

Shop Manual

HYDRAULIC
EXCAVATOR

PC350LC-8

PC350LCD-8

PC350NLC-8

PC350NLCD-8

SERIAL NUMBERS	PC350LC-8	K50001 and up
	PC350LCD-8	K50001 and up
	PC350NLC-8	K50001 and up
	PC350NLCD-8	K50001 and up

KOMATSU

HYDRAULIC EXCAVATOR

PC350LC-8

PC350LCD-8

PC350NLC-8

PC350NLCD-8

Machine model	Serial number
---------------	---------------

PC350LC-8	K50001 and up
PC350LCD-8	K50001 and up
PC350NLC-8	K50001 and up
PC350NLCD-8	K50001 and up

00 Index and foreword

Index

Composition of shop manual.....	2
Table of contents	4

Composition of shop manual

The contents of this shop manual are shown together with Form No. in a list.

Note 1: Always keep the latest version of this manual in accordance with this list and utilize accordingly.

The marks shown to the right of Form No. denote the following:

○: New issue (to be filed additionally) ●: Revision (to be replaced for each Form No.)

Note 2: This shop manual can be supplied for each Form No.

Note 3: To file this shop manual in the special binder for management, handle it as follows:

- Place a divider on the top of each section in the file after matching the Tab No. with No. indicated next to each Section Name shown in the table below:
- File overview and other materials in sections in the order shown below and utilize them accordingly.

Section Title	Form Number
Shop Manual, contents binder, binder label and tabs	UEN01983-03 ●
00 Index and foreword	
Index	UEN01985-03 ●
Foreword and general information	UEN01986-00
01 Specification	
Specification and technical data	UEN01988-02
10 Structure, function and maintenance standard	
Engine and cooling system	UEN01990-01
Power train	UEN01991-00
Undercarriage and frame	UEN01992-00
Hydraulic system, Part 1	UEN01993-00
Hydraulic system, Part 2	UEN01994-00
Hydraulic system, Part 3	UEN01995-01
Work equipment	UEN01996-01
Cab and its attachments	UEN01997-00
Electrical system	UEN01998-02
Auto Grease system	UEN01999-00
20 Standard value table	
Standard service value table	UEN02624-01
30 Testing and adjusting	
Testing and adjusting, Part 1	UEN02625-00
Testing and adjusting, Part 2	UEN02626-00
Testing and adjusting, Part 3	UEN02663-00
40 Troubleshooting	
Failure code table and fuse locations	UEN02627-00
General information on troubleshooting	UEN02628-02
Troubleshooting by failure code (Display of code), Part 1	UEN02629-00
Troubleshooting by failure code (Display of code), Part 2	UEN02630-00
Troubleshooting by failure code (Display of code), Part 3	UEN02631-00
Troubleshooting of electrical system (E-mode)	UEN02632-01

Troubleshooting of hydraulic and mechanical system (H-mode)	UEN02633-00
Troubleshooting of engine (S-mode)	UEN02634-01
Troubleshooting of Auto Grease system	UEN02650-00
50 Disassembly and assembly	
General information on disassembly and assembly	UEN02635-00
Engine and cooling system	UEN02636-00
Power train	UEN02637-00
Undercarriage and frame	UEN02638-00
Hydraulic system	UEN02639-00
Work equipment	UEN02640-00
Cab and its attachments	UEN02641-00
Electrical system	UEN02642-01
90 Diagrams and drawings	
Hydraulic diagrams and drawings	UEN02004-02 ●
Electrical diagrams and drawings	UEN02005-02

