

Shop Manual

ENGINE

140E -6 SERIES

KOMATSU

SHOP MANUAL

ENGINE

140E-6 SERIES

Model **Serial Number**

**140E-6
SERIES**

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Foreword, safety and general information (ALL-0370-001A00A)

Important safety notice (ALL-1120-012A01A)

(Rev. 2011/02)

- Appropriate servicing and repair are extremely important to ensure safe operation of the machine. The Shop Manual describes the effective and safe servicing and repair methods recommended by Komatsu. Some of these methods require the use of special tools designed by Komatsu for the specific purpose.
- The symbol mark  is used for such matters that require special precautions during the work. The work indicated with the warning mark should be performed according to the instructions with special attention to the precautions. Should a hazardous situation occur or be anticipated during such work, be sure to keep safe first and take every necessary measure.

General precautions

 **Inappropriate handling creates an extreme danger. Read and understand what is described in the Operation and Maintenance Manual before operating the machine. In addition read this manual carefully and understand its contents before starting work.**

- Before performing any greasing or repairs, read all the safety labels stuck to the machine. For the locations of the safety labels and detailed explanation of precautions, see the Operation and Maintenance Manual.
- Locate a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt, water, or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.
- When performing any work, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
 1. Always wear the protective eyeglasses when hitting parts with a hammer.
 2. Always wear the protective eyeglasses when grinding parts with a grinder, etc.
- When performing any work with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the work. During the work, hang UNDER REPAIR warning tag in the operator's compartment.
- Only qualified workers must perform the work and operation which require license or qualification.
- Keep all tools in good condition. Learn the correct way to use them, and use the proper ones of them. Before starting work, thoroughly check the tools, machine, forklift truck, service car, etc.
- If welding repairs are needed, always have a trained and experienced welder perform the work. When performing welding work, always

wear welding gloves, apron, shielding goggles, cap and other clothes suited for welding work.

- Before starting work, warm up your body thoroughly to start work under good condition.
- Avoid continuing work for long hours and take rests at proper intervals to keep your body in good condition. Take rests in specified safe places.

Safety points

1	Good arrangement
2	Correct work clothes
3	Following work standard
4	Making and checking signals
5	Prohibition of operation and handling by unlicensed workers
6	Safety check before starting work
7	Wearing protective goggles (for cleaning or grinding work)
8	Wearing shielding goggles and protectors (for welding work)
9	Good physical condition and preparation
10	Precautions against work which you are not used to or you are used to too much

Preparation work

- Before adding oil or making any repairs, park the machine on a hard and level ground, and apply the parking brake and chock the wheels or tracks to prevent the machine from moving.
- Before starting work, lower the work equipment (blade, ripper, bucket, etc.) to the ground. If this is not possible, insert the lock pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang warning tag on them.
- When disassembling or assembling, support the machine with blocks, jacks, or stands before starting the work.
- Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine. Never jump on or off the machine. When a scaffolding is not

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Foreword, safety and general information

provided, use steps or a step ladder to secure your footing.

Precautions during work

- For the machine equipped with a battery disconnect switch, before starting the work, check that the system operating lamp is turned OFF, and then turn the battery disconnect switch to the OFF (○) position and pull the switch key out. For machines without a battery disconnect switch, before starting the work, remove the cables from the battery. Always remove the cable from the negative (–) terminal first.
- Before disconnecting or removing components of the oil, water, or air circuits, first release the remaining pressure completely from the circuit. When removing the oil filter cap, a drain plug, or an oil pressure pickup plug, loosen it slowly to prevent the oil from spurting out.
- The coolant and oil in the circuits are hot when the engine is shut down. Be careful not to get scalded. Wait for the oil and coolant to cool before performing any work on the oil or water circuits.
- Before starting work, shut down the engine. When working on or around a rotating part, in particular, shut down the engine. When checking the machine without stopping the engine (measuring oil pressure, revolving speed, temperature, etc.), take extreme care not to get rolled or caught in rotating parts or moving parts.
- When raising a heavy component (heavier than 25 kg), use a hoist or crane. Before starting work, check that the slings (wire ropes, chains, and hooks) are free from damage. Always use slings which have ample capacity and install them to proper places. Operate the hoist or crane slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.
- When removing a cover which is under internal pressure or under reaction force of a spring, always leave two bolts in diagonal positions. Loosen those two bolts gradually and alternately to release the pressure, and then remove the cover.
- When removing components, be careful not to break or damage the electrical wiring. Damaged wiring may cause electrical fires.
- When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips onto the floor, wipe it off immediately. Fuel or oil on the floor can cause you to slip and can even cause fires.
- As a general rule, do not use gasoline to wash parts. Do not use it to clean electrical parts, in particular.
- Be sure to assemble all parts again in their original places. Replace any damaged parts and parts which must not be reused with new parts.

