a pothole or other object or if you strike the curb when parking.
- With radial tires, it is usually not possible to determine under inflation by visual inspection.

For convenience, purchase a tire pressure gauge to keep in your vehicle. Gauges can be purchased at tire dealerships, auto supply stores, and other retail outlets.

The recommended tire inflation pressure that vehicle manufacturers provide reflects the proper psi when a tire is cold. The term cold does not relate to the outside temperature. Rather, a cold tire is one that has not been driven on for at least three hours. When you drive, your tires get warmer, causing the air pressure within them to increase. Therefore, to get an accurate tire pressure reading, you must measure tire pressure when the tires are cold or compensate for the extra pressure in warm tires.

Steps for Maintaining Proper Tire Pressure

- Step 1: Locate the recommended tire pressure on the vehicle's tire information placard or certification label.
- Step 2: Record the tire pressure of all tires.
- Step 3: If the tire pressure is too high in any of the tires, slowly release air by gently pressing on the tire valve stem with the edge of your tire gauge until you get to the correct pressure.
- Step 4: If the tire pressure is too low, note the difference between the measured tire pressure and the correct tire pressure. These "missing" pounds of pressure are what you will need to add.
- Step 5: At a service station, add the missing pounds of air pressure to each tire that is underinflated.
- Step 6: Check all the tires to make sure they have the same air pressure (except in cases in which the front and rear tires are supposed to have different amounts of pressure).



If you have been driving your vehicle and think that a tire is underinflated, fill it to the recommended cold inflation pressure indicated on your vehicle's tire information placard or certification label. While your tire may still be slightly underinflated due to the extra pounds of pressure in the warm tire, it is safer to drive with air pressure that is slightly lower than the vehicle manufacturer's recommended cold inflation pressure than to drive with a significantly underinflated tire. Since this is a temporary fix, don't forget to recheck and adjust the tire's pressure when you can obtain a cold reading.

Tire Size

To maintain tire safety, purchase new tires that are the same size as the vehicle's original tires or another size recommended by the manufacturer. Look at the tire information placard or the sidewall of the tire you are replacing to find this information. If you have any doubt about the correct size to choose, consult with the tire dealer.

Tire Tread

The tire tread provides the gripping action and traction that prevent your vehicle from slipping or sliding, especially when the road is wet or icy. In general, tires are not safe and should be replaced when the tread is worn down to 1/16 of an inch. Tires have built-in tread wear indicators that let you know when it is time to replace your tires. These indicators are raised sections spaced intermittently in the bottom of the tread grooves. When they appear "even" with the outside of the tread, it is time to replace your tires. Another method for checking tread depth is to place a penny in the tread with Lincoln's head upside down and facing you. If you can see the top of Lincoln's head, you are ready for new tires.

Tire Balance and Wheel Alignment

To avoid vibration or shaking of the vehicle when a tire rotates, the tire must be properly balanced. This balance is achieved by positioning weights on the wheel to counterbalance heavy spots on the wheel-and-tire assembly. A wheel alignment adjusts the angles of the wheels so that they are positioned correctly relative to the vehicle's frame. This adjustment maximizes the life of your tires and prevents your car from veering to the right or left when driving on a straight, level road. These adjustments require special equipment and should be performed by a qualified technician.

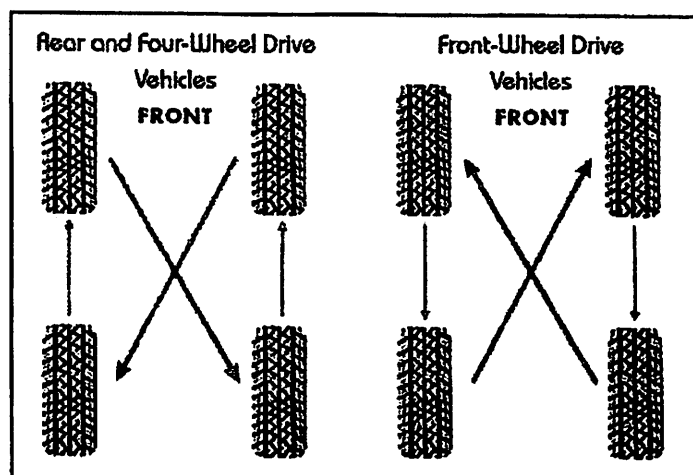
Tire Rotation

Rotating tires from front to back and from side to side can reduce irregular wear (for vehicles that have tires that are all the same size).

A Tire Rotation Example

For maximum mileage, rotate your tires every 5,000 miles.

Follow correct rotation patterns.



Tire Repair

The proper repair of a punctured tire requires a plug for the hole and a patch for the area inside the tire that surrounds the puncture hole. Punctures through the tread can be repaired if they are not too large, but punctures to the sidewall should not be repaired. Tires must be removed from the rim to be properly inspected before being plugged and patched.

Uniform Tire Quality Grading System (UTQGS)

To help consumers compare a passenger car tire's tread wear rate, traction performance, and temperature resistance, the federal government requires tire manufacturers to grade tires in these three areas. This grading system, known as the Uniform Tire Quality Grading System, provides guidelines for making relative comparisons when purchasing new tires. You also can use this information to inquire about the quality of tires placed on new vehicles.

Although this rating system is very helpful when buying new tires, it is not a safety rating or guarantee of how well a tire will perform or how long it will last. Other factors such as personal driving style, type of car, quality of the roads, and tire maintenance habits have a significant influence on your tire's performance and longevity.

Tread wear grades are an indication of a tire's relative wear rate. The higher the tread wear number is, the longer it should take for the tread to wear down. For example, a tire grade of 400 should wear twice as long as a tire grade of 200.

Traction grades are an indication of a tire's ability to stop on wet pavement. A higher graded tire should allow you to stop your car on wet roads in a shorter distance than a tire with a lower grade. Traction is graded from highest to lowest as "AA", "A", "B", and "C".

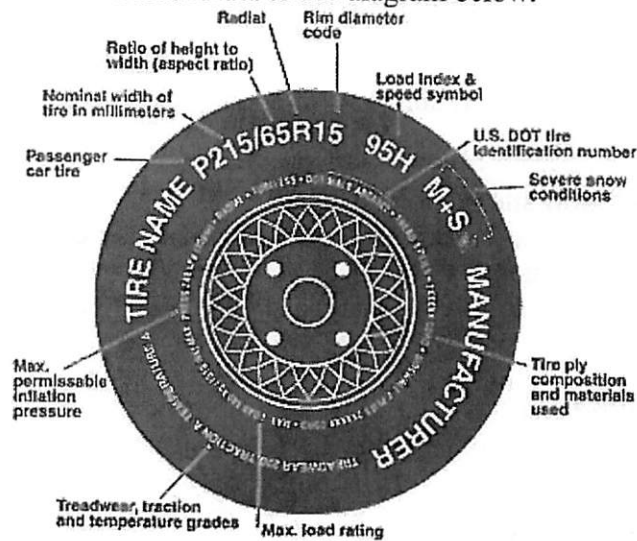
Temperature grades are an indication of a tire's resistance to heat. Sustained high temperature (for example, driving long distances in hot weather), can cause a tire to deteriorate, leading to blowouts and tread separation. From highest to lowest, a tire's resistance to heat is graded as "A", "B", or "C".

Tire Fundamentals

Federal law requires tire manufacturers to place standardized information on the sidewall of all tires. This information identifies and describes the fundamental characteristics of the tire and also provides a tire identification number for safety standard certification and in case of a recall.

Information on Passenger Vehicle Tires

Please refer to the diagram below.



P

The "P" indicates the tire is for passenger vehicles.

Next number

This three-digit number gives the width in millimeters of the tire from sidewall edge to sidewall edge. In general, the larger the number, the wider the tire.

Next number

This two-digit number, known as the aspect ratio, gives the tire's ratio of height to width. Numbers of 70 or lower indicate a short sidewall for improved steering response and better overall handling on dry pavement.

R

The "R" stands for radial. Radial ply construction of tires has been the industry standard for the past 20 years.

Next number

This two-digit number is the wheel or rim diameter in inches. If you change your wheel size, you will have to purchase new tires to match the new wheel diameter.

Next number

This two- or three-digit number is the tire's load index. It is a measurement of how much weight each tire can support. Note: You may not find this information on all tires because it is not required by law.

M+S

The "M+S" or "M/S" indicates that the tire has some mud and snow capability. Most radial tires have these markings; hence, they have some mud and snow capability.

Speed Rating

The speed rating denotes the speed at which a tire is designed to be driven for extended periods of time. Please remember, no trailer is to be hauled at speeds exceeding 60MPH.

U.S. DOT Tire Identification Number

This begins with the letters "DOT" and indicates that the tire meets all federal standards. The next two numbers or letters are the plant code where it was manufactured, and the last four numbers represent the week and year the tire was built. For example, the numbers 3197 means the 31st week of 1997. The other numbers are marketing codes used at the manufacturer's discretion. This information is used to contact consumers if a tire defect requires a recall.

Tire Ply Composition and Materials Used

The number of plies indicates the number of layers of rubber-coated fabric in the tire. In general, the greater the number of plies, the more weight a tire can support. Tire manufacturers also must indicate the materials in the tire, which include steel, nylon, polyester, and others.

Maximum Load Rating

This number indicates the maximum load in kilograms and pounds that can be carried by the tire.

Maximum Permissible Inflation Pressure

This number is the greatest amount of air pressure that should ever be put in the tire under normal driving conditions.

UTQGS Information

Tread wear Number

This number indicates the tire's wear rate. The higher the tread wear number is, the longer it should take for the tread to wear down. For example, a tire graded 400 should last twice as long as a tire graded 200.

Traction Letter

This letter indicates a tire's ability to stop on wet pavement. A higher graded tire should allow you to stop your car on wet roads in a shorter distance than a tire with a lower grade. Traction is graded from highest to lowest as "AA", "A", "B", and "C".

Temperature Letter

This letter indicates a tire's resistance to heat. The temperature grade is for a tire that is inflated properly and not overloaded. Excessive speed, under inflation or excessive loading, either separately or in combination, can cause heat build-up and possible tire failure. From highest to lowest, a tire's resistance to heat is graded as "A", "B", or "C".

Tire Safety Tips

Preventing Tire Damage

- Slow down if you have to go over a pothole or other object in the road.
- Do not run over curbs, and try not to strike the curb when parking.

Tire Safety Checklist

- Check tire pressure regularly (at least once a month), including the spare.
- Inspect tires for uneven wear patterns on the tread, cracks, foreign objects, or other signs of wear or trauma. Remove bits of glass and other foreign objects wedged in the tread.
- Make sure your tire valves have valve caps.
- Check tire pressure before going on a long trip.
- Do not overload your vehicle. Check the tire information placard for the maximum recommended load for the vehicle.
- If you are towing a trailer, remember that some of the weight of the loaded trailer is transferred to the towing vehicle.

Reporting Safety Defects

If you believe that your vehicle has a defect that could cause a crash or could cause injury or death, you should immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying Novae Corporation at 1-800-372-1755.

If NHTSA receives similar complaints, it may open an investigation, and if it finds that a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you, your dealer, or Novae Corporation.

To contact NHTSA, you may either call the Vehicle Safety Hotline toll-free at 1-888-327-4236 (TTY: 1-800-424-9153), go to <http://www.safecar.gov> or write to:

Administrator
NHTSA
1200 New Jersey Avenue S.E.
Washington, DC 20590

You can also obtain information about motor vehicles safety from <http://www.safecar.gov>.

Sure-Trac™ Trailer Warranty Registration Form

Trailer Model: _____ Date: _____

Vehicle Identification Number (VIN): _____

Owners Name: _____ Phone Number: _____

Street: _____

City, State Zip: _____

Primary Use: _____

Store and Location where purchased: _____ Delivery Date: _____

Store Representative: _____ Signature: _____

(Fold to conceal information, tape closed, affix postage and mail)

SURE-TRAC™

Name: _____

Address: _____

City, State Zip: _____

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Novae Corp.
One Novae Parkway
Markle, IN 46770



TRAILER AXLE (8K-12K)

OWNER'S MANUAL

L I P P E R T
C O M P O N E N T S[®]

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Introduction

Combining years of experience in the trailer frame and recreational vehicle industry with the newest and most innovative technology, Lippert Components, Inc. introduces its newest addition, The Axle and Running Gear Division.

The following publication is designed to give the customer an easy-to-understand operation and service manual to provide useful and important information. The quality of the Lippert name and the finest materials utilized in the production of the Axles and Running Gear provide you with hubs, brakes, drums and spindles that make trailering and braking the finest in the industry.

Quality comes threefold in Lippert Components, Inc.

1. The finest quality materials.
2. The latest technology and design.
3. The quality standards maintained from materials to final assembly.

All three points provide the customer with the best product they can possibly buy and the satisfaction of knowing they can trust the equipment on which they have spent their hard-earned money.

Lippert Components, Inc. thanks you for purchasing our Axles and Running Gear. When you speak of Lippert Components, Inc., our quality stands beside you.

Safety Information



The "WARNING" symbol above is a sign that a service or maintenance procedure has a safety risk involved and may cause death or serious injury if not performed safely and within the parameters set forth in this manual.

Always wear eye protection when performing service or maintenance to the vehicle. Other safety equipment to consider would be hearing protection, gloves and possibly a full face shield, depending on the nature of the service.

This manual provides general service and maintenance procedures. Many variables can change the circumstances of the service procedure, i.e., the degree of difficulty involved in the service operation and the ability level of the individual performing the operation. This manual cannot begin to plot out procedures for every possibility, but will provide the general instructions for effectively servicing the vehicle. In the event the skill level required is too high or the procedure too difficult, a certified technician should be consulted before performing the necessary service. Failure to correctly service the vehicle may result in voiding the warranty, inflicting injury or even death.

The owner's manual for your unit may have more procedures for service and maintenance.

Break-In Period For Electric Drum Brakes

The break-in period is a typical phenomenon with drum brakes and especially electric drum brakes. Electric drum brakes will require a break-in period to achieve full performance. This break-in period applies for new axles and any time new brake shoes and/or magnets are installed as part of regular maintenance.

Lippert Components has found through extensive brake testing that the break-in period for our drum brakes can range from 20 to 50 brake applications.

Brakes can be seated in by applying approximately 8-10 volts to the trailer brakes at an initial speed of 40 mph and allowing the truck/trailer combination to slow down to 20 or 25 mph. For best results do not use truck brakes during this procedure. The trailer brakes will seat in faster by using them to stop both the truck and trailer. The easiest method is to apply the trailer brakes using the manual activation lever located on the in-cab brake controller. Care **MUST** be taken to not overheat the lining material, therefore brake applications conducted at one-mile intervals will suffice. The driver should feel a noticeable difference in the brake performance during this period, sometimes in as few as 10 applications. After 50 applications, the brake lining material will be fully cured from the heat and develop close to 100% contact with the brake drum surface.