Table of contents

00 Index and foreword	
Index	UEN01985-03
Composition of shop manual	2
Table of contents	4
Foreword and general information	UEN01986-00
Safety notice	2
How to read the shop manual	7
Explanation of terms for maintenance standard	9
Handling electric equipment and hydraulic component	11
How to read electric wire code	23
Precautions when carrying out operation	26
Method of disassembling and connecting push-pull type coupler	29
Standard tightening torque table	32
Conversion table	36
01 Specification	
Specification and technical data	UEN01988-02
Specification dimension drawings	2
Dimensions	2
Working ranges	3
Weight table	7
Table of fuel, coolant and lubricants	8
10 Structure, function and maintenance standard	
Engine and cooling system	UEN01990-01
Engine related parts	2
Radiator, oil cooler and aftercooler	3
Diesel Particulate Filter	4
Power train	UEN01991-00
Power train	2
Final drive	4
Sprocket	6
Swing machinery	8
Swing circle	10
Undercarriage and frame	UEN01992-00
Track frame and recoil spring	2
Idler	4
Carrier roller	6
Track roller	7
Track shoe	8
Hydraulic system, Part 1	UEN01993-00
Hydraulic equipment layout drawing	2
Hydraulic tank and filter	4
Hydraulic pump	6
Hydraulic system, Part 2	UEN01994-00
Control valve	2
CLSS	14
Outline of CLSS	14
Basic principle	15
Functions and operation by valve	18
Hydraulic circuit diagram and the name of valves	18
Unload valve	20
Introduction of LS pressure	22

LS bypass plug.....	23
Pressure compensation valve.....	24
Pressure compensation valve inner shuttle valve.....	27
Boom regeneration circuit.....	29
Arm regeneration circuit.....	31
Merge-divider valve.....	33
LS select valve.....	35
Self pressure reducing valve.....	36
Travel junction valve.....	39
Travel PPC shuttle valve.....	41
Boom drift prevention valve.....	43
Arm drift prevention valve.....	46
Quick return valve.....	50
Lift check valve.....	52
Main relief valve.....	53
2-stage safety-suction valve.....	54
Variable pressure compensation valve.....	56
Attachment circuit selector valve.....	58
Hydraulic drift prevention valve.....	60
Hydraulic system, Part 3.....	UEN01995-01
Valve control.....	2
PPC valve.....	4
Solenoid valve.....	26
PPC accumulator.....	28
Return oil filter.....	29
Centre swivel joint.....	30
Travel motor.....	31
Swing motor.....	43
Hydraulic cylinder.....	52
Work equipment.....	UEN01996-01
Work equipment.....	2
Dimensions of components.....	4
Cab and its attachments.....	UEN01997-00
Air conditioner piping.....	2
Electrical system.....	UEN01998-02
Engine control.....	2
Electronic control system.....	11
Monitor system.....	37
Sensor.....	64
KOMTRAX terminal system.....	67
Auto Grease system.....	UEN01999-00
Assembly.....	3
Components.....	3
The Greasing Cycle.....	6
Introduction.....	7
20 Standard value table.....	
Standard service value table.....	UEN02624-01
Standard value table for engine related parts.....	2
Standard value table for chassis related parts.....	3
30 Testing and adjusting.....	
Testing and adjusting, Part 1.....	UEN02625-00
Tools for testing, adjusting and troubleshooting.....	3
Measuring engine speed.....	7
Measuring air boost pressure.....	8

Measuring exhaust gas color	9
Adjusting valve clearance.....	11
Measuring compression pressure	13
Measuring blow-by pressure	17
Measuring engine oil pressure	18
Measuring fuel pressure.....	19
Handling during cylinder cut-out operation.....	23
Handling during no injection cranking operation	23
Measuring fuel return rate and leakage.....	24
Bleeding air from fuel circuit.....	26
Checking fuel circuit for leakage	27
Testing and adjusting air compressor belt tension	28
Measuring clearance in swing circle bearings.....	29
Testing and adjusting track shoe tension	30
Testing and adjusting oil pressure in work equipment, swing and travel circuit	31
Testing and adjusting control circuit oil pressure.....	35
Testing and adjusting pump PC control circuit oil pressure.....	36
Testing and adjusting pump LS control circuit oil pressure	39
Measuring solenoid valve output pressure.....	44
Measuring PPC valve output pressure.....	48
Adjusting play of work equipment and swing PPC valves.....	49
Inspecting locations of hydraulic drift of work equipment.....	50
Releasing remaining pressure in hydraulic circuit.....	52
Measuring oil leakage amount	52
Bleeding air from various parts.....	55
Diode inspection procedures.....	57
Testing and adjusting, Part 2	UEN02626-00
Special functions of machine monitor.....	2
Testing and adjusting, Part 3	UEN02663-00
Handling voltage circuit of engine controller.....	2
Preparation work for troubleshooting of electrical system.....	3
Procedure for testing diodes	7
Pm clinic service.....	8
40 Troubleshooting	
Failure code table and fuse locations	UEN02627-00
Failure codes table	2
Fuse locations.....	5
General information on troubleshooting	UEN02628-02
Points to remember when troubleshooting	2
Sequence of events in troubleshooting.....	3
Checks before troubleshooting	4
Classification and troubleshooting steps	5
Information in troubleshooting table.....	6
Connection table for connector pin numbers	11
T-adapter box and T-adapter table	43
Troubleshooting by failure code (Display of code), Part 1	UEN02629-00
Failure code [A000N1] Eng. Hi Out of Std	3
Failure code [AA10NX] Air cleaner Clogging.....	4
Failure code [AB00KE] Charge Voltage Low	6
Failure code [B@BAZK] Eng Oil Level Low.....	10
Failure code [B@BCNS] Eng. Water Overheat	12
Failure code [B@BCZK] Eng Water Level Low	14
Failure code [B@HANS] Hydr Oil Overheat	16
Failure code [CA111] EMC Critical Internal Failure.....	17
Failure code [CA115] Eng Ne and Bkup Speed Sens Error.....	17
Failure code [CA122] Chg Air Press Sensor High Error	18

