SECTION 7 MAINTENANCE STANDARD

GROUP 1 OPERATIONAL PERFORMANCE TEST

1. PURPOSE

Performance tests are used to check :

1) OPERATIONAL PERFORMANCE OF A NEW MACHINE

Whenever a new machine is delivered in parts and reassembled at a customer's site, it must be tested to confirm that the operational performance of the machine meets HD Hyundai Construction Equipment spec.

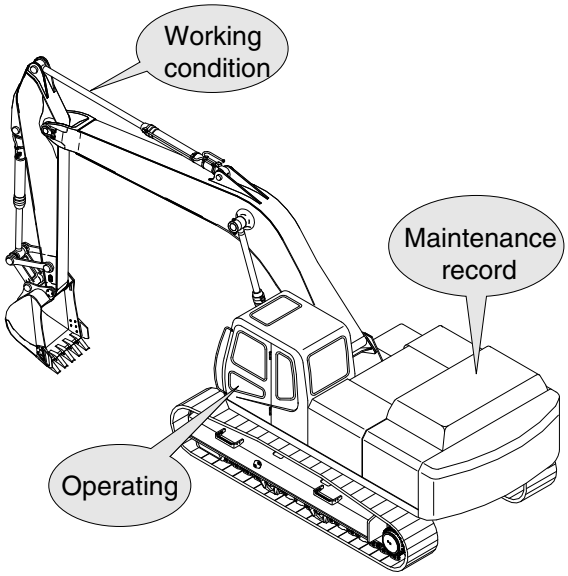
2) OPERATIONAL PERFORMANCE OF A WORKING MACHINE

With the passage of time, the machine's operational performance deteriorates, so that the machine needs to be serviced periodically to restore it to its original performance level.

Before servicing the machine, conduct performance tests to check the extent of deterioration, and to decide what kind of service needs to be done(by referring to the "Service Limits" in this manual).

3) OPERATIONAL PERFORMANCE OF A REPAIRED MACHINE

After the machine is repaired or serviced, it must be tested to confirm that its operational performance was restored by the repair and/or service work done.



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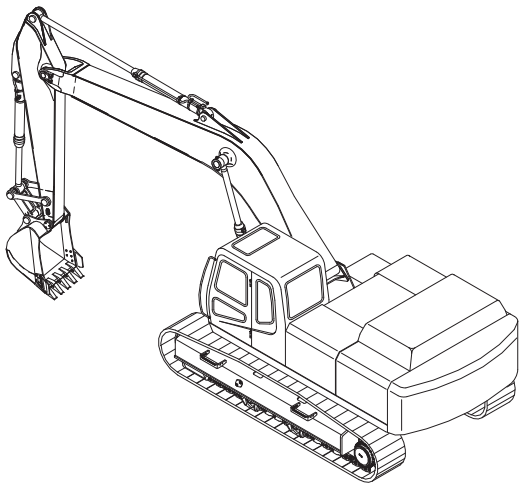
2. TERMINOLOGY

1) STANDARD

Specifications applied to the brand-new machine, components and parts.



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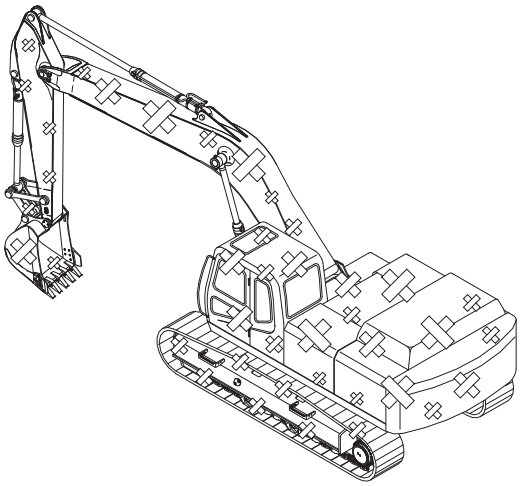
2) SERVICE LIMIT

The lowest acceptable performance level. When the performance level of the machine falls below this level, the machine must be removed from work and repaired. Necessary parts and components must be replaced.



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3. OPERATION FOR PERFORMANCE TESTS

1) Observe the following rules in order to carry out performance tests accurately and safely.

(1) The machine

Repair any defects and damage found, such as oil or water leaks, loose bolts, cracks and so on, before starting to test.

(2) Test area

① Select a hard, flat surface.