This break-in period not only seats the shoe lining material but also seats in the brake electromagnets. During the break-in period, the linings will wear at a faster rate than they do after they are seated in.

NOTE: Brakes should be manually adjusted after the first 200 miles of operation and periodically thereafter, approx. 3,000 mile intervals.

Hubs/Drums/Bearings

Hub Removal

To remove the hub assembly for inspection, maintenance or service, follow the six (6) steps below:

⚠ WARNING

Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing death or serious injury.

1. Lift trailer and support it per manufacturer's requirements.
2. Remove the wheel.
3. Remove the grease cap by prying the edge out of the hub. If equipped with oil lubrication, unscrew oil cap using a 2 ¼" socket (8K) or 2½" socket (10-12K). Let oil drain into pan.
4. Pull the cotter pin from the castle nut and remove the outer spindle nut.
5. Remove the spindle washer.
6. Pull the hub off the spindle. Do not let the outer bearing cone fall free of the assembly. The inner bearing cone will be contained by the seal and will not fall out.

NOTE: Brakes may need to be adjusted or backed off to remove drum from spindle.

NOTE: A gear puller may be necessary to remove hub from spindle.

Brake Drum Inspection

The brake shoes contact the drum surface and the magnet contacts the armature. These surfaces are subject to wear and should be inspected periodically.

The drum surface should be re-machined if wear is more than .030" or out of round by more than .015". The drum should be replaced if scoring or wear is greater than .090".

The inner surface of the brake drum that contacts the brake magnet is the armature surface. If the armature surface is scored or worn unevenly, it should not be machined more than .030". The magnets should be replaced whenever the armature surface is refaced and vice versa.

NOTE: Ensure that the wheel bearing cavities are clean and free of contamination before reinstalling bearing and seals. Resurfacing procedures can produce metal chips and dust that can contaminate the wheel bearings and cause failure.

Drum	Maximum Re-bore Diameter
12.25"	12.340"

Bearing Inspection

Wash all grease and oil from the bearing cone using a suitable solvent. Dry the bearing with a clean, lint-free cloth and inspect each roller completely. If any pitting, spalling, or corrosion is present, then the bearing **MUST** be replaced. The bearing cup inside the hub **MUST** be inspected.

NOTE: Bearings **MUST** always be replaced in sets of one cone and one cup.



Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

Follow the procedure below to replace the bearing cup:

1. Place hub on a flat surface with bearing cup on the bottom.
2. With brass drift punch, lightly tap around the small end of the cup to push it out.
3. Clean the hub bore. Replace the cup by tapping it back in with the brass drift punch. Cup should be seated against the retaining shoulder in the hub.

NOTE: Consult Bearing Replacement Chart for proper replacement bearings.

NOTE: Replacing the bearing cup is a very precise process. The cup **MUST** be perfectly seated when replaced. If the cup is not seated correctly, damage to the assembly may not be covered by the warranty. Consult Lippert Components, Inc. prior to replacing bearing and bearing cup. The trailer should be taken to a certified service center for this work to be done.



Do not mix Lithium, calcium, sodium or barium complex greases. Chemical compatibility problems may occur. If you are changing from one chemical grease to another, be sure all old grease is removed prior to applying new grease. If the old grease is not removed completely, chemical compatibility may result in component failure or damage.

Bearing Lubrication - Grease

Bearing grease should be replaced every 12,000 miles or 12 months, whichever comes first. Remove all old grease from wheel hub and bearings first. Bearings should be packed by machine if possible. Packing bearings by machine is preferable; however, packing by hand is a viable alternative.

Follow these procedures to repack bearings by hand:

1. Place grease into the palm of your hand (Fig. 1).
2. Press widest end of bearing into the outer edge of the grease pile, forcing grease into the inner area of the bearing between two adjacent rollers (Fig. 2).
3. Repeat this process while turning bearing from roller to roller until all rollers are coated.
4. Apply a light coat of grease to the bearing cup surface.
5. Reassemble bearing into cup.



Recommended Wheel Bearing Grease Specifications	
Thickener Type	Lithium Complex
Dropping Point	230°C (446°F) Minimum
Consistency	NLGI No. 2
Additives	EP, Corrosion, & Oxidation Inhibitors
Base Oil	Solvent Refined Petroleum Oil
Base Oil Viscosity	@40°C (104°F) 150cSt (695 SUS) Minimum
Viscosity Index	80 Minimum
Pour Point	-10°C (14°F) Minimum

Approved Sources	
Mobil Oil	Mobilgrease HP
Exxon/Standard	Ronex MP
Kendal Refining Co.	Kendall L-427
Ashland Oil Co.	Valvoline Val-plex EP Grease
Pennzoil Prod. Co.	Premium Wheel Bearing Grease 707L

Seal Inspection and Replacement

Always check the seal to make sure that it is not damaged, nicked, cracked or torn and is in good working order. If there is any question of condition, replace the seal.

Procedure to replace seal:

1. Pull seal from the hub with a seal puller. Never push the seal out with the bearing. The bearing may get damaged.
2. Apply a PERMATEX sealant to the outside of the new seal.

NOTE: Do not use PERMATEX on rubber encased seals.

3. Tap the new seal into place using a clean, hardwood block (Fig. 3).

NOTE: When installing a new oil seal, be sure side marked "AIR SIDE" is away from bearing cone.

Fig. 3

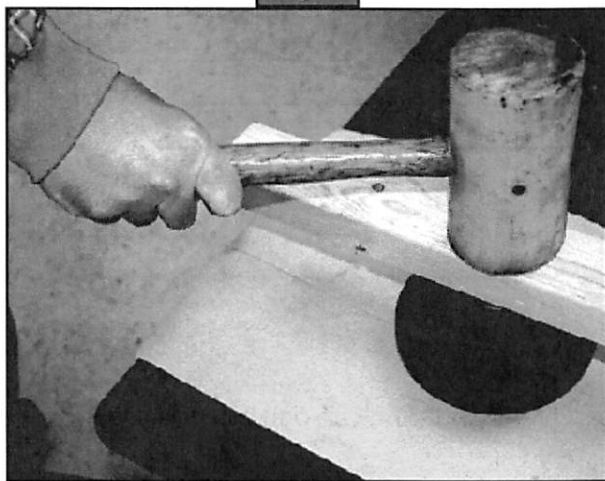
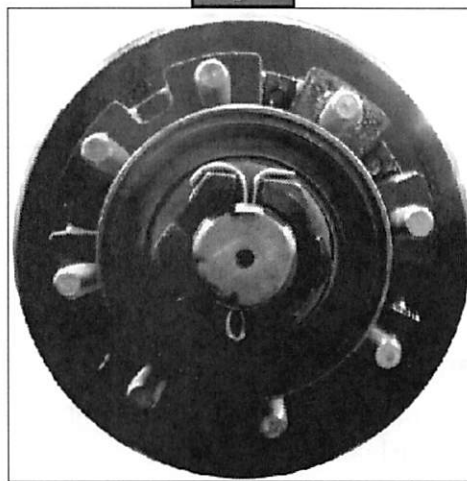


Fig. 4



Bearing Adjustment/Hub Replacement

To adjust bearings or replace removed hub, follow procedures below:

1. Place hub, bearing, washers and castle nut back on axle spindle in the reverse order from which they were removed. Castle nut should be torqued to 50 ft.-lb. Hub will rotate during this process.
2. Loosen castle nut to back off the torque.
3. Tighten castle nut finger tight until snug.
4. Insert cotter pin. If cotter pin does not line up with hole, back castle nut up slightly until pin can be inserted (Fig. 4).
5. Bend cotter pin over to lock nut in place. Nut should be free to move with only the cotter pin keeping it in place.
6. Tighten screw in cap to 25 ft.-lbs.

Lubrication

Bearing Lubrication - Oil

Your axle bearings are lubricated with a SAE 80-90W hypoid gear oil. Periodically check and refill the hub as necessary to the level indicated on the clear plastic oil cap. The oil can be filled through the cap by removing the rubber plug. In order to check oil level, do so after unit has been parked for a few minutes.

Recommended Oil Lube for axle bearings:

Oil designation: SAE 90, SAE 80W-90, SAE 75W-90

Approved Sources	
Union Oil Co.	Unocal MP Gear Lube
Exxon Co.	Gear Oil GX 80W-90
Mobil Oil	Mobilube SHC 75W-90
Pennzoil Co.	Gear Plus 80W-90 GL-5
	Gear Plus Super 75W-90

Oil Cap and Oil Seal

The clear plastic oil cap should be tightened to 25 ft-lbs. Over-tightening can damage the sealing o-ring and cause an oil leak.

In order to remove hub/rotor assembly a gear puller may be required. The oil seal is a 2 part seal where the inside diameter of the seal presses onto the spindle journal and the outside diameter of the seal presses into the hub bore. Therefore a gear puller is the most efficient way to remove hub from spindle. A new oil seal **MUST** be installed before reassembly or the old seal will leak upon re-installation and use. When reinstalling a new oil seal, be sure to correctly orient the seal. Most are marked "AIR SIDE." This side **MUST** not be placed towards the oil and bearing or it will fail in service. Install new seal using a block of wood and hammer to drive the seal in the seal bore square until the outer face of the seal is flush with the seal bore face. Do not use permatex on rubber encased oil seals.

Periodic Bearing Inspection

A physical bearing inspection should be conducted every 15,000 miles. An inspection of the bearing condition can detect early bearing issues. Upon inspection, bearings should look brand new and can be reassembled and used if in this condition. If discoloration, pitting, corrosion, flat spots or some abnormal condition is observed, the bearing and race should be replaced at the same time. Bearings are available at auto part stores, see components pages (27-36) for part numbers.

Spindle Nut Adjustment

The proper method to assemble the spindle nut is as follows:

1. After hub installation onto spindle, install outer bearing.
2. Install spindle washer and thread on spindle nut with slots facing outward.
3. Tighten spindle nut with a pair of slip joint pliers to approx 50 ft-lbs.
4. Back off torque usually $\frac{1}{4}$ turn so that you can finger tighten the spindle nut.
5. Finger tighten, drop cotter pin through slot and hole in spindle. If slot in nut does not align with hole in spindle, back nut off until it does, never tighten past finger tight.
6. Bend legs over end of spindle and be sure legs do not interfere with oil cap upon reassembly.

Disc Brake Option

Disc Brake Pads

Disc brake pads are available through auto part stores. Brake pads are a consumable item so be sure to visually check pads every 3,000 miles. Be sure to also check rotor surfaces visually when you are checking the brake pads. Deep groves developing on one or both rotor surfaces can indicate a caliper piston, slider bolt or residual pressure problem if this ever occurs. Brake rotors should be turned when disc brake pads are replaced.

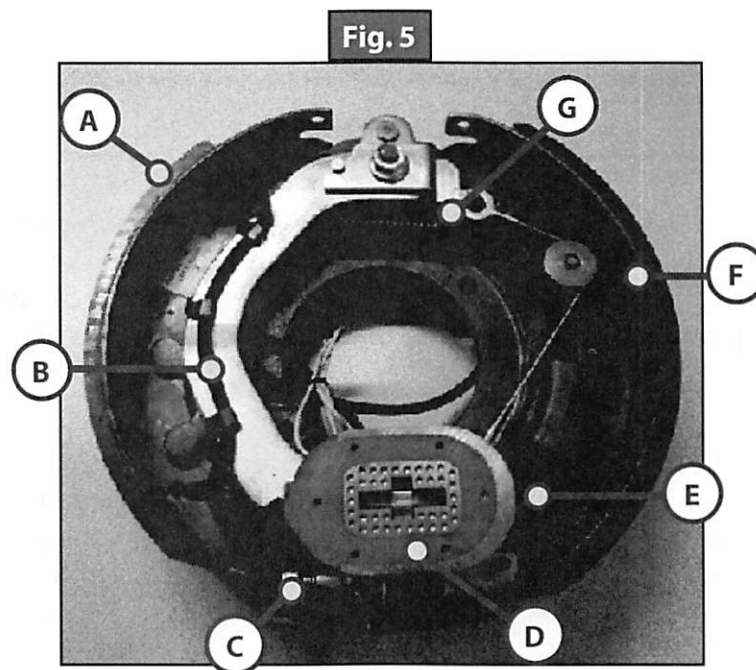
Disc Brake Caliper

The proper mounting torque for the disc brake caliper mounting bolts is 40-50 ft-lbs. If these are removed for servicing the brake system, add blue thread locking compound to the threaded area of the bolt at time of reassembly. Also lubricate the inside of caliper bushings that the slider bolts go through. Be sure to only use silicone based grease. The rubber bushings are not compatible with petroleum-based greases.

Electric Brakes

The basic structure of the Electric Brakes on your trailer will resemble the brakes on your car or tow vehicle, with one major difference; your trailer implements an Electric Actuation system and your tow vehicle utilizes a hydraulic system. The Electric Braking System operates in the following order of steps: (Refer to the Electric Braking System Diagram and the brake diagram below to follow along.)

1. Electric current is supplied to the trailer's braking system when the tow vehicle's brakes are applied.
2. From the tow vehicle's battery, the electricity flows to the brake's electromagnet.
3. When energized the magnets are attracted to the rotating surface of the drums.
4. This moves the actuating levers in the direction the drums are turning.
5. The actuating cam at the end of the shoe forces the primary shoe out to the drum surface.
6. The force of the primary shoe actuates the secondary shoe to contact the drum.
7. The force applied to the brake drum can be increased by elevating the current flow to the magnet.



Callout	Description
A	Primary Shoe
B	Actuating Lever
C	Adjuster
D	Magnet
E	Adjusting Spring
F	Secondary Shoe
G	Retracting Spring

How To Use Lippert Electric Brakes Properly

The Lippert Components, Inc. Electric Braking System is synchronized with the tow vehicle brakes. Never attempt to stop the combined load of the tow vehicle and the trailer by using either the tow vehicle brakes or the trailer brakes only. They are designed to work together.

Small manual adjustments may occasionally be necessary to accommodate changing loads and driving conditions. Synchronization of tow vehicle to trailer braking can only be accomplished by road testing. Locking up, excessive grab, or delayed application is quite often due to the lack of synchronization between the tow vehicle and the trailer being towed. High voltage (2V+), Low voltage (2V-) or improperly adjusted brakes are the most common causes of these problems and can be easily remedied.

Prior to any adjustments, your trailer brakes should be burnished-in by applying the brakes 20-30 times with a 20 m.p.h. decrease in speed, e.g. 40 m.p.h. to 20 m.p.h. Allow ample time for brakes to cool between application. This allows the brake shoes and magnets to begin seating to the brake drum.

Trailer Wire Gauge Chart		
Wire Gauge and Type	Number of Axles	Length of Run
16 Ga Stranded Copper	1	N/A
14 Ga Stranded Copper	2	Under 30ft. (9.1m) from hitch to center of axles
12 Ga Stranded Copper	2 or 3	Over 30ft. (9.1m) from hitch to center of axles

General Maintenance - Electric Brakes

Brake Adjustment



Prior to testing or adjusting brakes, be sure area is clear of any persons and vehicles. Failure to perform test in a clear area may result in death or serious injury.