Failure code [CA123] Chg Air Press Sensor Low Error.....	20
Failure code [CA131] Throttle Sensor High Error.....	22
Failure code [CA132] Throttle Sensor Low Error.....	24
Failure code [CA144] Coolant Temp Sens High Error.....	26
Failure code [CA145] Coolant Temp Sens Low Error.....	28
Failure code [CA153] Chg Air Temp Sensor High Error.....	30
Failure code [CA154] Chg Air Temp Sensor Low Error.....	32
Failure code [CA187] Sens Supply 2 Volt Low Error.....	34
Failure code [CA221] Ambient Press Sens High Error.....	36
Failure code [CA222] Ambient Press Sens Low Error.....	38
Failure code [CA227] Sens Supply 2 Volt High Error.....	40
Failure code [CA234] Eng Overspeed.....	41
Failure code [CA238] Ne Speed Sens Supply Volt Error.....	42
Failure code [CA271] IMV/PCV1 Short Error.....	43
Failure code [CA272] IMV/PCV1 Open Error.....	44
Failure code [CA322] Inj #1 Open/Short Error.....	46
Failure code [CA323] Inj #5 Open/Short Error.....	48
Failure code [CA324] Inj #3 Open/Short Error.....	50
Failure code [CA325] Inj #6 Open/Short Error.....	52
Failure code [CA331] Inj #2 Open/Short Error.....	54
Failure code [CA332] Inj #4 Open/Short Error.....	56
Troubleshooting by failure code (Display of code), Part 2	UEN02630-00
Failure code [CA342] Calibration Code Incompatibility.....	3
Failure code [CA351] Injectors Drive Circuit Error.....	4
Failure code [CA352] Sens Supply 1 Volt Low Error.....	6
Failure code [CA386] Sens Supply 1 Volt High Error.....	8
Failure code [CA428] Water in Fuel Sensor High Error.....	10
Failure code [CA429] Water in Fuel Sensor Low Error.....	12
Failure code [CA441] Battery Voltage Low Error.....	14
Failure code [CA442] Battery Voltage High Error.....	16
Failure code [CA449] Rail Press Very High Error.....	18
Failure code [CA451] Rail Press Sensor High Error.....	22
Failure code [CA452] Rail Press Sensor Low Error.....	24
Failure code [CA553] Rail Press High Error.....	26
Failure code [CA559] Rail Press Low Error.....	27
Failure code [CA689] Eng Ne Speed Sensor Error.....	29
Failure code [CA731] Eng Bkup Speed Sens Phase Error.....	31
Failure code [CA757] All Persistent Data Lost Error.....	32
Failure code [CA778] Eng Bkup Speed Sensor Error.....	34
Failure code [CA1633] KOMNET Datalink Timeout Error.....	36
Failure code [CA2185] Throt Sens Sup Volt High Error.....	38
Failure code [CA2186] Throt Sens Sup Volt Low Error.....	39
Failure code [CA2249] Rail Press Very Low Error.....	40
Failure code [CA2265] Electric Lift Pump High Error.....	42
Failure code [CA2266] Electric Lift Pump Low Error.....	44
Failure code [CA2555] Grid Htr Relay Volt High Error.....	46
Failure code [CA2556] Grid Htr Relay Volt Low Error.....	48
Failure code [D110KB] Battery Relay Drive S/C.....	50
Failure code [DA25KP] 5V sensor 1 power abnormality.....	52
Failure code [DA2RMC] Pump Comm. Abnormality.....	56
Failure code [DA2SKQ] Model Selection Abnormality.....	58
Troubleshooting by failure code (Display of code), Part 3	UEN02631-00
Failure code [DAFRMC] CAN discon (Monitor detected).....	4
Failure code [DHPAMA] F Pump Press Sensor Abnormality.....	6
Failure code [DHPBMA] R Pump Press Sensor Abnormality.....	8
Failure code [DHS3MA] Arm Curl PPC Sen. Abnormality.....	10
Failure code [DHS4MA] Bucket Curl PPC Press Sensor Abnormality.....	12
Failure code [DW43KA] Travel Speed Sol. Disc.....	14