When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is operated.

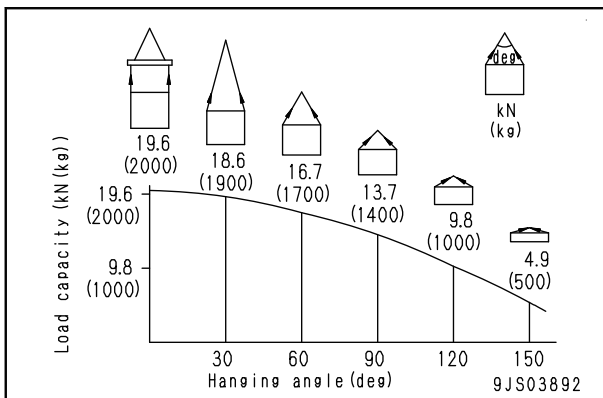
- When installing high pressure hoses and tubes, make sure that they are not twisted. Damaged hoses and tubes are dangerous, so be extremely careful when installing hoses and tubes for high-pressure circuits. In addition, check that connections of them are correct.
- When assembling or installing parts, always tighten them to the specified torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speeds, be particularly careful to check that they are installed correctly.
- When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.
- When measuring hydraulic pressure, check that the measuring tools are correctly installed.
- Take care when removing or installing the tracks of track-type machines. When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.
- If the engine is operated for a long time in a place which is not ventilated well, you may suffer from gas poisoning. Accordingly, open the windows and doors to ventilate well.

Precautions for slinging work and making signals

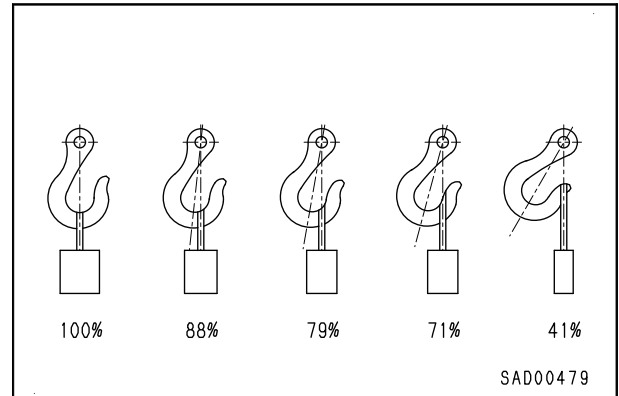
- Only one appointed worker must make signals and co-workers must communicate with each other frequently. The appointed signaler must make specified signals clearly at a place where he (she) is well seen from the operator's seat and where he (she) can see the working condition easily. The signaler must always stand in front of the load and guide the operator safely.
 1. Do not stand under the load.
 2. Do not step on the load.
- Check the slings before starting sling work.
- Keep putting on gloves during sling work. (Put on leather gloves, if available.)
- Measure the weight of the load by the eye and check its center of gravity.
- Use proper sling according to the weight of the load and method of slinging. If too thick wire ropes are used to sling a light load, the load may slip and fall.
- Do not sling a load with one wire rope alone. If it is slung by one wire rope, it may rotate and slip out of the rope. Install two or more wire ropes symmetrically.

⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

- Limit the hanging angle to 60 degrees, as a rule.
- Do not sling a heavy load (25 kg or more) with ropes forming a wide hanging angle from the hook.
- ★ When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angle. The figure below shows the variation of allowable load in kN {kg} when hoisting is made with two ropes, each of which is allowed to sling up to 9.8 kN {1,000 kg} vertically, at various hanging angles. When the two ropes sling a load vertically, up to 19.6 kN {2,000 kg} of total weight can be suspended. This weight is reduced to 9.8 kN {1,000 kg} when the two ropes make a hanging angle of 120 degrees. If the two ropes sling a 19.6 kN {2,000 kg} load at a lifting angle of 150 degrees, each rope is subjected to a force as large as 39.2 kN {4,000 kg}.