Lippert Components, Inc. Electric Brakes are automatic adjust only. If manual adjusting is needed, the following 6-step procedure can be utilized. The brakes should be adjusted in the following manner:

1. Jack up trailer and secure on adequate capacity jack stands. Follow trailer manufacturer's recommendations for lifting and supporting the unit. Make sure the wheel and drum rotates freely.



Lift unit by frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing death or serious injury.

2. Remove the adjusting hole cover from the adjusting slot on the bottom of the brake backing plate.
3. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust the brake shoes out until the pressure of the linings against the drum makes the wheel very difficult to turn.
4. Then rotate the starwheel in the opposite direction until the wheel turns freely with a slight lining drag.

NOTE: A second screwdriver will be needed to push the auto adjusting lever away from the adjuster starwheel so that the starwheel can be rotated backwards.

5. Replace the adjusting hole cover and lower the wheel to the ground.
6. Repeat the above procedure on all brakes. For best results, the brakes should all be set at the same clearance.

Lubricate Brakes

Prior to reassembling the brake drum assembly, remember to apply a light film of white grease or an anti-seize compound on the brake anchor pin, the actuating arm bushing and pin, and the areas on the backing plate that are in contact with the brake shoes and magnet lever arm. In addition, apply a light film of grease on the actuating block mounted on the actuating arm.

Clean and Inspect Brakes

In the event the braking system encounters symptoms of improper application or failure, immediate inspection and service **MUST** be implemented. During normal use, servicing the braking system once a year is considered normal. Increased usage will require service on a regulated schedule based on 3000-6000 mile increments. As magnets and shoes become worn, they need to be changed to maintain maximum braking capability.

Be sure, when disassembling brakes for cleaning, to clean the backing plate, magnet arm, magnet and shoes. Also, make sure that any and all parts removed for cleaning are placed back into the same brake drum assembly. This is also an excellent time to check for parts that have become loose or worn.

⚠ WARNING Potential Asbestos Dust Hazard.

Older brake linings have the potential to contain asbestos dust, which has been linked to serious or fatal illnesses. Certain precautions **MUST** be taken when servicing brakes:

1. Avoid creating and/or breathing any brake dust.
2. Do not machine, file, or grind the brake linings.
3. Remove with a damp brush or cloth. Dry brushing or compressed air will cause the dust particles to become airborne.

Magnets

This electric braking system utilizes an electromagnet to actuate the brake shoes. These high-quality magnets provide superior force and friction to safely and effectively stop the trailer. These magnets should be inspected and serviced on the same schedule as the rest of the axle system, at least once a year for normal use and more often if the trailer is used extensively. Abnormal or uneven wear is a sign that the magnet needs to be replaced. Check the surface of the magnet with a straight edge to check for uneven wear. The surface of the magnet should be completely flat.

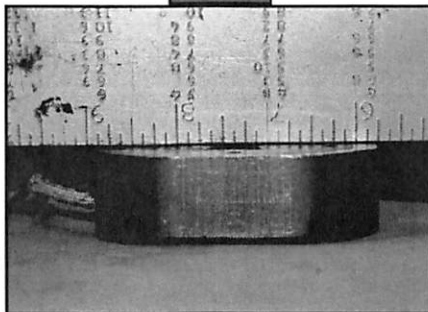
If the magnet's coil is exposed in any way, even if normal wear is evident, the magnets should be replaced immediately. If the electromagnets are replaced, the drum armature surface should also be refaced. If a magnet is replaced on one side of an axle, it is recommended that the magnet on the opposite brake assembly also be replaced to ensure even braking capacity.

Figure 6 (Page 14) shows an Electro-Magnet with little or no wear. If there are any pronounced gaps on the surface of the Electro-Magnet, the magnet should be replaced.

Shoes and Linings

Linings should be replaced if the material is worn to $\frac{1}{16}$ " or less. Shoes should also be replaced if they become contaminated with grease or oil or have become scored, pitted or gouged. Heat cracks are normal and rarely require attention. When replacing shoes, both shoes on the same brake and the brakes on the same axle should all be replaced at the same time, once again ensuring even braking capacity. After replacing shoes and linings, your trailer brakes should be burnished-in by applying the brakes 20-30 times with a 20 mph decrease in speed, e.g. 40 mph to 20 mph. Allow ample time for brakes to cool between application. This allows the brake shoes and magnets to begin seating to the brake drum.

Fig. 6



Axle and Suspension Installation

The single most important portion of axle installation is parallel alignment of the trailer axle(s) to the tow vehicle or drive axle(s). Parallel installation allows for correct and safe control, prolonged tread life and will all but eliminate dog-tracking. Proper alignment is most readily achieved by measuring from the center of the trailer king pin to the center of each end of the axles.

Lippert Components, Inc. tubular axles are made of high strength steel to prevent metal fatigue and provide the best possible welding conditions. The round tubular axles allow for even and uniform structure.

CAUTION

Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

Suspension Systems

The suspension systems incorporated into Lippert Component, Inc. axles are designed to provide the following benefits:

1. Attach the axle to the trailer.
2. Dampen the effects of road shock.
3. Provide stability to the trailer.

All Lippert suspension systems are available in single and multiple axle configurations. For specific or custom applications, please contact Lippert Components, Inc. Axle Division.

Double-Eye Leaf Springs

Double-eye leaf springs have eyes at either end of the spring assembly with nylon bushings to assist in preventing wear. U-bolts hold the springs to the axle with a plate.

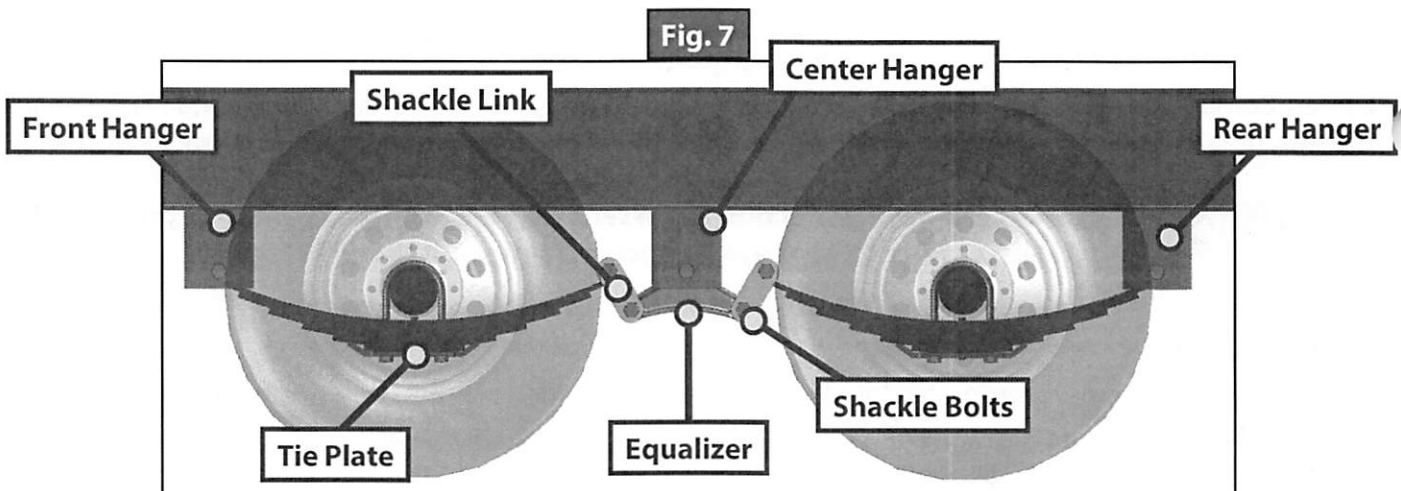
The articulation of this suspension occurs when the eyes rotate on the wear surfaces provided in eyes of the springs and on the equalizers. This suspension is also available in single and multiple axle configurations. In trailers with 2 or more axles, the additional movement is maintained by an equalizer. This feature allows for even load handling from axle to axle.

Double-eye suspension systems are available on 8,000 lb. axles. Tandem and triple axle mounting kits are available for both 33" and 35" axle spacing.

Slipper Leaf Springs

Slipper springs have a loop eye formed on one end and a reverse radius on the other. The front eye is secured to either the front hanger or rear of the equalizer with a bolt and nut. The slipper end rides against a wear block located in either the front of the equalizer or the rear hanger.

A keeper bolt or strap is placed under the slipper end to contain spring when the trailer is lifted off the ground. 8K tandem and triple axle attaching kits are available for both 33.5" and 36" axle spacing. 10K and 12K tandem and triple axle kits are also available for 42.25" or 48.25" axle spacing.



Inspection

All the components of your suspension system should be visually inspected for signs of wear, damage or loose fasteners at least every 6,000 miles. When replacing or tightening loose fasteners, consult the torque specs below for correct torque values.

Equalizer and Spring Eye Nut Torque Specifications	
Bolt Type	Torque
$\frac{3}{16}$ " 8K U-Bolt Nuts	90 ft-lbs
$\frac{5}{8}$ " 10K U-Bolt Nuts	95 ft-lbs
$\frac{5}{8}$ " 12K U-Bolt Nuts	115 ft-lbs
$\frac{3}{16}$ " Shoulder Bolts	35 ft-lbs
$\frac{3}{16}$ " Non-Shoulder Bolts	Snug
10K and 12K Spring Eye Bolt	200 ft-lbs
10K and 12K Center Hanger/Equalizer Bolt	300 ft-lbs
Keeper Bolt	Snug

Worn spring eye bushings or sagging or broken springs should be replaced using the following method:

1. Support the trailer with the wheels just off the ground. Follow the trailer manufacturer's recommendations for lifting and supporting the unit.
2. After the unit is properly supported, place a suitable block under the axle tube near the end to be repaired. This block is to support the weight of the axle only so that suspension components can be serviced or replaced.
3. Disassemble the U-bolts, nuts, and tie plates.
4. Remove the spring eye bolts and the spring.
5. If the spring eye bushings are to be replaced, press out the old bushing by hand or tapping out with a punch.
6. Free-floating nylon bushing needs no lubrication. Press the new bushing into the spring eye by hand or gently tapping it in with a bounceless rubber or plastic mallet.
7. Reinstall repaired or replaced components in reverse order.

NOTE: For multiple axle units, the weight of each axle **MUST** be supported as outlined in Step 2 before disassembly of any component of the suspension system.

▲ WARNING

Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing death or serious injury.

▲ CAUTION

Always wear eye protection when servicing the axle, brakes, hubs, springs and wheels. Failure to wear eye protection may result in serious injury.

If the equalizer or equalizer bushings **MUST** be replaced, follow the instructions above for lifting and supporting the trailer unit and then proceed as follows:

1. With both axles blocked up, remove the spring eyebolt, keeper bolt, and equalizer bolt from the equalizer to be repaired or replaced.
2. Press the old nylon bushing out of the equalizer.
3. Reassemble in reverse order.

Suspension Replacement

1. Make sure springs are on straight. Align spring eyes to front hanger. Insert spring eye bolts but do not torque at this point.
2. Assemble springs into equalizer.
3. After leveling equalizer to frame, torque equalizer nuts and spring eye nuts.

Adjustable Spring Seats

The procedure for setting adjustable spring seats can be found on LIP Sheet 0226, which is available on the Lippert Components Customer Service website: <http://lci1.com/images/support/lipsheet/0226.pdf>

Wheels

Wheel Selection

When specifying or replacing your trailer wheels it is important that the wheels, tires, and axle are properly matched. The following characteristics are extremely important and should be thoroughly checked when replacement wheels are considered:

1. **Bolt Circle.** Wheels have many bolt circle variations and some are so close that it could be possible to attach an inappropriate wheel that does not match the axle hub.
2. **Capacity.** Wheel load capacity should match tire and trailer max. load ratings.
3. **Offset.** The relationship of the center line of the tire to the hub face of the axle should match any replacement. Failure to match offset may result in reducing the carrying capacity of your axle.
4. **Rim Contour.** Replacement wheels should be direct replacements to match the rim contour.

⚠ WARNING

Use only rim contours suggested by manufacturer. Failure to use correct rim contour may cause dramatic separation of tire and wheel and could cause death or serious injury.

⚠ WARNING

Attempting to modify or repair a wheel can cause unsafe conditions that may result in an explosion. Air pressure on a weakened or cracked rim can cause death or serious injury.

Torque Requirements

It is extremely important to apply and maintain proper wheel mounting torque on your trailer axle. Torque wrenches assure the proper amount of torque is being applied to a fastener. Use no other method to torque fasteners.

⚠ WARNING

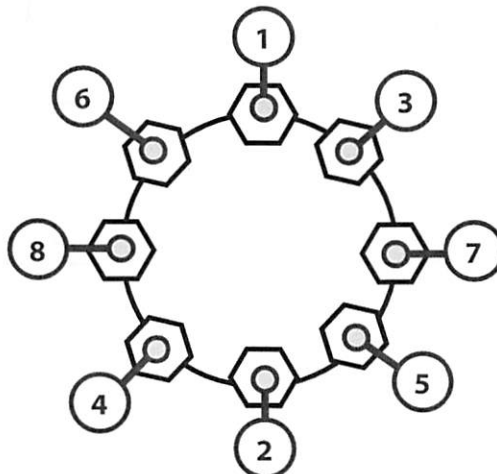
Proper and accurate torque MUST be maintained to prevent wheels from loosening, studs from cracking and/or breaking or other possible hazardous breakage resulting in death or serious injury.

Be sure to use only the fasteners matched to the cone angle of your wheel (usually 60° or 90°). The proper procedure for attaching your wheels is as follows:

1. Start all bolts or nuts by hand to prevent cross threading.
2. Tighten bolts or nuts in the following sequence (see Wheel Torque Requirement Chart below).
3. Tightening fasteners should be done in stages. Follow the recommended sequence (Fig. 8), tighten fasteners per wheel torque requirements chart below.
4. Wheel nuts/bolts should be torqued before first road use and after each wheel removal. Check and re-torque after the 10 and 25 miles and again at 50 miles. A periodic check during regular service is recommended.

Wheel Torque Requirement Chart				
Wheel Size	Stud Size	Torque Sequence		
		1st Stage	2nd Stage	3rd Stage
14"	½"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
15"	½"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16"	½"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16.5" x 6.75"	½"	20-25 ft-lbs	50-60 ft-lbs	90-120 ft-lbs
16"	⅝"	20-25 ft-lbs	60-70 ft-lbs	120-130 ft-lbs
16.5" x 6.75"	⅝"	20-25 ft-lbs	60-70 ft-lbs	120-130 ft-lbs
16" Dual and 17.5" Cone Nut	⅝"	50-60 ft-lbs	100-120 ft-lbs	190-210 ft-lbs
16" Dual and 17.5" Flange Nut	⅝"	50-60 ft-lbs	150-200 ft-lbs	275-325 ft-lbs
14.5" Demount	⅝"	Tighten sequentially to 85-95 ft-lbs		

Fig. 8









Tires

Prior to mounting tires onto wheels, be sure the rim size and contour are approved by the Tire and Rim Association Yearbook or the tire manufacturers catalog. In addition, confirm that the tire will carry the rated load. If the load is not evenly distributed on all tires, use the tire rated for the heaviest wheel position. The Rubber Manufacturers Association or the tire manufacturers guidelines should be consulted for mounting procedures.