Failure code [DW43KB] Travel Speed Sol. S/C	16
Failure code [DW45KA] Swing Brake Sol. Disc.....	18
Failure code [DW45KB] Swing Brake Sol. S/C.....	22
Failure code [DW91KA] Travel Junction Sol. Disc.....	24
Failure code [DW91KB] Travel Junction Sol. S/C.....	26
Failure code [DWJ0KA] Merge-divider Sol. Disc.....	28
Failure code [DWJ0KB] Merge-divider Sol. S/C.....	30
Failure code [DWK0KA] 2-stage Relief Sol. Disc.....	32
Failure code [DWK0KB] 2-stage Relief Sol. S/C.....	34
Failure code [DXA0KA] PC-EPC Sol. Disc.....	36
Failure code [DXA0KB] PC-EPC Sol. S/C.....	38
Failure code [DXE0KA] LS-EPC Sol. Disc.....	40
Failure code [DXE0KB] LS-EPC Sol. S/C.....	42
Failure code [DXE4KA] Service Current EPC Disc.....	44
Failure code [DXE4KB] Service Current EPC S/C.....	45
Failure code [DY20KA] Wiper Working Abnormality.....	46
Failure code [DY20MA] Wiper Parking Abnormality.....	48
Failure code [DY2CKB] Washer Drive Short.....	50
Failure code [DY2DKB] Wiper Drive (For) Short.....	52
Failure code [DY2EKB] Wiper Drive (Rev) Short.....	54
Troubleshooting of electrical system (E-mode)	UEN02632-01
Before carrying out troubleshooting of electrical system	4
Information contained in troubleshooting table	6
E-1 Engine does not start	7
E-2 Auto-decelerator does not operate.....	10
E-3 Automatic warming-up system does not operate.....	12
E-4 Preheater does not operate	14
E-5 All work equipment, swing, and travel mechanism do not move.....	16
E-6 Power maximizing function does not operate	18
E-7 Machine monitor does not display at all.....	20
E-8 Machine monitor does not display some items.....	22
E-9 Contents of display by machine monitor are different from applicable machine.....	22
E-10 Fuel level monitor was lighted in red while engine running.....	23
E-11 Engine coolant temperature gauge does not indicate normally.....	24
E-12 Hydraulic oil temperature gauge does not indicate normally.....	26
E-13 Fuel level gauge does not indicate normally.....	27
E-14 Swing lock monitor does not indicate normally.....	28
E-15 When monitor switch is operated, monitor displays nothing.....	30
E-16 Windshield wiper and window washer do not operate.....	32
E-17 Machine push-up function does not operate normally.....	36
E-18 Monitoring function fails to display "boom raise" normally.....	38
E-19 Monitoring function fails to display "boom lower" normally.....	40
E-20 Monitoring function fails to display "arm IN" normally.....	42
E-21 Monitoring function fails to display "arm OUT" normally.....	44
E-22 Monitoring function fails to display "bucket CURL" normally.....	46
E-23 Monitoring function fails to display "bucket DUMP" normally.....	48
E-24 Monitoring function fails to display "swing" normally.....	50
E-25 Monitoring function fails to display "travel" normally.....	52
E-26 Monitoring function fails to display "travel differential pressure" normally.....	54
E-27 Monitoring function fails to display "service" normally.....	56
E-28 KOMTRAX system does not operate normally.....	58
E-29 Air conditioner does not operate.....	60
E-30 Travel alarm does not sound or does not stop sounding.....	62
E-31 Horn does not sound.....	64
Troubleshooting of hydraulic and mechanical system (H-mode)	UEN02633-00
System chart for hydraulic and mechanical system	4
Information contained in troubleshooting table.....	6
H-1 All work equipment lack power, or travel and swing speeds are slow.....	8