- When installing wire ropes to an angular load, apply pads to protect the wire ropes. If the load is slippery, apply proper material to prevent the wire rope from slipping.
- Use the specified eyebolts and fix wire ropes, chains, etc. to them with shackles, etc.
- Apply wire ropes to the middle portion of the hook.
- ★ Slinging near the tip of the hook may cause the rope to slip off the hook during hoisting. The hook has the maximum strength at the middle part.



- Do not use twisted or kinked wire ropes.
- When lifting up a load, observe the following.
 1. Wind in the crane slowly until wire ropes are stretched. When settling the wire ropes with the hand, do not grasp them but press them from above. If you grasp them, your fingers may be caught.
 2. After the wire ropes are stretched, stop the crane and check the condition of the slung load, wire ropes, and pads.
 3. If the load is unstable or the wire rope or chains are twisted, lower the load and lift it up again.
 4. Do not lift up the load at an angle.
- When lowering a load, observe the following.
 1. When lifting down a load, stop it temporarily at 30 cm above the floor, and then lower it slowly.
 2. Check that the load is stable, and then remove the sling.
 3. Remove kinks and dirt from the wire ropes and chains used for the sling work, and put them in the specified place.

Precautions for using mobile crane

- ★ Read the Operation and Maintenance Manual of the crane carefully in advance and operate the crane safely.

Precautions for using overhead traveling crane

⚠ When raising a heavy part (heavier than 25 kg), use a hoist, etc. . In disassembly and assembly, the weight of a part heavier than 25 kg is indicated after the mark of

- Before starting work, inspect the wire ropes, brake, clutch, controller, rails, over wind stop device, ground fault circuit interrupter, crane collision prevention device, and power application warning lamp, and check safety.
- Observe the signals for sling work.
- Operate the hoist at a safe place.
- Check the direction indicator plates (north, south, east, and west) and the directions of the control buttons without fail.

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- Do not sling a load at an angle. Do not move the crane while the slung load is swinging.
- Do not raise or lower a load while the crane is moving longitudinally or laterally.
- Do not drag a sling.
- When lifting up a load, stop it just after it leaves the ground and check safety, and then lift it up.
- Consider the travel route in advance and lift up a load to a safe height.
- Place the control switch in a position where it will not be an obstacle to work and passage.
- After operating the hoist, do not swing the control switch.
- Remember the position of the main switch so that you can turn off the power immediately in an emergency.
- If the hoist stops because of a power failure, turn the power switch OFF. When turning on a switch which was turned OFF by the ground fault circuit interrupter, check that the devices related to that switch are not in operating condition.
- If you find an obstacle around the hoist, stop the operation.
- After finishing the work, stop the hoist at the specified position and raise the hook to at least two meters above the floor. Do not leave the sling attached to the hook.

Selecting wire ropes

- Select adequate ropes depending on the weight of parts to be hoisted, referring to the table below

Wire ropes (standard "Z" twist ropes without galvanizing) (JIS G3525, No. 6, Type 6x37-A)

Nominal diameter of rope	Allowable load	
	kN	ton
mm		
10	8.8	0.9
12	12.7	1.3
14	17.3	1.7
16	22.6	2.3
18	28.6	2.9
20	35.3	3.6
25	55.3	5.6
30	79.6	8.1
40	141.6	14.4
50	221.6	22.6
60	318.3	32.4

- ★ The allowable load is one-sixth of the breaking strength of the rope to be used (Safety coefficient: 6).

Precautions for disconnecting and connecting hoses and tubes in air conditioner circuit

Disconnection

⚠ Disconnection although the refrigerant (refrigerant gas: R134a) used on the machine's air conditioner is less destructive to the ozone layer for environmental friendliness, it is not allowed to be released into the atmosphere as is. Whenever disconnecting the air conditioner gas circuit, be sure to recover the refrigerant gas to reuse it.

- ★ Ask a qualified person for collection, and charge of the refrigerant (R134a).
- ★ Never release the refrigerant (R134a) to the atmosphere.

⚠ If refrigerant gas (R134a) gets in your eyes, you may lose your sight. And if it touches your skins, you may suffer from frostbite. Accordingly, put on protective eyeglasses, gloves and working suits with long sleeves while you are collecting or filling the refrigerant (R134a).

- When loosening the nuts fixing air conditioner hoses and tubes, be sure to use two wrenches; use one wrench to fix and use the other one to loosen the nut.