Tire inflation pressure is the most important factor in tire life. Tire pressure should always be what is recommended by the manufacturer for the load. Always check pressure cold before operation. DO NOT bleed air from tires when they are hot. Check inflation pressure weekly during use to insure maximum tire and tread life.

The following tire wear diagnostic chart will help you pinpoint the causes and solutions of tire wear problems.

NOTE: Tire wear should be checked frequently because once a wear pattern becomes firmly established in a tire it is difficult to stop, even if the underlying cause is corrected.

Problem	Probable Cause	Corrective Action
Center Wear 	Over-inflation	Adjust pressure to particular load per tire catalog.
Edge Wear 	Under-inflation	Adjust pressure to particular load per tire catalog.
Side Wear 	Loss of camber or overloading	Make sure load does not exceed axle rating. Call Lippert Service & Warranty to advise.
Toe Wear 	Incorrect Toe-in	Call Lippert Service & Warranty to advise.
Cupping 	Out-of-balance	Check bearing adjustment and balance tires.
Flat Spots 	Wheel lockup and tire skidding	Avoid sudden stop if possible and adjust brakes.

Introduction To Troubleshooting

The following section is a guideline for ensuring operation of your braking system. The safety of you, those traveling with you and those sharing the road is paramount and it starts with the ability to safely stop the tow vehicle and the towed vehicle.

Troubleshooting

Most brake malfunctions can be corrected by utilizing the Troubleshooting Chart on the next page. Mechanical failure is the most common form of malfunction, however, if the brake system fails and it's not mechanical, it is usually electrical. A Voltmeter and Ammeter are essential tools to diagnose these problems. Mechanical problems are mostly self-evident; something is bent or broken. Consult the troubleshooting chart on Page 21 to determine the probable cause and corrective actions for a variety of issues with the braking system.

Remember to use only Lippert Components, Inc. replacement parts on these systems. Consult the Limited Warranty or call our Service Department for any other related issues.

Measuring Voltage

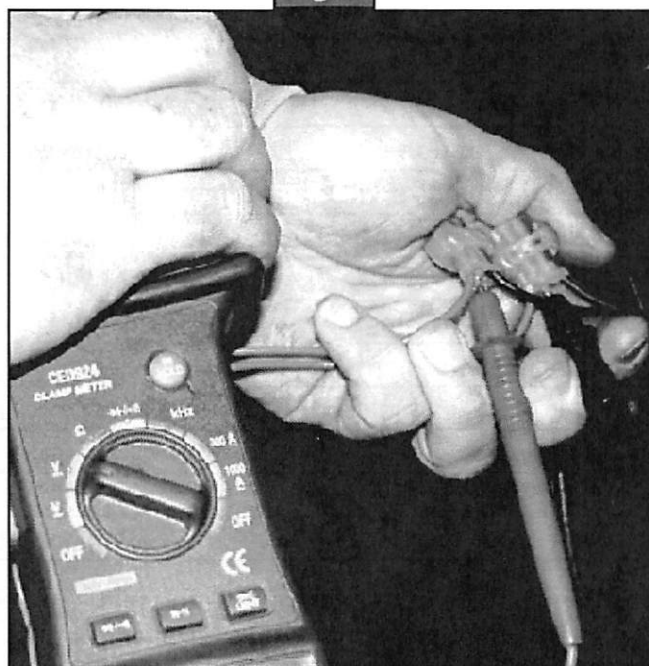
The Braking System voltage is measured at the two lead wires of the magnet on any brake. Use the pin probes inserted through the insulation of the lead wires. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

Voltage in the system should begin at 0 volts and, as the brake pedal of the tow vehicle is applied, voltage will gradually increase to about 12 volts. If the system does not indicate at least 12 volts, problems may occur in the wiring of the system, the battery or alternator of the tow vehicle.

When the brakes are applied, a gradual increase in voltage is preferable to a quick increase to 12 volts. A gradual increase in voltage ensures smooth and firm trailer braking. A quick increase in voltage will cause the braking system to feel like the trailer is grabbing too quickly.

Taking a Voltage reading is usually done with probes inserted into the wire connector (Fig. 9).

Fig. 9



Troubleshooting Chart

Problem	Probable Cause	Corrective Action
No brakes	Open circuits	Find and correct
	Short circuits	Test and correct
	Severe under-adjustment	Adjust brakes
Weak brakes	Grease or oil on magnets or linings	Clean or replace
	Corroded connections	Clean and correct cause of corrosion
	Worn linings or magnets	Replace
	Scored or grooved brake drums	Machine or replace
	Improper synchronization	Correct
	Under-adjustment	Adjust brakes
	Glazed Linings	Re-burnish or replace
Locking brakes	Under-adjustment	Adjust
	Improper synchronization	Correct
	Loose, bent or broken brake components	Test and correct
	Out-of-round brake drums	Machine or replace
	Insufficient wheel load	Adjust system resistor and synchronize
Intermittent brakes	Broken wires	Test and correct
	Loose connections	Repair or replace
	Faulty ground	Find and repair
Brakes pull to one side	Wrong magnet lead wire color	Adjust
	Incorrect adjustment	Correct
	Grease or oil on linings or magnets	Clean or replace
	Broken wires	Find and repair
	Bad connections	Find and repair
Harsh brakes	Under-adjustment	Adjust
	Improper synchronization	Correct
Noisy brakes	Under-adjustment	Adjust
	Lack of lubrication	Lubricate
	Broken component	Replace component
	Incorrect brake components	Correct
Surging brakes	Grease or oil on linings or magnets	Clean or replace
	Out-of-round or cracked brake drums	Machine or replace
Dragging brakes	Over-adjustment	Readjust
	Out-of-round brake drums	Machine or replace
	Incorrect brake components	Replace
	Loose, bent or broken brake components	Replace
	Faulty breakaway switch	Repair or replace
	Loose wheel bearing adjustment	Adjust
	Bent spindle	Replace axle

NOTE: If all trailer lights and brakes do not work, check your wiring plug connection and make sure the ball is making solid contact with the coupler (that is how a trailer is grounded). Too much grease or not using dielectric grease on the ball and coupler can cause this to happen.

Measuring Amperage

The Braking System amperage is the amount of current flowing through the system when all magnets have been energized. The amperage will change proportionately with the voltage. To ensure that the battery is indicating a full charge, the towing vehicle engine should be running with the trailer coupler connected when checking the voltage.

If a resistor is used in the brake system, it **MUST** be set at zero or bypassed completely to obtain the maximum amperage reading. Individual amperage draw can be measured by inserting the ammeter in the line at the magnet you want to check. Disconnect one of the magnet lead wire connectors and attach the ammeter between the two wires. Consult Amperage Chart on the next page for normal amp readings. Make sure that the wires are properly reconnected and sealed after testing is completed.

Testing for Amperage can be done with probes (Fig. 10) or alligator clips on the leads or an amp clamp (Fig. 11).

Fig. 10

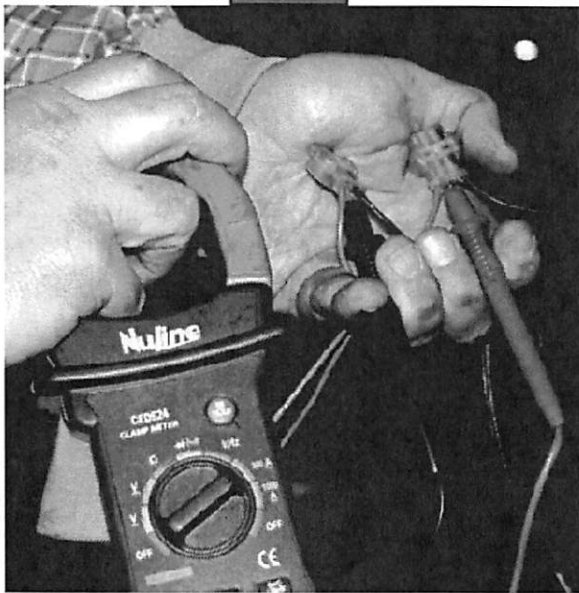
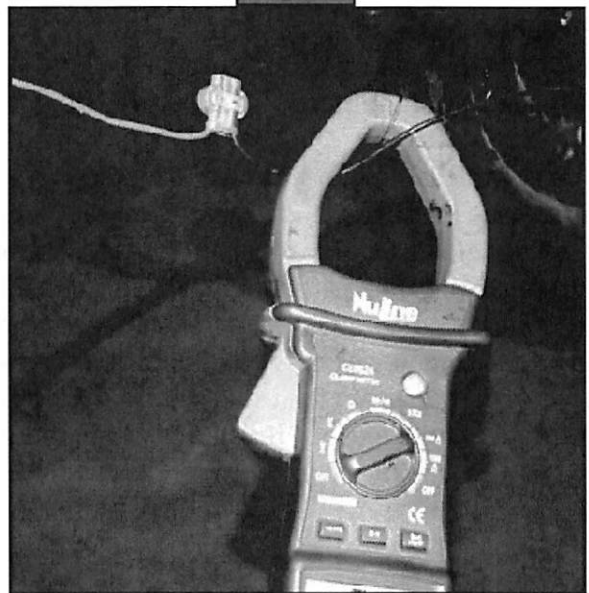


Fig. 11



Amperage Chart

Amps/Magnet	Two Brakes	Four Brakes	Six Brakes
3.0	6.0	12.0	18.0

Low or no voltage are the most common problem with the Braking System. Amperage at the brakes is also a relatively common issue.

Common causes of these conditions are:

1. Low quality electrical connections
2. Open circuits
3. Insufficient wire gauge
4. Broken wires
5. Blown fuses (fusing of brakes is not recommended)
6. Short circuits (indicated by high amperage)

Possible causes of shorts are:

1. Shorted magnet coils
2. Bare wires contacting a grounded object

Finding the cause of a short circuit in the system is done by isolating one section at a time. If the high amperage reading drops to zero by unplugging the trailer, then the short is in the trailer. If the amperage reading remains high with all the brake magnets disconnected, the short is in the trailer wiring.

All electrical troubleshooting procedures should start at the controller. Most complaints regarding brake harshness or malfunction are traceable to improperly adjusted or nonfunctional controllers. See your controller manufacturer's data for proper adjustment and testing procedures. For best results, all the connection points in the brake wiring should be sealed to prevent corrosion. Loose or corroded connectors will cause an increase in resistance which reduces the voltage available for the brake magnets.

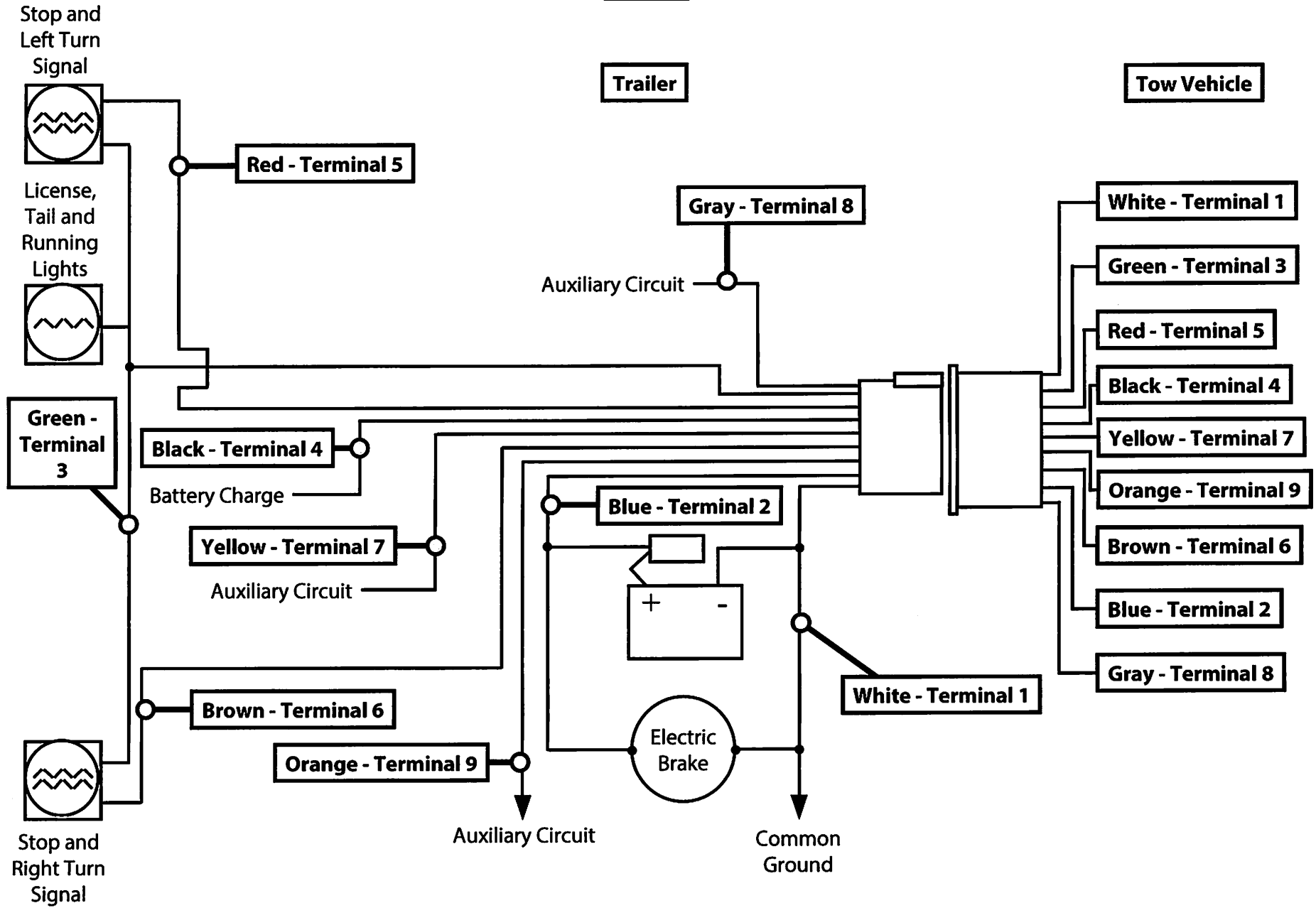
Maintenance Schedule

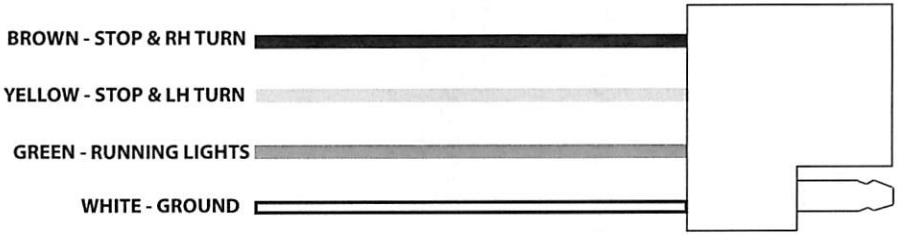
Item	Function Required	Weekly	3 Months / 3,000 Miles	6 Months / 6,000 Miles	12 Months / 12,000 Miles
Brakes	Test that they're operational.	At Every Use			
Breakaway System	Check battery charge and switch operation.	At Every Use			
Brake Adjustment	Adjust to proper operating clearance.		◆		
Brake Magnets	Inspect for wear and current draw.			◆	
Brake Linings	Inspect for wear or contamination.				◆
Brake Controller	Check for correct amperage and modulation.			◆	
Trailer Brake Wiring	Inspect wiring for bare spots, fray, etc.				◆
Hub/Drum	Inspect for abnormal wear or scoring.				◆
Wheel Bearing	Inspect for corrosion or wear. Clean and repack.				◆
Seals	Inspect for leakage. Replace if removed.				◆
Springs	Inspect for wear, loss of arch.				◆
Suspension Parts	Inspect for bending, loose fasteners, wear.			◆	
Hangers	Inspect welds.				◆
Wheel Nuts and Bolts	Tighten to specified torque values.		◆		
Wheels	Inspect for cracks, dents, or distortion.			◆	
Tire Inflation Pressure	Inflated tires to mfg's. specifications.	◆			
Tire Condition	Inspect for cuts, wear, bulging, etc.		◆		