H-2 Engine speed sharply drops or engine stalls.....	10
H-3 No work equipment, swing or travel move	11
H-4 Abnormal noise is heard from around hydraulic pump.....	11
H-5 Auto-decelerator does not work	12
H-6 Fine control mode does not function or responds slow	12
H-7 Boom moves slowly or lacks power	13
H-8 Arm moves slowly or lacks power	14
H-9 Bucket moves slowly or lacks power.....	15
H-10 Work equipment does not move in its single operation.....	15
H-11 Work equipment has a bit too fast hydraulic drift.....	16
H-12 Work equipment has big time lag	18
H-13 Other work equipment moves when relieving single circuit.....	18
H-14 Power max. switch does not operate	19
H-15 In compound operation, work equipment with larger load moves slowly	19
H-16 In swing + boom RAISE operation, boom moves slowly	20
H-17 In swing + travel operation, travel speed drops sharply	20
H-18 Machine swerves in travel	21
H-19 Machine travels slowly	22
H-20 Machine cannot be easily steered or lacks power.....	23
H-21 Travel speed does not shift, or it is too slow or fast.....	24
H-22 Track shoe does not turn (on one side only)	25
H-23 Machine does not swing.....	26
H-24 Swing acceleration is poor, or swing speed is slow.....	28
H-25 Excessive overrun when stopping swing.....	30
H-26 There is big shock when stopping swing.....	31
H-27 Large sound is made when upper structure stops swinging.	31
H-28 Swing hydraulic drift is too big	32
Troubleshooting of engine (S-mode)	UEN02634-01
Method of using troubleshooting chart	3
S-1 Starting performance is poor	6
S-2 Engine does not start.....	7
S-3 Engine does not pick up smoothly	10
S-4 Engine stops during operations	11
S-5 Engine does not rotate smoothly	12
S-6 Engine lacks output (or lacks power).....	13
S-7 Exhaust smoke is black (incomplete combustion).....	14
S-8 Oil consumption is excessive (or exhaust smoke is blue)	15
S-9 Oil becomes contaminated quickly	16
S-10 Fuel consumption is excessive	17
S-11 Oil is in coolant (or coolant spurts back or coolant level goes down)	18
S-12 Oil pressure drops	19
S-13 Oil level rises (Entry of coolant or fuel).....	20
S-14 Coolant temperature becomes too high (overheating)	21
S-15 Abnormal noise is made	22
S-16 Vibration is excessive	23
S-17 Diesel Particulate Filter System.....	24
Troubleshooting of Auto Grease system	UEN02650-00
Finding malfunctions	2
Malfunction reports of the display	2
General	4
Malfunction finding procedures	5
Procedure to check the correct working of the grease pressure switch and cable	5
Procedure to check the working of the pump and the 5/2-magnetic valve.....	6
Procedure when an internal system leak is suspected	6
50 Disassembly and assembly	
General information on disassembly and assembly	UEN02635-00
How to read this manual.....	2