Connection

- When installing the air conditioner hoses and tubes, take care to prevent any dirt, dust or water from entering.
- When installing the air conditioner hoses and tubes, check that O-rings are fitted to their joints.
- Once an O-ring is used, it is deformed and deteriorated. Accordingly, do not reuse it.
- When removing O-rings, use a soft tool so that the piping will not be damaged.
- Check that there is no defect or deterioration on the O-ring.
- Apply compressor oil for refrigerant (R134a) to the O-ring.
 - ★ However, do not apply oil to the threads portion of a bolt, nut or union.

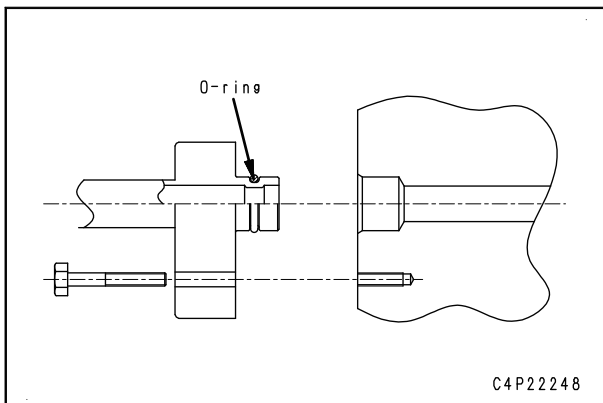
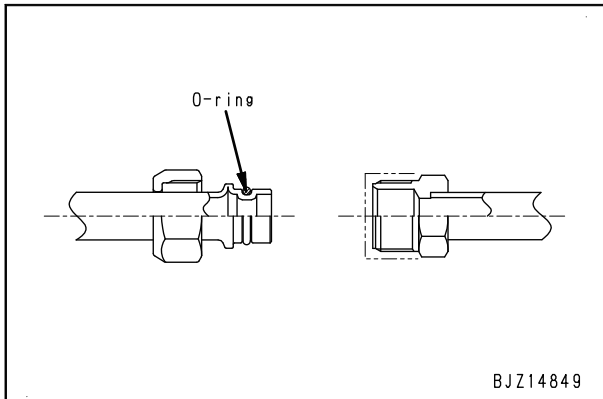
Manufacturer	Part name
DENSO	ND-OIL8
VALEO THERMAL SYSTEMS	ZXL100PG (equivalent to PAG46)
SANDEN	SP-10

- When tightening nuts of the air conditioner hoses and tubes, be sure to use two wrenches. Use one wrench to fix and tighten the nut with

the other wrench to the specified torque (Use a torque wrench for tightening).

★ Example of fitting of O-ring

- An O-ring is fitted to every joint of hoses and tubes in the air conditioner circuit.



- ★ For tightening torques, see "Others",
"Precautions for disconnection and connection
of air conditioner piping".

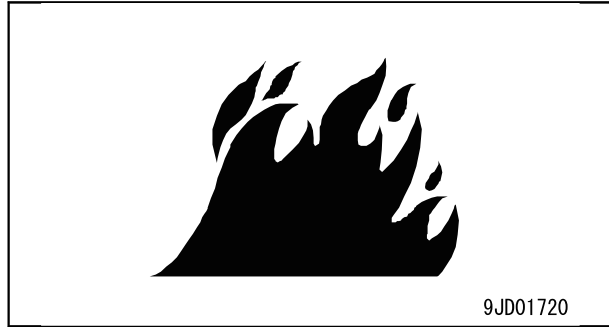
Fire prevention (ALL-0000-001K27A)

Action if fire occurs (ALL-0000-17AK01A)

- Turn the start switch OFF to stop the engine.
- Use the handrails and steps to get off the machine.
- Do not jump off the machine. There is the danger of falling and suffering serious injury.
- When the machine is involved with a fire, fumes include harmful materials.
Don't breathe the fumes.
- After a fire, there might be harmful material left. Don't touch them directly, because they might be harmful to person.
Anyone conducting clean-up must wear rubber groves.
Rubber gloves should be polychloroprene (Neoprene) or polyvinyl chloride (in the case of low temperature).
When wearing cotton-work-gloves, wear rubber gloves under them.