Fig. 12

Trailer

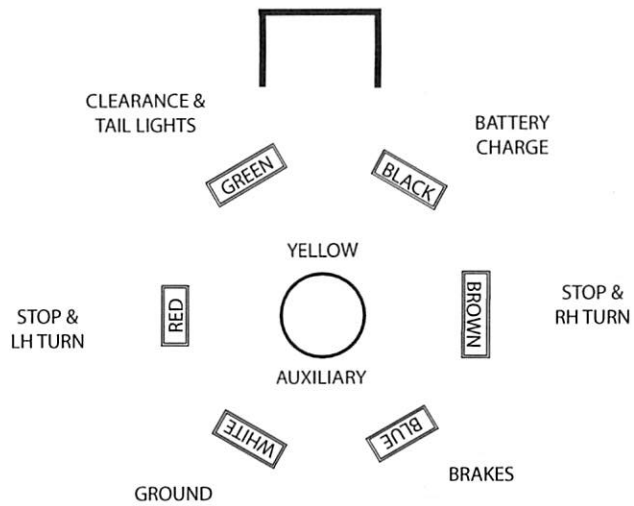
Tow Vehicle



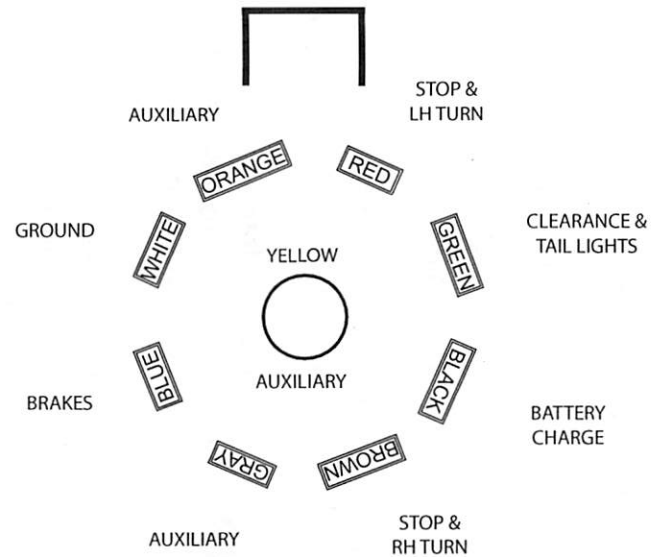


TRAILER LIGHTS PIGTAIL - DOES NOT OPERATE BRAKES

7-PIN COUPLER



9-PIN COUPLER



TRAILER BRAKE AND LIGHT COUPLER - OPERATES BRAKES

Storage

Storage Preparation

If your trailer is to be stored for an extended period of time, the trailer will need to be prepared prior to going into storage. Follow these guidelines to set up your trailer for storage:

1. If the trailer has an emergency breakaway battery, remove it and store it inside, out of the weather. Charge the battery at least every 90 days.
2. Jack up the trailer and place jack stands under the trailer frame so that the weight will be off the tires. Follow trailer manufacturer's guidelines to lift and support the trailer.
3. Lubricate mechanical moving parts such as the hitch, and suspension parts, that are exposed to the weather.
4. In the case of boat trailer axles that are subject to repeated immersion, remove brake drums; clean, dry and re-lubricate moving brake components; inspect bearings - clean and re-lubricate.



Lift unit by the frame and never the axle or suspension. Do not go under unit unless it is properly supported by jack stands. Unsupported units can fall causing death or serious injury.

Extended Storage Inspection Procedures

Trailer should remain on jack stands during this procedure:

1. Remove all wheels and hubs or brake drums. Reinstall drum to same spindle and brake from which it was removed.
2. Inspect suspension for wear.
3. Check tightness of hanger bolt, shackle bolt, and U-bolt nuts of the suspension for correct torque.
4. Check brake linings, brake drums and armature faces for excessive wear, scoring, damage or corrosion.
5. Check brake magnets with an ohmmeter. The magnets should check 3.2 ohms. If shorted or worn excessively, they **MUST** be replaced.
6. Lubricate all brake moving parts using a high temperature brake lubricant.
7. Remove any rust from braking surface and armature surface of drums with fine emery paper or crocus cloth. Be sure to protect bearings from contaminating dust.
8. Inspect oil or grease seals for wear or nicks. Replace if necessary.
9. Lubricate hub bearings.
10. Reinstall hubs and adjust bearings.
11. Mount and tighten wheels.

NOTE: Avoid getting any grease or oil on brake linings and pads or magnet surfaces.

Trip Preparation Checklist

The following checklist offers several guidelines to prolonging the quality of your running gear and will provide trustworthy and safe trailering for years to come.

Using the following checklist before starting a trip with your trailer is highly recommended. Allow plenty of time prior to any trip for any service or repairs that may need to be done before using the trailer.

1. Maintenance schedule should be current.
2. Inspect hitch for corrosion, lubrication and wear.
3. Inspect safety chains for rust and wear. Engage chains and breakaway switch actuating chain securely. Breakaway battery should be fully charged.
4. Electronic coupler **MUST** be secure. Run check on all lights and brake engagement and synchronization.
5. Load trailer with 10% of total weight on the hitch end of trailer. Smaller trailers' front end load should be increased to 15%.
6. **DO NOT OVERLOAD!** Consult your trailers i.d. plate for gross vehicle weight restrictions.
7. Tires should be inflated to manufacturer's specs. Inspect tires for any damage or wear.
8. Inspect lug nuts/bolts. All should be torqued to spec. (See Page 17 for specs).
9. Check torque of hanger bolt, shackle bolt, and U-bolt nuts on suspension.
10. Check that your trailer is towing level. Adjust hitch height if necessary to level trailer.

CUSTOMER SERVICE - TRAILER

PLANT #39

1902 W. SAMPLE ST.

SOUTH BEND, IN 46619

PH: (574) 312-6425

FAX: (574) 534-7161

E-MAIL: trailerwarranty@lci1.com

WEBSITE: www.lci1.com

Lippert Components **MUST** be notified of all issues prior to work being performed. For the quickest and most efficient response, Lippert Service & Warranty can be reached via e-mail at trailerwarranty@lci1.com.

Submissions should include full unit info including full VIN, Model, Date of Mfr, Date of Purchase and

Retail Owner name or by filling out the Repair Request Form. The Repair Request Form and other service forms can be found online in addition to all owners manuals and informational publications.

See specific web addresses below.

ONLINE MANUALS, TECHNICAL INFORMATION & SERVICE FORMS

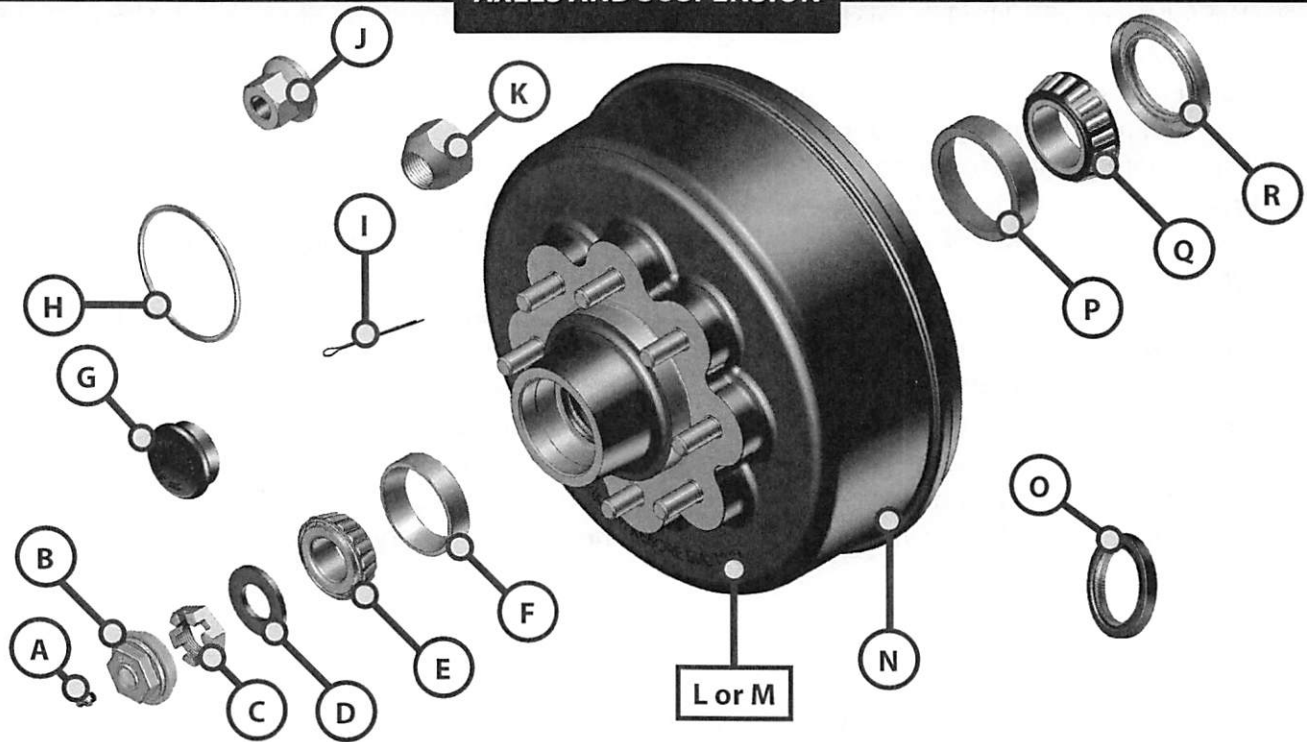
To find manuals, technical information, and service forms, please visit

www.lci1.com/customerservice



8,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION



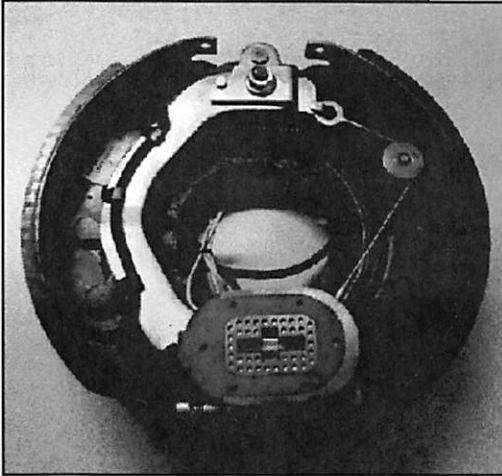
Callout	Part #	Description
A	122255	Grease Zerk (Lubed)
B	277223	Oil Cap, Clear
	2772231	Oil Cap, Black
C	122081	Spindle Nut; 1" - 14
D	179660	Spindle Washer; 1.06 x 2.00 OD
E	129752	Outer Bearing Cone (02475)
F	168687	Outer Bearing Cup (02420)
G	183804	Rubber Cap Plug
H	277215	O-Ring
I	122075	Cotter Pin; .120" x 1.75"
J	176321	Flanged Wheel Nut; $\frac{5}{8}$ - 18
K	134581	Cone Wheel Nut; $\frac{9}{16}$ " - 18 - 60°
L	175704	Stud; $\frac{9}{16}$ " - 18 GR8
M	175705	Stud; $\frac{5}{8}$ " - 18 GR8
N	2772101	Brake Hub; 865 - $\frac{9}{16}$ "; 12 $\frac{1}{4}$ " BRK; 4.75" Pilot
	2772121	Brake Hub; 865 - $\frac{5}{8}$ "; 12 $\frac{1}{4}$ " BRK; 4.75" Pilot
	242080	Brake Hub; 865 - $\frac{5}{8}$ "; 12" BRK; 4.75" Pilot, Grease
	347627	Brake Hub; 865 - $\frac{5}{8}$ "; 12" BRK; 4.75" Pilot, Oil
O	276712	Oil Hub Seal
P	124287	Inner Bearing Cup (25520)
Q	122066	Inner Bearing Cone (25580)
R	122088	Grease Seal Shaft; 2.25"



8,000-LB AXLE WHEEL END COMPONENTS

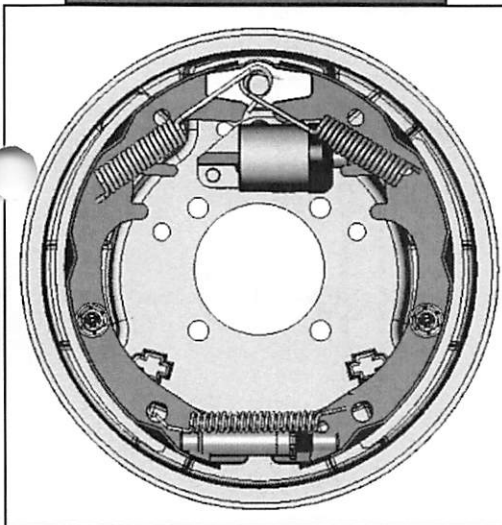
AXLES AND SUSPENSION

Electric Brake Assembly



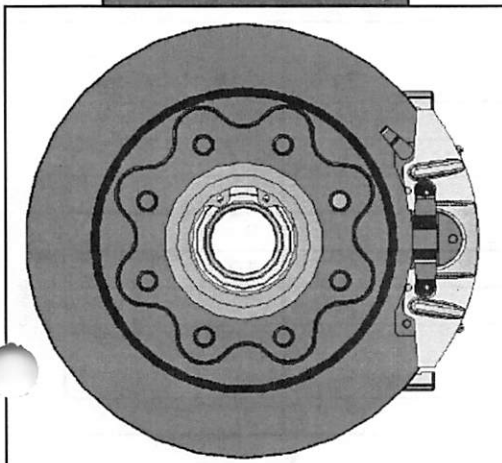
Part #	Description
156443	Brake; Electric; 12.25 x 3.38; 4 Bolt (Left Hand)
156444	Brake; Electric; 12.25 x 3.38; 4 Bolt (Right Hand)
330792	Shoe and Lining Kit - 12 1/4" x 3.38" (8,000-10,000), 1 BRK