Coating materials list	4
Special tools list	7
Sketches of special tools	11
Engine and cooling system	UEN02636-00
Removal and installation of fuel supply pump assembly	2
Removal and installation of engine front seal	5
Removal and installation of engine rear seal	7
Removal and installation of cylinder head assembly	12
Removal and installation of radiator assembly	24
Removal and installation of hydraulic oil cooler assembly	26
Removal and installation of aftercooler assembly	28
Removal and installation of engine and hydraulic pump assembly	29
Power train	UEN02637-00
Removal and installation of final drive assembly	2
Disassembly and assembly of final drive assembly	3
Removal and installation of swing motor and swing machinery assembly	11
Disassembly and assembly of swing motor and swing machinery assembly	12
Removal and installation of swing circle assembly	19
Undercarriage and frame	UEN02638-00
Disassembly and assembly of carrier roller	2
Disassembly and assembly of track roller assembly	3
Disassembly and assembly of idler assembly	4
Disassembly and assembly of recoil spring	7
Removal and installation of sprocket	9
Expansion and installation of track shoe assembly	10
Removal and installation of revolving frame assembly	11
Removal and installation of counterweight assembly	13
Hydraulic system	UEN02639-00
Removal and installation of centre swivel joint assembly	2
Disassembly and assembly of centre swivel joint assembly	4
Removal and installation of hydraulic tank assembly	5
Removal and installation of control valve assembly	7
Disassembly and assembly of control valve assembly	10
Removal and installation of hydraulic pump assembly	12
Removal and installation of oil seal in hydraulic pump input shaft	14
Disassembly and assembly of work equipment PPC valve assembly	15
Disassembly and assembly of travel PPC valve assembly	16
Disassembly and assembly of hydraulic cylinder assembly	17
Work equipment	UEN02640-00
Removal and installation of work equipment assembly	2
Cab and its attachments	UEN02641-00
Removal and installation of operator's cab assembly	2
Removal and installation of operator cab glass (stuck glass)	5
Removal and installation of front window assembly	15
Removal and installation of floor frame assembly	22
Electrical system	UEN02642-01
Removal and installation of air conditioner unit assembly	2
Removal and installation of KOMTRAX communication modem assembly	5
Removal and installation of monitor assembly	6
Removal and installation of pump controller assembly	8
Removal and installation of engine controller	10

90 Diagrams and drawings	
Hydraulic diagrams and drawings	UEN02004-02
Hydraulic circuit diagram 1/2	3
Hydraulic circuit diagram 2/2	5
Electrical diagrams and drawings	UEN02005-02
Connector arrangement diagram	3
Electrical circuit diagrams K50001-K50649 (1/5)	5
Electrical circuit diagrams K50650-Up (1/5)	15

PC350LC/NLC-8 Hydraulic excavator

Form No. UEN01985-03

© 2010 KOMATSU
All Rights Reserved
Printed in Belgium 07-10 (01)

HYDRAULIC EXCAVATOR

PC350LC-8
PC350LCD-8
PC350NLC-8
PC350NLCD-8

Machine model Serial number

PC350LC-8	K50001 and up
PC350LCD-8	K50001 and up
PC350NLC-8	K50001 and up
PC350NLCD-8	K50001 and up

00 Index and foreword

Foreword and general information

Safety notice	2
How to read the shop manual	7
Explanation of terms for maintenance standard	9
Handling electric equipment and hydraulic component	11
How to read electric wire code	23
Precautions when carrying out operation	26
Method of disassembling and connecting push-pull type coupler	29
Standard tightening torque table	32
Conversion table	36

Safety notice

(Rev. 2006/09)

Important safety notice

Proper service and repair are extremely important for safe machine operation. The service and repair techniques recommended by Komatsu and described in this manual are both effective and safe. Some of these techniques require the use of tools specially designed by Komatsu for the specific purpose.

To prevent injury to workers, the symbol **▲** is used to mark safety precautions in this manual. The cautions accompanying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.

1. General precautions

▲ Mistakes in operation are extremely dangerous. Read the Operation and Maintenance Manual carefully before operating the machine.

- 1) Before carrying out any greasing or repairs, read all the safety plates stuck to the machine. For the locations of the safety plates and detailed explanation of precautions, see the Operation and Maintenance Manual.
- 2) Decide 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.
- 3) When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
 - Always wear safety glasses when hitting parts with a hammer.
 - Always wear safety glasses when grinding parts with a grinder, etc.
- 4) When carrying out any operation with 2 or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR warning signs in the operator's compartment.
- 5) Only qualified workers must carry out work and operation which require license or qualification.
- 6) 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, fork-lift, service car, etc.
- 7) If welding repairs are needed, always have a trained and experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, shielding goggles, cap and other clothes suited for welding work.
- 8) Before starting work, warm up your body thoroughly to start work under good condition.