Prevent fire (ALL-0000-17BK03A)

- **Fire caused by fuel, oil, coolant, or window washer fluid**
Do not bring any flame or fire close to flammable substances such as fuel, oil, coolant, or window washer fluid. There is danger that they may catch fire. To prevent fire, always observe the following.
 - Do not smoke or use any flame near fuel or other flammable substances.
 - Stop the engine before adding fuel.
 - Do not leave the machine when adding fuel or oil.
 - Tighten all fuel and oil caps securely.
 - Be careful not to spill fuel on overheated surfaces or on parts of the electrical system.
 - After adding fuel or oil, wipe up any spilled fuel or oil.
 - Put greasy rags and other flammable materials into a safe container to maintain safety at the workplace.
 - When washing parts with oil, use a non-flammable oil. Do not use diesel oil or gasoline. There is danger that they may catch fire.
 - Do not weld or use a cutting torch to cut any pipes or tubes that contain flammable liquids.
 - Determine well-ventilated areas for storing oil and fuel. Keep the oil and fuel in the determined place and do not allow unauthorized persons to enter.
 - When carrying out grinding or welding work on the machine, move any flammable materials to a safe place before starting.



- **Fire caused by accumulation of flammable material**
 - Remove any dry leaves, chips, pieces of paper, coal dust, or any other flammable materials accumulated or affixed around the engine exhaust manifold, muffler or battery, or inside the undercovers.
 - To prevent fires spreading from sparks or burning particles from other fires, remove any flammable materials such as dry leaves, chips, coal dust, or any other flammable materials accumulated around the cooling system (radiator, oil cooler) or inside the undercover.
- **Fire coming from electric wiring**
Short circuits in the electrical system can cause fire. To prevent fire, always observe the following.
 - Keep all electric wiring connections clean and securely tightened.
 - Check the wiring every day for looseness or damage. Tighten any loose connectors or wiring clamps. Repair or replace any damaged wiring.
- **Fire coming from piping**
Check that all the hose and tube clamps, guards, and cushions are securely fixed in position. If they are loose, they may vibrate during operation and rub against other parts. There is danger that this may lead to damage to the hoses and cause high-pressure oil to spurt out, leading to fire, serious personal injury or death.
- **Fire around the machine due to highly heat exhaust gas**
This machine is equipped with KDPF (Komatsu Diesel Particulate Filter).
KDPF is a system for purifying soot in exhaust gas. Its exhaust gas discharged during

purification process (regeneration) can be at higher temperature than that from existing models. Do not bring any flammable close the outlet of the exhaust pipe.

- When there are thatched houses, dry leaves or pieces of paper near the work site, set the system to disable the regeneration before starting work to prevent fire hazards due to highly heated exhaust gas.
For the setting procedure, see the Operation and Maintenance Manual.

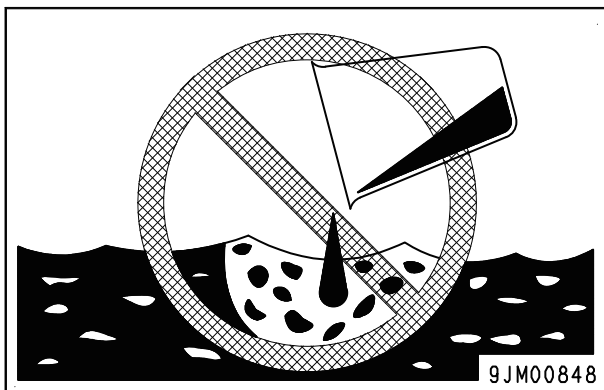
- **Explosion caused by lighting equipment**

- When checking fuel, oil, battery electrolyte, or coolant, always use lighting with anti-explosion specifications.
- When taking electrical power for the lighting from the machine itself, see the Operation and Maintenance Manual.

Dispose of waste materials (ALL-0000-99AK02A)

To prevent pollution, pay careful attention to the method of disposing of waste materials.

- Always put oil drained from your machine in containers. Never drain oil directly onto the ground or dump into the sewage system, rivers, the sea, or lakes.
- Obey appropriate laws and regulations when disposing of harmful objects such as oil, fuel, coolant, solvent, filters, and batteries.



Some kinds of rubber, plastics might produce poisonous gas harmful to person, when they are burned.

- When disposing of rubber, plastics, or parts (hoses, cables, and harness) made of those materials, these must be treated by industrial waste disposer in accordance with local regulations.

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Foreword, safety and general information

How to read the shop manual (ALL-0320-010A03A)

(Rev. 2011/02)

- Some attachments and optional parts in this shop manual may not be delivered to certain areas. If one of them is required, consult KOMATSU distributors.
- Materials and specifications are subject to change without notice.
- Shop manuals are divided into the "Chassis volume" and "Engine volume". For the engine unit, see the engine volume of the engine model mounted on the machine.

Composition of shop manual

- This shop manual contains the necessary technical information for services performed in a workshop. For ease of understanding, the manual is divided into the following sections.