Hydraulic Brake Assembly



Part #	Description
336252	Brake; Hydraulic; 12.25 x 3.38; 4 Bolt (Left Hand)
3362521	Brake; Hydraulic; 12.25 x 3.38; 4 Bolt (Right Hand)

Disc Brake Assembly



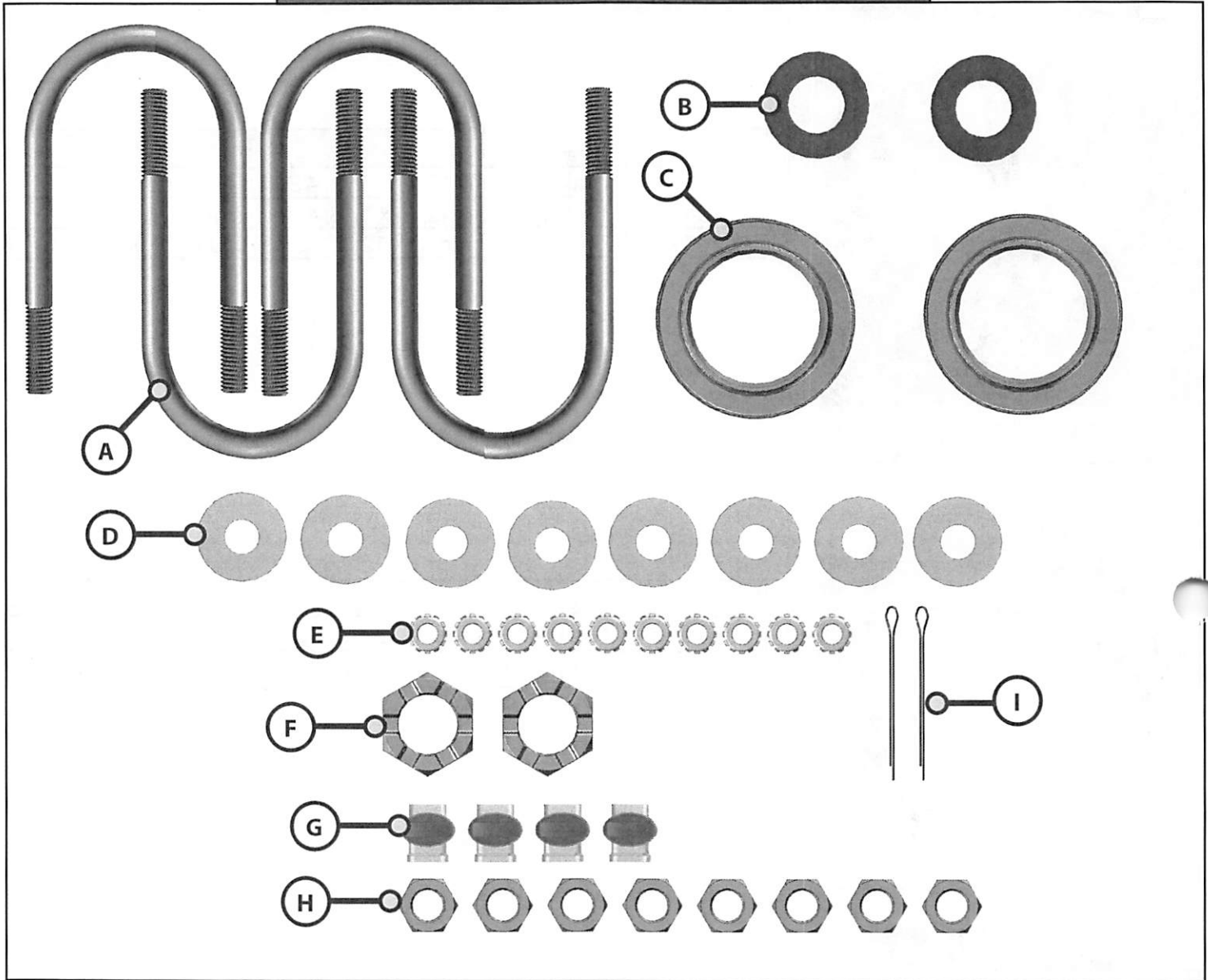
Part #	Description
307319	Disc Brake; Rotor; 865 - 5/8" Studs
307318	Disc Brake; Rotor; 865 - 9/16" Studs
286594	Caliper Mounting Bracket for 5 Bolt Brake Flange
158797	Caliper Mounting Bracket for 4 Bolt Brake Flange
134421	Brake Caliper Assembly, includes Pads and Fittings



8,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION

Axle Service Kit Part #232997 (5 Bolt Brake Grease Setup)



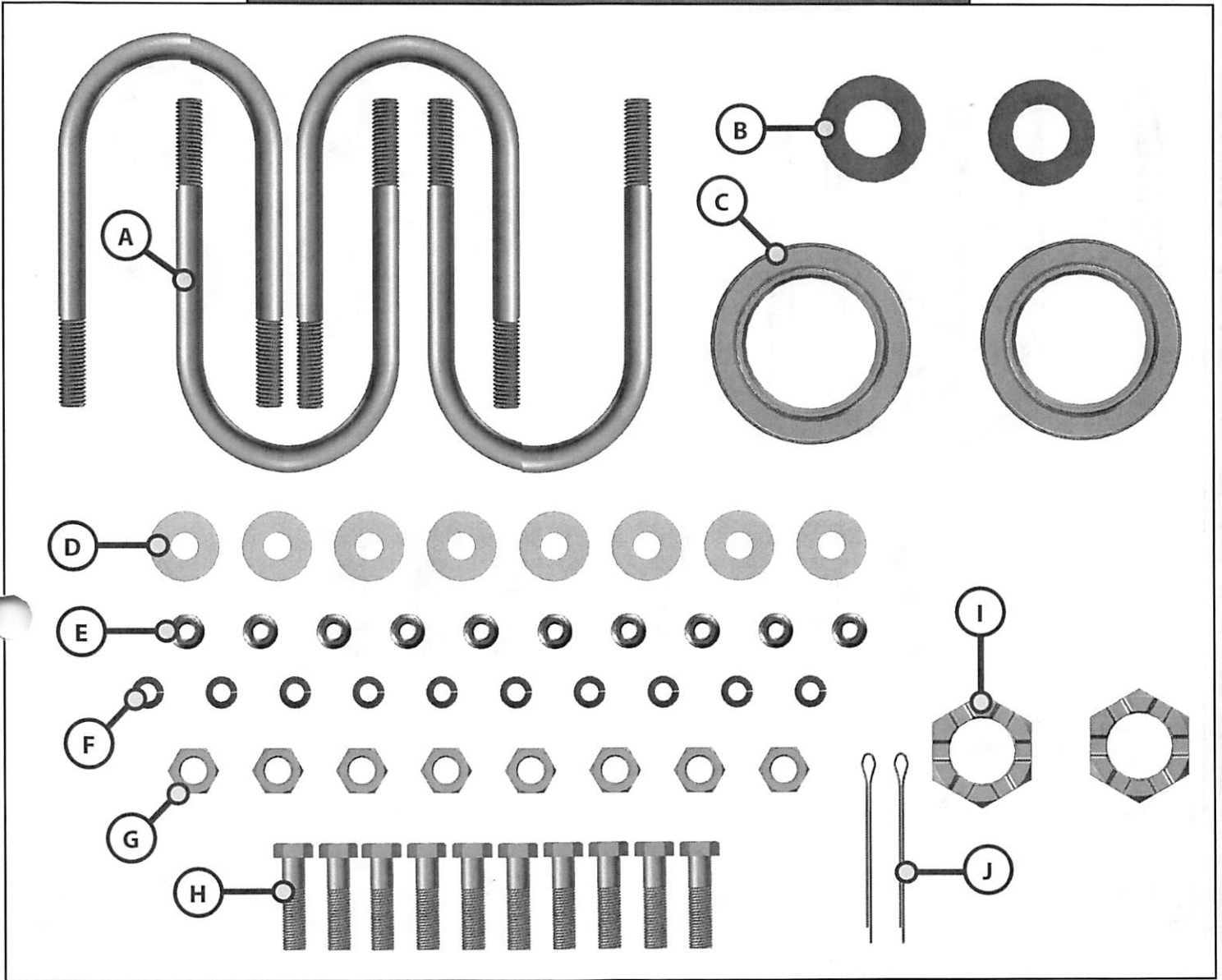
Callout	Part #	Description	Quantity
A	1963511	U-Bolt; $\frac{5}{16}$ - 18 x 7.25 for 3" Tube YZ	4
B	179660	Flat Hardened SAE Washer; 1.06 ID x 2.00 OD	2
C	122088	Double Lip Grease Seal (5,200-7,000)	2
D	170997	Flat USS Hardened Washer; $\frac{5}{16}$ "	8
E	122077	Brake Nut Locking Keys Clear Dich	10
F	122081	Castle Nut; 1 - 14	2
G	122084	Sealed Wire Connector	4
H	182274	Hex Nut; $\frac{5}{16}$ " - 18 GR8	8
I	122075	Cotter Pin; .120" x 1.75"	2



8,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION

Axle Service Kit Part #309893 (5 - Bolt Disc Brake Grease Setup)



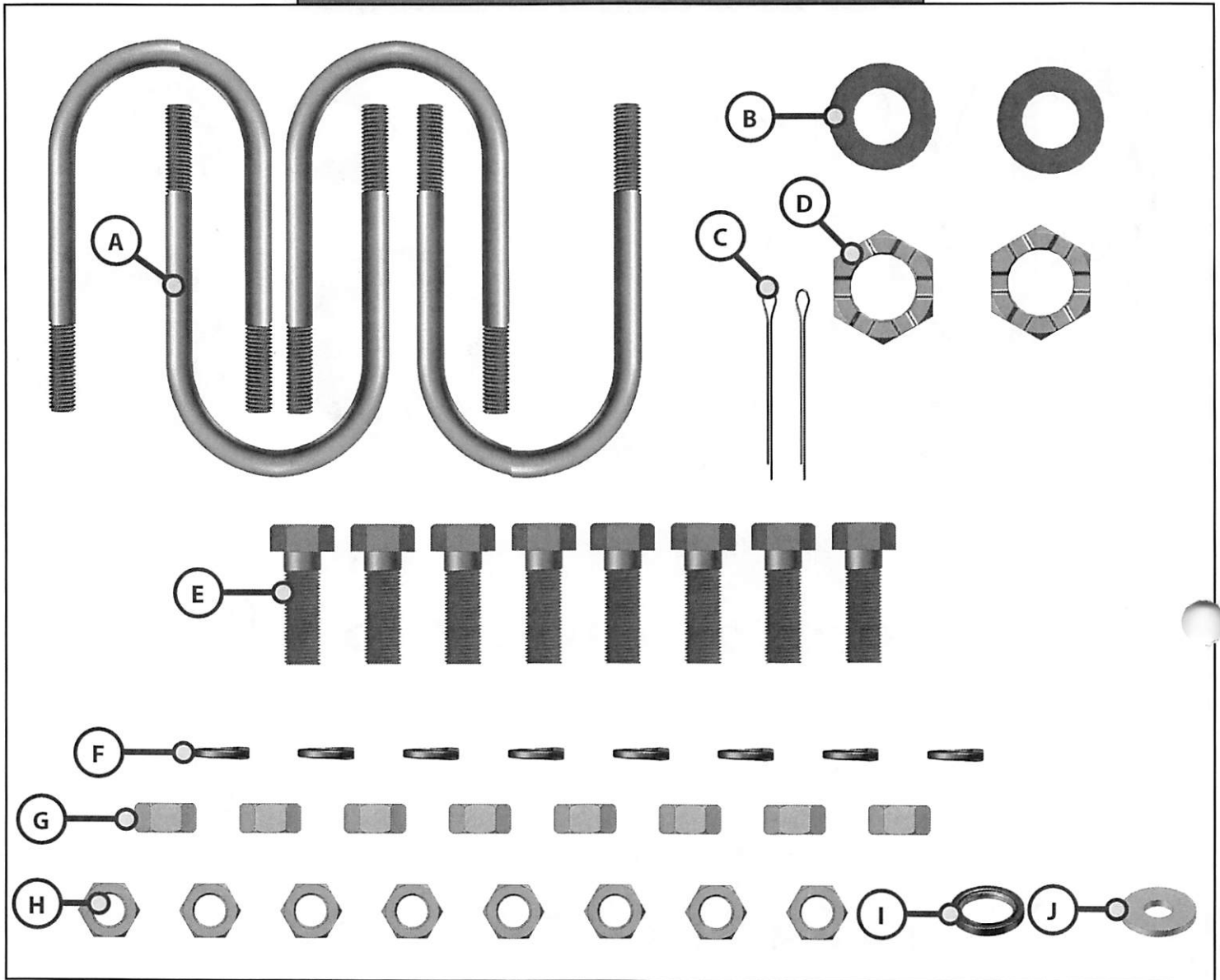
Callout	Part #	Description	Quantity
A	1963511	U-Bolt; $\frac{1}{2}$ " - 18 x 7.25" for 3" tube	4
B	179660	Flat Hardened SAE Washer; 1.06 ID x 2.00 OD	2
C	122088	Double Lip Grease Seal (5,200-7,000)	2
D	170997	Flat USS Hardened Washer; $\frac{1}{16}$ "	8
E	119072	Flange Nut; $\frac{3}{8}$ " - 16 GR5	10
F	126030	Washer; .385" x .68" x .094"	10
G	182274	Hex Nut; $\frac{1}{16}$ " - 18 GR8	8
H	135835	Tap Bolt; $\frac{3}{8}$ " - 16 x 1 $\frac{1}{2}$ GR5 ZN FT HD ST	10
I	122081	Castle Nut; 1 - 14	2
J	122075	Cotter Pin; .120 x 1.75	2



8,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION

Axle Service Kit Part #313729 (4 - Bolt Brake Oil Setup)