Safety points

1	Good arrangement
2	Correct work clothes
3	Following work standard
4	Making and checking signs
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

2. Preparations for work

- 1) Before adding oil or making any repairs, park the machine on hard and level ground, and apply the parking brake and block the wheels or tracks to prevent the machine from moving.
- 2) 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 signs on them.

- 3) When disassembling or assembling, support the machine with blocks, jacks, or stands before starting work.
- 4) 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. If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

3. Precautions during work

- 1) Before disconnecting or removing components of the oil, water, or air circuits, first release the pressure completely from the circuit. When removing the oil filler cap, a drain plug, or an oil pressure pickup plug, loosen it slowly to prevent the oil from spurting out.
- 2) The coolant and oil in the circuits are hot when the engine is stopped, so be careful not to get scalded. Wait for the oil and coolant to cool before carrying out any work on the oil or water circuits.
- 3) Before starting work, stop the engine. When working on or around a rotating part, in particular, stop 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.
- 4) Before starting work, remove the leads from the battery. Always remove the lead from the negative (-) terminal first.
- 5) 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.
- 6) When removing a cover which is under internal pressure or under pressure from a spring, always leave 2 bolts in diagonal positions. Loosen those bolts gradually and alternately to release the pressure, and then remove the cover.
- 7) When removing components, be careful not to break or damage the electrical wiring. Damaged wiring may cause electrical fires.
- 8) When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips onto the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip and can even start fires.
- 9) As a general rule, do not use gasoline to wash parts. Do not use it to clean electrical parts, in particular.
- 10) 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.
- 11) When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. In addition, check that connecting parts are correctly installed.
- 12) 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 speed, be particularly careful to check that they are installed correctly.
- 13) When aligning 2 holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.
- 14) When measuring hydraulic pressure, check that the measuring tools are correctly assembled.
- 15) 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.
- 16) 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.

4. Precautions for sling work and making signs

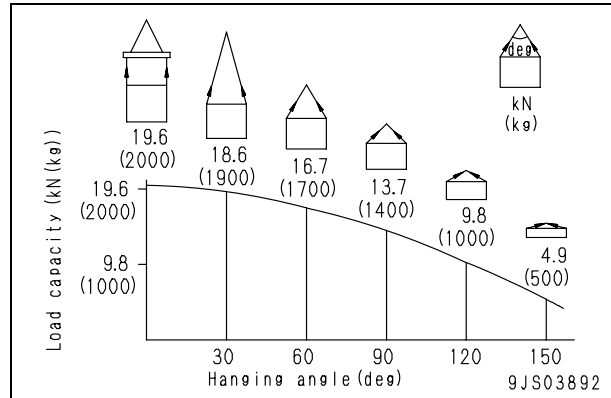
1) Only one appointed worker must make signs and co-workers must communicate with each other frequently. The appointed sign maker must make specified signs clearly at a place where he is seen well from the operator's seat and where he can see the working condition easily. The sign maker must always stand in front of the load and guide the operator safely.

- Do not stand under the load.
- Do not step on the load.

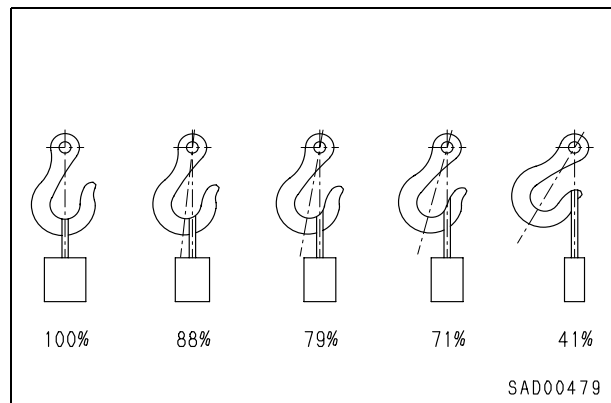
- 2) Check the slings before starting sling work.
- 3) Keep putting on gloves during sling work. (Put on leather gloves, if available.)
- 4) Measure the weight of the load by the eye and check its center of gravity.
- 5) Use proper sling according to the weight of the load and method of slinging. If too thick wire ropes are used to sling a light load, the load may slip and fall.
- 6) Do not sling a load with 1 wire rope alone. If it is slung so, it may rotate and may slip out of the rope. Install 2 or more wire ropes symmetrically.