00. Index and foreword

- This section contains the index, foreword, safety and basic information. If any revision is made, the LIST OF REVISED PAGES will be added.

01. Specification

- This section explains the specifications of the machine.

10. Structure and function

- This section explains the structure and function of each component. It serves not only to give an understanding for the structure of each component, but also serves as reference material for troubleshooting.

20. Standard value table

- This section explains the standard values for new machine and judgement criteria for testing, adjusting, and troubleshooting. This standard value table is used to check the standard values in testing and adjusting and to judge parts in troubleshooting.

50. Disassembly and assembly

- This section explains the special tools and procedures for removing, installing, disassembling, and assembling each component, as well as precautions for them. In addition, tightening torque, and quantity and weight of coating material, oil, grease, and coolant necessary for the work are also explained.

60. Maintenance standard








- This section gives maintenance standard values of each component. The maintenance standard sub-section explains the criteria and remedies for disassembly and service.

Revision and distribution

- Any additions, revisions, or other change of notices will be sent to KOMATSU distributors. Get the most up-to-date information before you start any work.

Symbol

Important safety and quality portions are marked with the following symbols so that the shop manual will be used practically.

Symbol	Item	Description
	Safety	Special safety precautions which are necessary when performing work are described.
	Caution	Special technical precautions or other precautions for preserving standards which are necessary when performing work are described.
	Weight	Weight of parts of component or parts are indicated. Caution necessary when selecting hoisting wire, or when working posture is important, etc. are described.
	Tightening torque	Tightening torque of the places that requires special attention.
	Coat	Places to be coated with adhesives, etc. during assembly are indicated.
	Oil, coolant	Places where oil, etc. must be added, and capacity are indicated.
	Drain	Places where oil, etc. must be drained, and quantity to be drained are indicated.

Unit

- In this shop manual, the units are indicated with International System of units (SI).

- For reference, conventionally used Gravitational System of units is indicated in parentheses {}.

Explanation of terms for maintenance standard (ALL-0330-006A01A)

(Rev. 2011/02)

- The maintenance standard chapter describes the criteria for replacing or reusing products or parts in the machine disassembly and maintenance work. The following terms are used to describe the criteria.

Standard dimension and tolerance

- To be accurate, the finished dimension of parts is slightly different from one to another.
- To specify the finished dimension of a part, a certain dimension is set for the part and an allowable difference from that dimension is indicated.
- The above dimension set is called the "standard dimension" and the range of difference from the standard dimension is called the "tolerance".
- The tolerance with the symbols of + or - is indicated on the right side of the standard dimension.

Example:

Standard dimension	Tolerance
120	-0.022
	-0.126

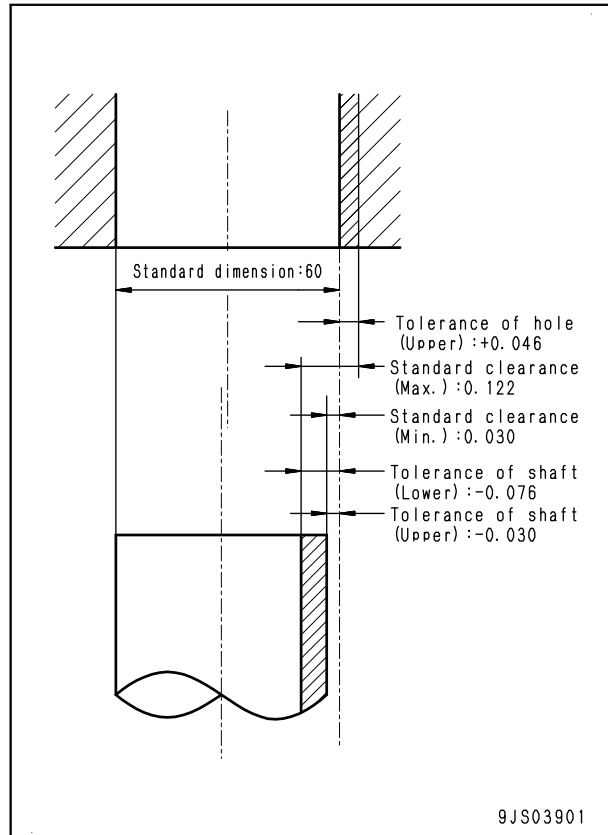
- The tolerance may be indicated in the text and a table as "standard dimension (upper limit of tolerance/lower limit of tolerance)." Example) 120 (-0.022/-0.126)
- Usually, the dimension of a hole and the dimension of the shaft to be inserted into that hole are indicated by the same standard dimension and different tolerances of the hole and shaft. The tightness of fit is decided by the tolerance.
- Indication of dimension of rotating shaft and hole and their related drawing.