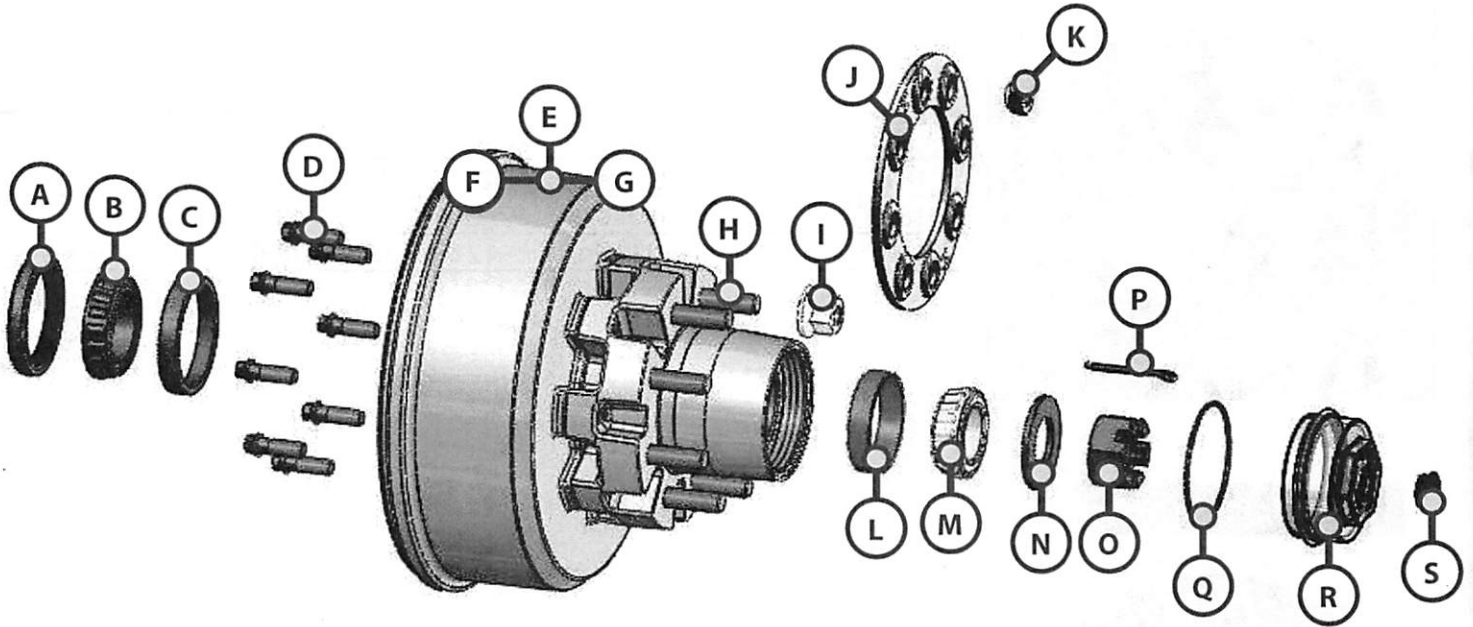


Callout	Part #	Description	Quantity
A	1963511	U-Bolt; $\frac{3}{16}$ " - 18 x 7.25" for 3" tube	4
B	179660	Flat Hardened SAE Washer; 1.06 ID x 2.00 OD	2
C	122075	Cotter Pin; .120 x 1.75	2
D	122081	Castle Nut; 1 - 14	2
E	162836	Hex Bolt; $\frac{1}{2}$ " - 20 x 1.50"	8
F	162838	Lock Washer; $\frac{1}{2}$ x .86 x .125	8
G	122253	Hex Nut; $\frac{1}{2}$ - 20	8
H	182274	Hex Nut; $\frac{3}{16}$ " - 18 GR8	8
I	276712	Seal, Oil	1
J	170997	Washer; $\frac{3}{16}$ " Flat	8



10,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION



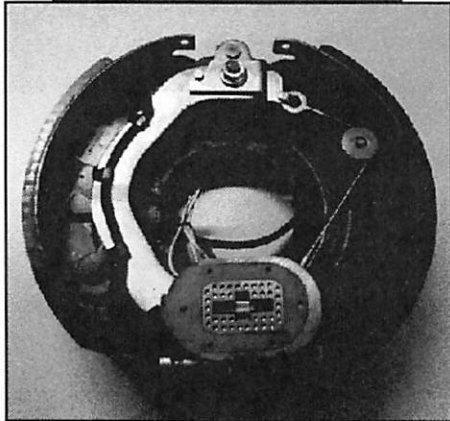
Callout	Part #	Description
A	176692	Oil Seal - 2.855 ID x 3.880 OD, National #370150A
B	183807	Inner Bearing Cone - 10,000 (387A)
C	183463	Inner Bearing Cup/Race - 10,000 (382A)
D	183536	Drum Mounting Bolt
E	183662	Brake Drum Hub; 865 - 5/8"; 4.75" Pilot
F	183168	Idler Hub, 865 - 5/8"; 4.75" Pilot
G	183537	Brake Drum, 865 - 5/8"
H	183128	Stud - 5/8" - 18; GR8
I	176321	Flanged Wheel Nut 5/8 - 18
J	205049	Wheel Clamp Ring for 5/8" Studs
K	205048	Wheel Nut - 5/8" - 18; 90°
L	124287	Outer Bearing Cup/Race - 10,000 (25520)
M	122066	Outer Bearing Cone - 10,000 (25580)
N	181895	Spindle Washer - 1.50" x 3.00" OD
O	181894	Spindle Nut - 1 1/2" - 12
P	181899	Cotter Pin - 1/4" x 2 1/4"
Q	183805	O-Ring (For Oil Cap)
R	183772	Oil Cap
S	183804	Rubber Plug (For Oil Cap)



10,000-LB AXLE WHEEL END COMPONENTS

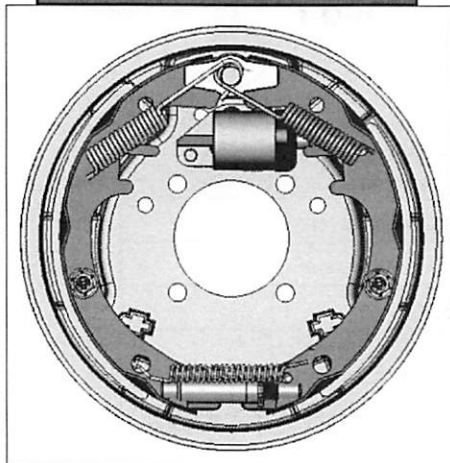
AXLES AND SUSPENSION

Electric Brake Assembly



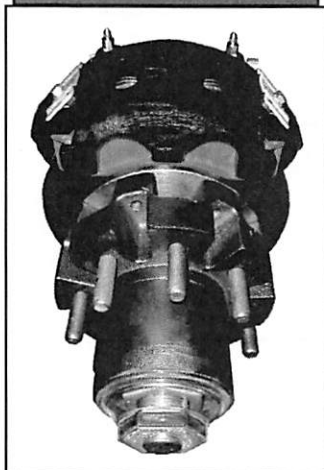
Part #	Description
181935	Electric Brake (LH) 12.25" x 3.38", 7 Bolt
181936	Electric Brake (RH) 12.25" x 3.38", 7 Bolt
330792	Shoe and Lining Kit - 12 1/4" x 3.38" (8,000-10,000), 1 BRK

Hydraulic Brake Assembly



Part #	Description
213222	Brake; Hydraulic (LH) - 12.25" x 3.38", 7 Bolt
213223	Brake; Hydraulic (RH) - 12.25" x 3.38", 7 Bolt

Disc Brake Assembly



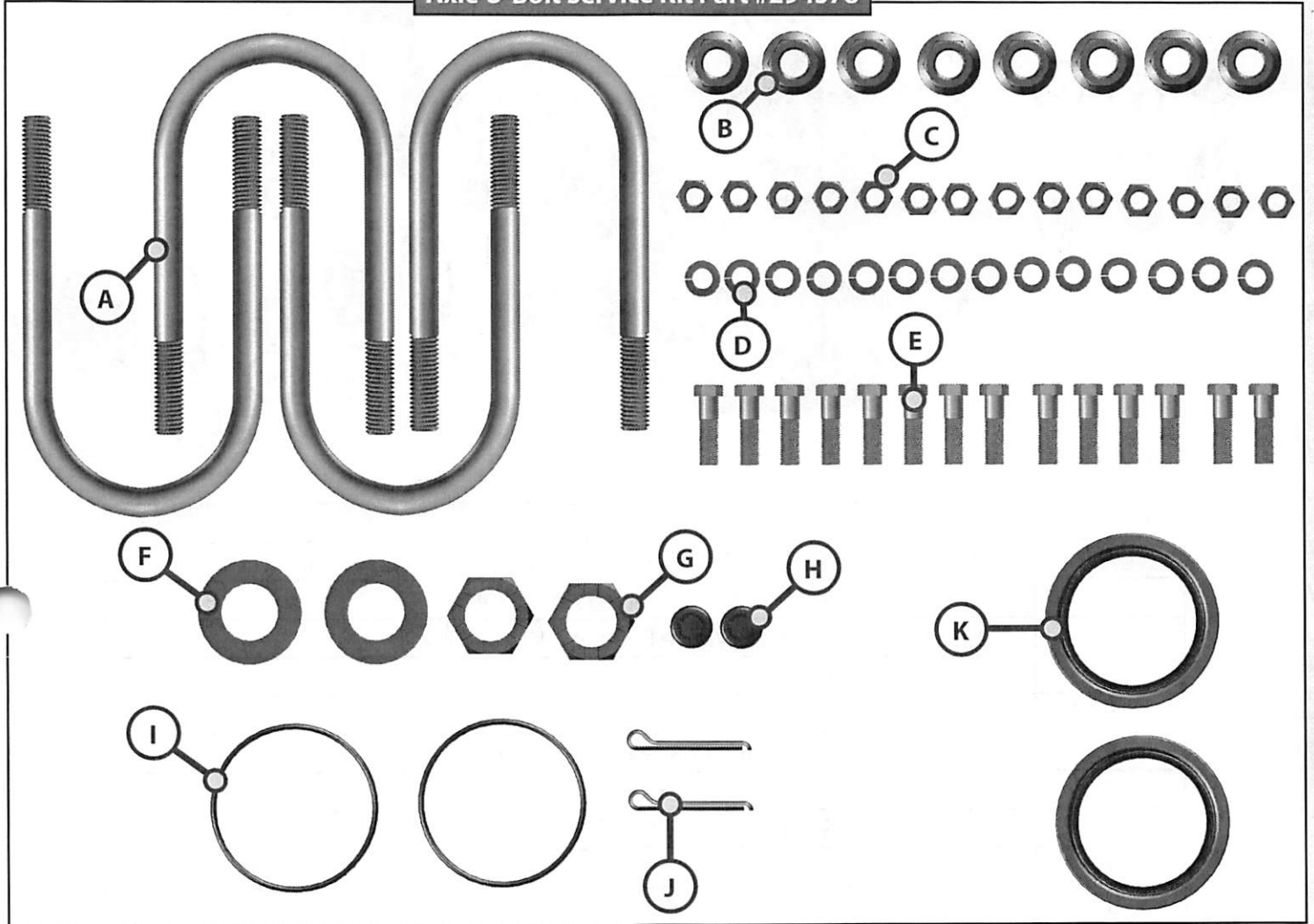
Part #	Description
294061	Disc Brake; 865 - 5/8" Studs, 7 Bolt Flange, Kit for one axle



10,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION

Axle U-Bolt Service Kit Part #294378

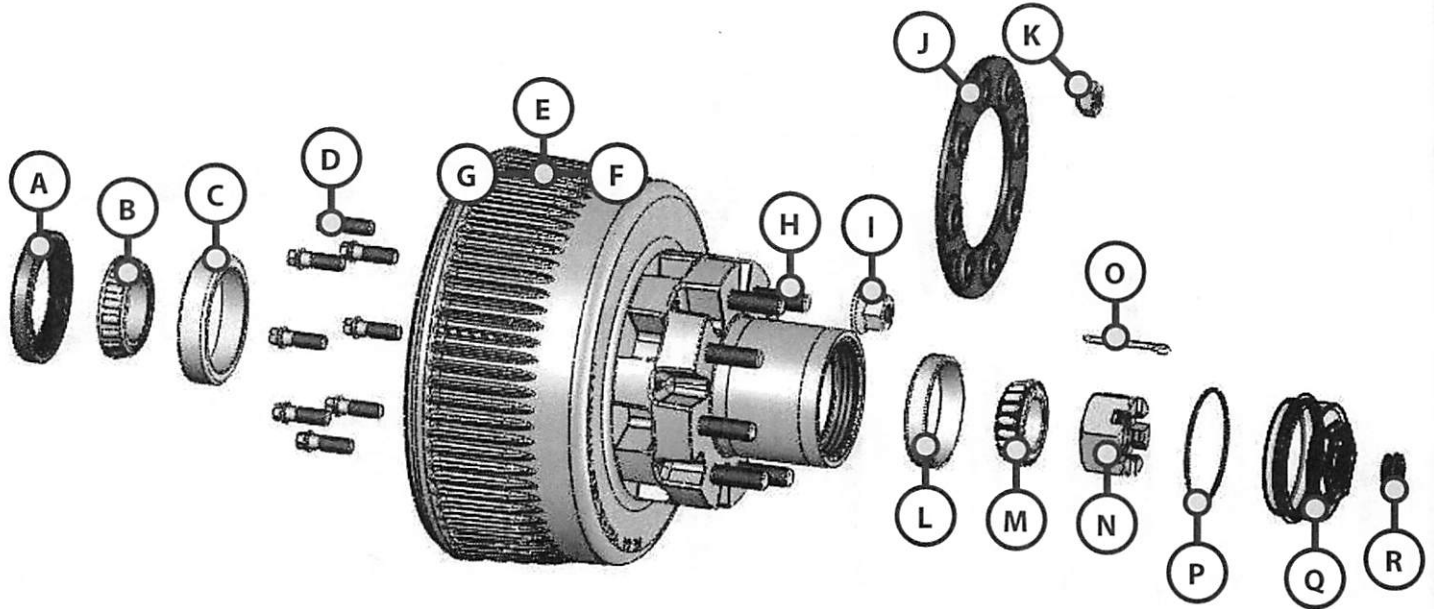


Callout	Part #	Description	Quantity
A	181926	U-Bolt - $\frac{5}{8}$ - 11 for 4" tube	4
B	142833	Flange Nut $\frac{5}{8}$ - 11 Top Lock GR5	8
C	122085	Nut, $\frac{7}{16}$ - 20 Hex	14
D	122086	Washer $\frac{7}{16}$ x $\frac{3}{4}$ x 11 GA Helical Lock	14
E	207576	Bolt $\frac{7}{16}$ - 20 x 1 $\frac{1}{2}$ Hex GR5	14
F	181895	Washer - 1 $\frac{1}{2}$ " ID x 3 OD	2
G	181894	Nut - 1 $\frac{1}{2}$ - 12 - 6 Slot Castle GR2	2
H	183804	Rubber Plug for 10,000 Oil Cap	2
I	183805	O-ring 3 $\frac{47}{64}$ ID 4 OD .138 DIA	2
J	181899	Cotter Pin $\frac{1}{4}$ x 2 $\frac{1}{4}$	2
K	176692	Seal 2.855 ID x 3.88 OD Unitized Oil	2