⚠ Slinging with 1 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.

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



- 8) 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.
- 9) Use the specified eyebolts and fix wire ropes, chains, etc. to them with shackles, etc.
- 10) 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 portion.




- 11) Do not use twisted or kinked wire ropes.
- 12) When lifting up a load, observe the following.
- 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.
 - After the wire ropes are stretched, stop the crane and check the condition of the slung load, wire ropes, and pads.

- If the load is unstable or the wire rope or chains are twisted, lower the load and lift it up again.
 - Do not lift up the load slantingly.
- 13) When lifting down a load, observe the following.
- When lifting down a load, stop it temporarily at 30 cm above the floor, and then lower it slowly.
 - Check that the load is stable, and then remove the sling.
 - Remove kinks and dirt from the wire ropes and chains used for the sling work, and put them in the specified place.

5. Precautions for using mobile crane

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

6. Precautions for using overhead hoist 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 .

- 1) Before starting work, inspect the wire ropes, brake, clutch, controller, rails, over wind stop device, electric shock prevention earth leakage breaker, crane collision prevention device, and power application warning lamp, and check safety.
- 2) Observe the signs for sling work.
- 3) Operate the hoist at a safe place.
- 4) Check the direction indicator plates (east, west, south, and north) and the directions of the control buttons without fail.
- 5) Do not sling a load slantingly. Do not move the crane while the slung load is swinging.
- 6) Do not raise or lower a load while the crane is moving longitudinally or laterally.
- 7) Do not drag a sling.
- 8) When lifting up a load, stop it just after it leaves the ground and check safety, and then lift it up.
- 9) Consider the travel route in advance and lift up a load to a safe height.
- 10) Place the control switch on a position where it will not be an obstacle to work and passage.
- 11) After operating the hoist, do not swing the control switch.
- 12) Remember the position of the main switch so that you can turn off the power immediately in an emergency.

- 13) 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 electric shock prevention earth leakage breaker, check that the devices related to that switch are not in operation state.
- 14) If you find an obstacle around the hoist, stop the operation.
- 15) After finishing the work, stop the hoist at the specified position and raise the hook to at least 2 m above the floor. Do not leave the sling installed to the hook.

7. Selecting wire ropes

- 1) 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 mm	Allowable load	
	kN	ton
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 used (Safety coefficient: 6).

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

1) Disconnection

⚠ **Collect the air conditioner refrigerant gas (R134a).**

⚠ **If the refrigerant gas (R134a) gets in your eyes, you may lose your sight. Accordingly, when collecting or adding it, you must be qualified for handling the refrigerant and put on protective goggles.**

2) Connection

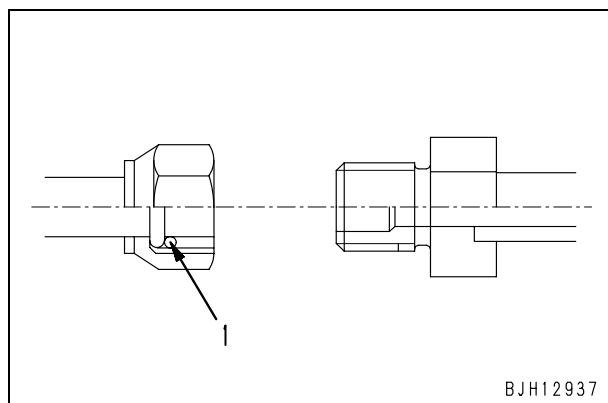
1] When installing the air conditioner circuit hoses and tubes, take care that dirt, dust, water, etc. will not enter them.

2] When connecting the air conditioner hoses and tubes, check that O-rings (1) are fitted to their joints.

3] Check that each O-ring is not damaged or deteriorated.

4] When connecting the refrigerant piping, apply compressor oil for refrigerant (R134a) (**DENSO: ND-OIL8, ZEXEL: ZXL100PG (equivalent to PAG46)**) to its O-rings.

★ Example of O-ring (Fitted to every joint of hoses and tubes)



★ For tightening torque, see the precautions for installation in each section of "Disassembly and assembly".