Example:

Standard dimension	Tolerance	
	Shaft	Hole
60	-0.030	+0.046
	-0.076	0

Standard clearance and standard value

- The clearance made when new parts are assembled is called the standard clearance, which is indicated by the range from the minimum clearance to the maximum clearance.
- When some parts are repaired, the clearance is generally adjusted to the standard clearance.
- The values indicating performance and function of new products or equivalent are called the "standard value", which is indicated by a range or a target value.
- When some parts are repaired, the value of performance/function is set to the standard value.



Standard interference

- When the diameter of a hole of a part shown in the given standard dimension and tolerance table is smaller than that of the shaft to be inserted, the difference between those diameters is called the "interference".
- Subtract the maximum dimension of the hole from the minimum dimension of the shaft and call it (A). Subtract the minimum dimension of the hole from the maximum dimension of the shaft and call it (B). The range between (A) and (B) is the "standard interference".
- After repairing or replacing some parts, measure the dimension of their hole and shaft and check that the interference is in the standard range.

Repair limit and allowable value or allowable dimension

- The dimension of parts changes due to the wear or deformation while they are used. When the dimension charges exceeding certain value, parts can not be used any longer. This value is called the "repair limit".
- If a part is worn to the repair limit, it must be replaced or repaired.

- The performance and function of products lowers while they are used. When alternative characteristic value of the performance and function towers exceeding certain limit, it fluence operation etc. This value is called the allowable value or allowable dimension
- If a product deviates from the allowable value, it must be checked or repaired. However, since the allowable values are generally estimated from various tests or experiences in most cases, it must be judged after considering the operating condition and customer's requirement.

Allowable clearance

- Parts can be used until the clearance between them is increased to a certain limit. The limit at which those parts cannot be used is called the "allowable clearance".
- If the clearance between the parts exceeds the allowable clearance, they must be replaced or repaired.

Allowable interference

- The allowable maximum interference between the hole of a part and the shaft of another part to be assembled is called the "allowable interference".
- The allowable interference shows the repair limit of the part of smaller tolerance.
- If the interference between the parts exceeds the allowable interference, they must be replaced or repaired.

Handling of fuel system devices *(PC-AD00-2A4K00A)*

(Rev. 2011/02)

- The common rail fuel injection system (CRI) consists of more precise parts than the conventional fuel injection pump and nozzles. If foreign matter enters this system, it can cause a problem. Use special care to prevent entry of foreign matter when performing inspection and maintenance of the fuel system.

Be careful of the work environment

- Avoid replacing filters or repairing the machine in rain or high winds, or at places where there is a lot of dust.

Sealing openings

- After any piping or equipment is removed, the openings should be sealed with caps, tapes, or vinyl bags to prevent any dirt or dust from entering. If the opening is left open or is blocked with a rag, there is danger of dirt entering or of the surrounding area being made dirty by leaking oil so never do this. Do not simply drain oil out onto the ground, but collect it and ask the customer to dispose of it, or take it back with you for disposal.

Cleaning off dusts

- Wash the system carefully with clean fuel if dusts enter the system.

Precautions for replacing fuel filter cartridge

- Be sure to use the Komatsu genuine fuel filter cartridge.
- Since the common rail fuel injection system (CRI) consists of more precise parts than the conventional fuel injection pump and nozzles, it employs a high-efficiency special filter to prevent foreign matter from entering it. If a filter other than the genuine one is used, the fuel system may have a trouble. Accordingly, never use such a filter.

Handling of intake system parts *(PC220-A900-2A4K00A)*

(Rev. 2011/02)

- The Komatsu Variable Geometry Turbocharger (KVGT) consists of more precise parts (variable mechanism) than the conventional turbocharger. If foreign matter enters this system, it can cause a problem. Use special care to prevent entry of foreign matter when servicing the air intake system.

Be careful of the work environment

- Avoid repairing the machine in rain or high winds, or at places where there is a lot of dust.

Sealing openings

- Install a cap, tape, plastic bag, etc. to the open ends of disconnected piping to prevent entry of foreign matter. Never leave the openings uncovered nor plug the openings with rags. Foreign matter will enter the system.