12,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION



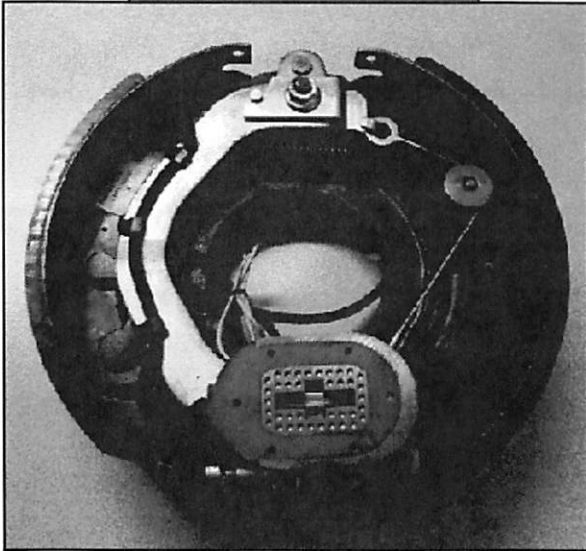
Callout	Part #	Description
A	295924	Seal - 3.125 Shaft X 4.50 " Bore, 12 K Unitized Oil
B	293380	Inner Cone Bearing - 12,000 (3984)
C	293379	Inner Cup/Race Bearing - 12,000 (3920)
D	183536	Drum Mounting Bolt
E	297983	Brake Drum Hub - 865 - 5/8"; 4.75" Pilot
F	301691	Idler Hub - 865 - 5/8"; 4.75" Pilot
G	301940	Brake Drum - 865 - 5/8"
H	183128	Stud - 5/8" - 18; GR8
I	176321	Flanged Wheel Nut 5/8 - 18
J	205049	Wheel Clamp Ring for 5/8" Studs
K	205048	Wheel Nut - 5/8" - 18; 90°
L	293381	Outer Cup/Race Bearing - 12,000 (3920)
M	293382	Outer Cone Bearing - 12,000 (28682)
N	330037	Spindle Nut - 1 3/4" - 12
O	181899	Cotter Pin - 1/4" x 2 1/4"
P	183805	O-Ring (For Oil Cap)
Q	183772	Oil Cap
R	183804	Rubber Plug (For Oil Cap)



12,000-LB AXLE WHEEL END COMPONENTS

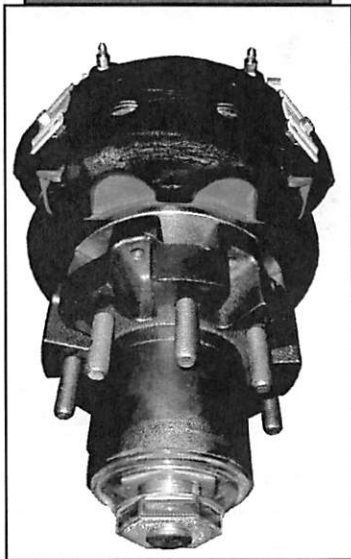
AXLES AND SUSPENSION

Electric Brake Assembly



Part #	Description
297998	Electric Brake (LH) 12.25" x 5", 7 Bolt (12,000)
2979981	Electric Brake (RH) 12.25" x 5", 7 Bolt (12,000)
330793	Shoe and Lining Kit - 12 1/4" x 5" (12,000), 1 BRK

Disc Brake Assembly

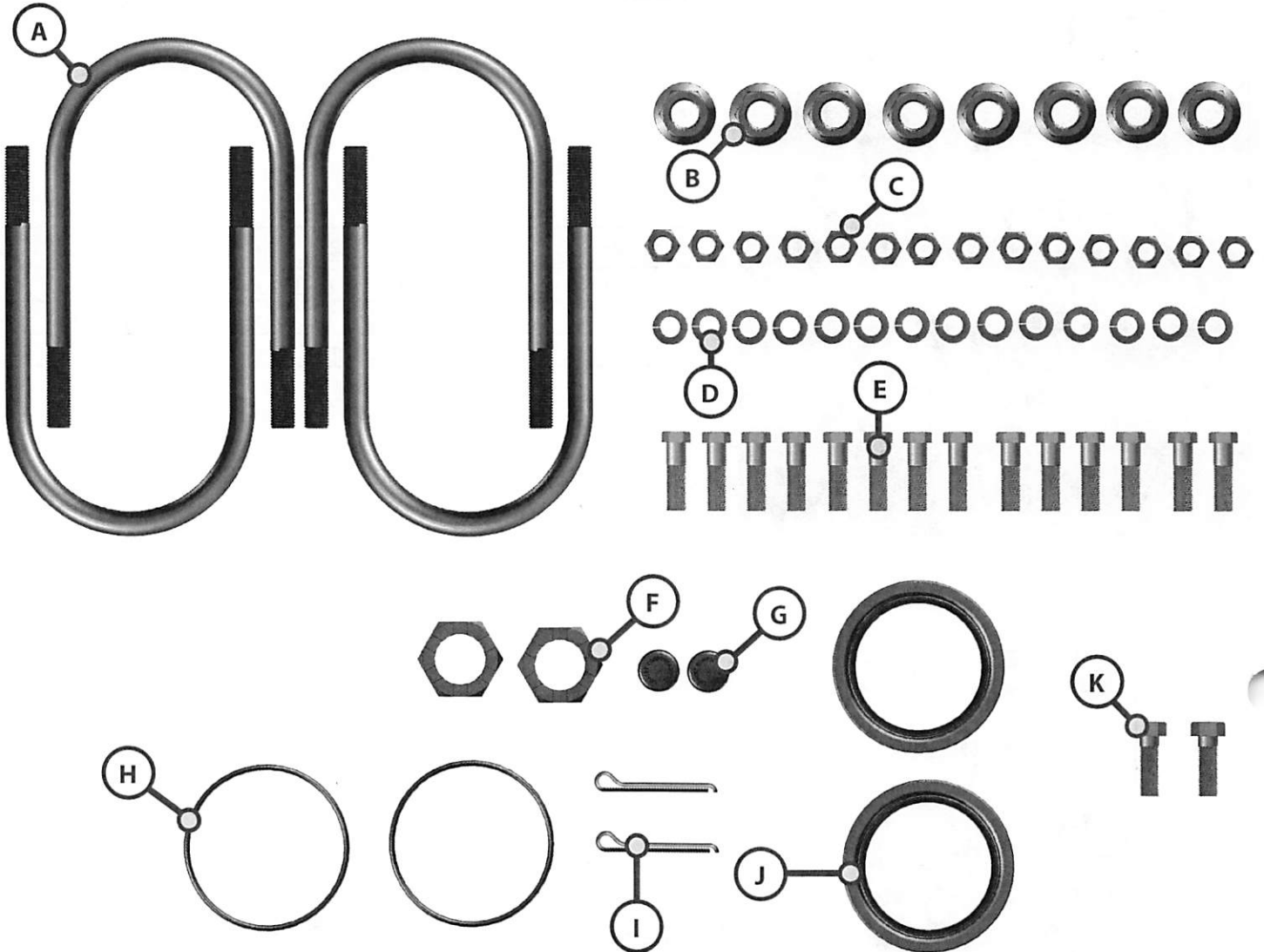


Part #	Description
327573	12000# DISC - 865 5/8" STUDS, 7 BOLT FLG



12,000-LB AXLE WHEEL END COMPONENTS

AXLES AND SUSPENSION



Callout	Part #	Description	Quantity
A	2961681	U-Bolt - 5/8 - 11 for 5" tube	4
B	142833	Flange Nut 5/8 - 11 Top Lock GR5	8
C	122085	Nut, 7/16 - 20 Hex	14
D	122086	Washer 7/16 x 3/4 x 11 GA Helical Lock	14
E	207576	Bolt 7/16 - 20 x 1 1/2 Hex GR5	14
F	330037	Nut - 1 3/4 - 12 - 6 Slot Castle GR2	2
G	183804	Rubber Plug for 10,000 Oil Cap	2
H	183805	O-ring 3 47/64 ID 4 OD .138 DIA	2
I	181899	Cotter Pin 1/4 x 2 1/4	2
J	295924	Seal - 3.125 Shaft X 4.50 " Bore, 12 K Unitized Oil	2
K	162836	Bolt 1/2" - 20 X 1 1/2"	2



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Lippert Components, Inc.
Ph: (574) 537-8900 | Web: lci1.com | Email: customerservice@lci1.com

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Warranty Registration Pre-Delivery Inspection Form

IMPORTANT UNIT WARRANTY INFORMATION

Please note that the 12 month warranty period on your new SKYLIFT unit begins at the unit delivery date at your facility.

In order to insure the correct processing of any warranty claim, it is important that this page be filled out and returned to SKYLIFT, INC. at the address given below within ten (10) days of the delivery date of the equipment.

Fill out form and return to: SKYLIFT, INC.
ATTN: Susan Naso
3000 LEAVITT RD. UNIT 6,
LORAIN, OH 44052
Phone: 440-960-2100
Fax: 440-960-2104

Skylift Model Name: _____

Skylift Serial Number: _____

Company Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Contact Name: _____

Phone Number: _____ Fax Number: _____

Email Address: _____

Date Delivered to Customer: _____



Limited Warranty

On machines manufactured after July 1, 2010

Skylift, Inc. provides a **ONE (1) year** limited warranty on the entire machine.

Skylift, Inc. provides a **TWO (2) year** limited warranty on Skylift manufactured components.
(Parts built and manufactured by Skylift only)

Products designed and manufactured by Skylift, Incorporated, are warranted to be free from defects in material and workmanship at the time of initial delivery subject to the following provisions:

1. For **one (1) year** following initial delivery of the product, Skylift will, at its option, repair or replace any part found by Skylift to be defective in material or workmanship. The customer is obligated to contact Skylift, Inc. prior to any work being performed on equipment. A completed Skylift Warranty Claim Form is required within thirty (30) days of the date of failure of any warranted part. Skylift will inspect defective parts for approval prior to issuing credit to the customer. Defective parts shall be shipped to the factory pre-paid motor freight or UPS within 30 days of failure of any warranted part is factory requests return of said parts.
2. The Skylift limited warranty does not cover: (a) products which have not been operated and maintained in accordance with Skylift operators and maintenance schedules, programs, or bulletins; (b) products which have not been mounted in accordance with Skylift installation procedures; (c) products not manufactured by Skylift which are supplied by Skylift (d) products which are repaired without using original Skylift parts; or (e) transportation or delivery to a Skylift service facility or the customer's location.
3. The battery, generator, hydraulic components, electrical components, drive motors, and or other parts/equipment, but not limited to, not manufactured by Skylift is subject to warranty guidelines set forth by the respective manufacturers and their allowed warranty period. Such warranties shall be handled direct through the respective manufacturer or one of its distributors.

This warranty is in lieu of any other warranties, express or implied. There is no warranty of merchantability or fitness for a particular purpose, nor is there any other warranty, express or implied, except as specifically stated herein. No associate, agent or representative of Skylift is authorized to extend any warranty on Skylift's behalf. Skylift shall in no event be liable for any special, indirect, or consequential damages or claims of any third party against the Customer.

WARRANTY CLAIMS will NOT be processed unless there has been prior approval from the factory for the repair work that is to be performed. (This excludes travel time and or mileage which is NOT allowed or covered under the Skylift Limited Warranty.) NO EXCEPTIONS will be made.



WARRANTY GUIDELINES / INSTRUCTIONS

Warranty procedures MUST be followed in order for a warranty claim to be considered. WARRANTY CLAIMS will NOT be processed unless there has been prior approval from the factory for the repair work that is to be performed.

The service technician that is repairing the Skylift manufactured machinery MUST call Skylift and advise Skylift's service director of the problem they are having with the Skylift equipment prior to any repair work being done. (440) 960-2100

Skylift keeps a very detailed daily log of all service calls/emails that come in from our distributors and their service technicians. The service department records the date the call came in including the time, machine serial number, and info on the person that reported the issue.

When contacting Skylift to report a problem with a Skylift piece of equipment we will ask for the following information to be provided.

- Date issue reported to Skylift _____
- Name of Skylift tech that was spoken to _____
- Owner of the equipment _____
- Location of the equipment _____
- Technician's name _____
- Technician's company name _____
- Technician's phone number _____
- Technician's email address _____
- Equipment model type _____
- Machine serial number _____
- Machine manufactured date _____
(Refer to the Skylift DATA TAG on the machine)
- Hours on the equipment _____
(Refer to the HOUR METER located on the machine)

The reported issue will be evaluated by Skylift's service department and Skylift will work with the technician over the phone to determine the problem and advise on the repairs if needed. The Skylift technician will estimate labor hours for the repair as well. Skylift MUST provide the parts for the repair if there are any parts that need to be replaced on the equipment.

- 1) The customer will need to issue a purchase order for the parts
- 2) Skylift in most cases will issue a return material authorization for the parts to be returned to Skylift or directly to the supplier for evaluation.
- 3) After warranty has been approved credits will be given to the customer.
- 4) Please note that warranty coverage DOES NOT cover travel time to the machine, transport of the machine to a repair facility, routine maintenance, misc. material, fluids nor shop supplies.
- 5) Warranty claim form to be completed detailing the breakdown of repairs:
 1. Parts
 2. Travel time
 3. Shop Supplies
 4. Misc.
 5. Labor

If a warranty claim is submitted to Skylift does not contain all information requested and documented the claim will not be considered or paid.

Claim forms can be requested by phone (440) 960-2100 or emailing susan@skyliftus.com

Please refer to Limited Warranty document for complete warranty coverage info.



Skylift Warranty Department
 FAX: (440) 960-2104
 susan@skyliftus.com

WARRANTY CLAIM FORM

Skylift, Inc.
 3000 Leavitt Rd., Unit 6
 Lorain, OH 44052

Today's Date: _____

Claim, Repair, or Work Order No. _____

Skylift Model Type		Unit Serial No.	Trailer Serial No.	Hour Meter Reading
Company Name, Address & Contact Person		Phone No.		Email Address
Detailed Description of Problem(s) and (if known) Cause of Failure				
			Total Cost of Parts:	
Labor Rate Per Hour	Total Labor Time	Total Labor Charge:		
			Other Charges (explain):	
			Sales Tax (if applicable):	
			TOTAL of Claim:	
Claim, Repair, or Work Order No. FOR OFFICE USE ONLY BELOW Notes: _____ _____ _____ _____ _____ _____			Skylift, Inc. Authorization <p style="text-align: center;">WARRANTY CLAIMS will NOT be processed unless there has been prior approval from the factory for the repair work that is to be performed. Call: (440) 960-2100 After Hours Emergencies Call: (440) 725-2181</p>	