Handling of hydraulic equipment (ALL-C000-2A4P01A)

(Rev. 2011/02)

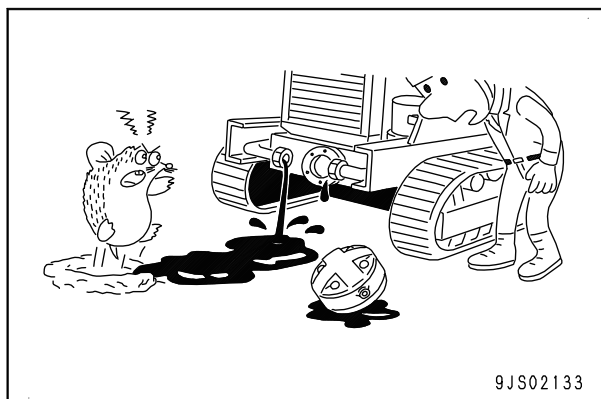
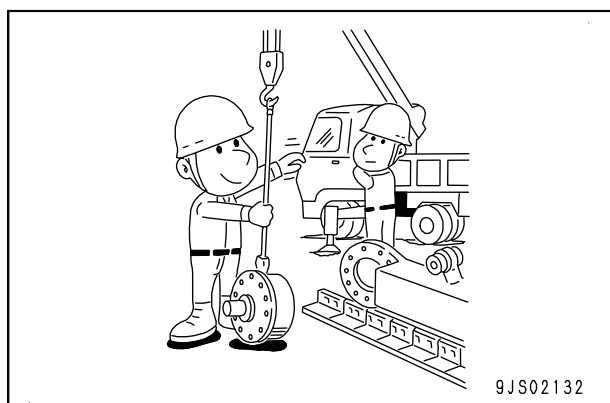
- With the increase in pressure and precision of hydraulic components, the most common cause of failure is dirt (foreign material) in the hydraulic circuit. Therefore, special precaution is required when adding hydraulic oil, or when disassembling or assembling hydraulic components.

Be careful of the work environment

- Avoid adding hydraulic oil, replacing filters, or repairing the machine in rain or high winds, or at places where there is a lot of dust.

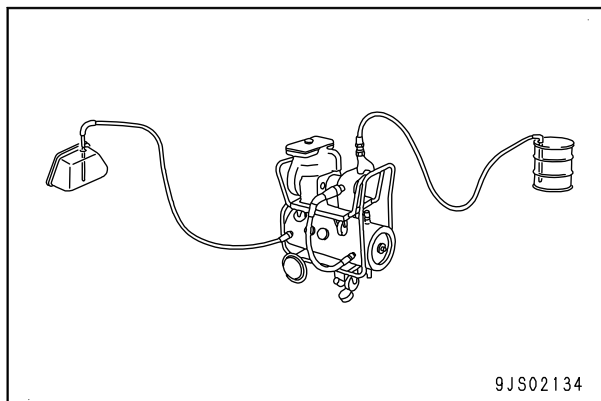
Disassembly and maintenance work in the field

- When disassembly or maintenance work is performed on hydraulic components in the field, there is danger of dust entering the components. It is also difficult to check the performance after repairs, so it is desirable to use unit exchange. Disassembly and maintenance of hydraulic components should be performed in a specially prepared dustproof workshop, and the performance should be checked with special test equipment.



Preventing intrusion of foreign materials during refilling operations.

- Be careful not to let any foreign materials get in when refilling with hydraulic oil. Always keep the oil filler and the area around it clean, and also use clean pumps and oil containers. If an oil cleaning device is used, it is possible to filter out the dirt that has been collected during storage, so this is an even more effective method.



Sealing openings

- After any piping or equipment is removed, the openings should be sealed with caps, tapes, or vinyl bags to prevent any foreign materials from entering. If the opening is exposed or is blocked with a rag, there is a danger of foreign materials entering or of the surrounding area being contaminated by leaking oil, so never do this. Do not simply drain oil out onto the ground, but collect it and ask the customer to dispose of it, or take it back with you for disposal.

Replacing hydraulic oil while its temperature is high

- When hydraulic oil or other oil is warm, it flows easily. In addition, the sludge can also be drained out easily from the circuit together with the oil, so it is better to change the oil when it is still warm. When changing the oil, the old hydraulic oil must be drained out as much as possible. (Drain the oil not only from the hydraulic tank, but also from the filter and the drain plug hole in the circuit.) If any old oil is left, the contaminants and sludge in it will mix with the new oil and will shorten the life of the hydraulic oil.