② Secure enough space to allow the machine to run straight more than 20 m, and to make a full swing with the front attachment extended.

③ If required, rope off the test area and provide signboards to keep unauthorized personnel away.

(3) Precautions

① Before starting to test, agree upon the signals to be employed for communication among coworkers. Once the test is started, be sure to communicate with each other using these signals, and to follow them without fail.

② Operate the machine carefully and always give first priority to safety.

③ While testing, always take care to avoid accidents due to landslides or contact with high voltage power lines. Always confirm that there is sufficient space for full swings.

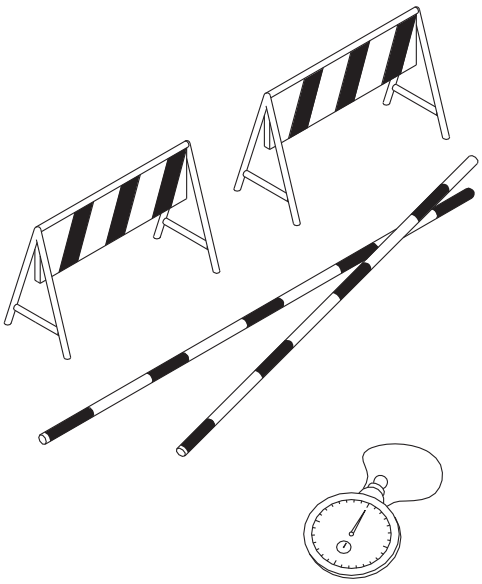
④ Avoid polluting the machine and the ground with leaking oil. Use oil pans to catch escaping oil. Pay special attention to this when removing hydraulic pipings.

(4) Make precise measurements

① Accurately calibrate test instruments in advance to obtain correct data.

② Carry out tests under the exact test conditions prescribed for each test item.

③ Repeat the same test and confirm that the test data obtained can be procured repeatedly. Use mean values of measurements if necessary.



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2) ENGINE SPEED

(1) Measure the engine speed at each power mode

※ The engine speed at each power mode must meet standard RPM; if not, all other operational performance data will be unreliable. It is essential to perform this test first.

(2) Preparation

① Warm up the machine, until the engine coolant temperature reaches 50˚C or more, and the hydraulic oil is 50±5˚C.

② Set the accel dial at 10 (Max) position.

③ Measure the engine RPM.

(3) Measurement

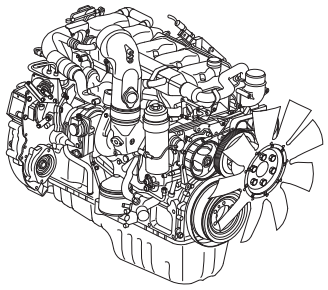
① Start the engine. The engine will run at start idle speed. Measure engine speed with a engine rpm display.

② Measure and record the engine speed at each mode (P, S, E).

③ Select the P-mode.

④ Lightly operate the bucket control lever a few times, then return the control lever to neutral; The engine will automatically enter the auto-idle speed after 4 seconds.

⑤ Measure and record the auto deceleration speed.



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(4) Evaluation

The measured speeds should meet the following specifications.

Unit : rpm

Model	Engine speed	Standard	Remarks
HX900 L	Start idle	850±100	
	P mode	1750±50	
	S mode	1650±50	
	E mode	1550±50	
	Auto decel	1000±100	
	One touch decel	850±100	

Condition : Set the accel dial at 10 (Max) position.

3) TRAVEL SPEED

(1) Measure the time required for the excavator to travel a 20 m test track.

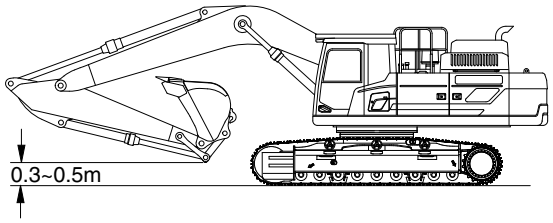
(2) Preparation

① Adjust the tension of both tracks to be equal.

② Prepare a flat and solid test track 20m in length, with extra length of 3 to 5 m on both ends for machine acceleration and deceleration.

③ Hold the bucket 0.3 to 0.5 m above the ground with the arm and bucket rolled in.

④ Keep the hydraulic oil temperature at 50±5˚C.



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(3) Measurement

① Measure both the low and high speeds of the machine.

② Before starting either the low or high speed tests, adjust the travel mode switch to the speed to be tested, then select the following switch positions.

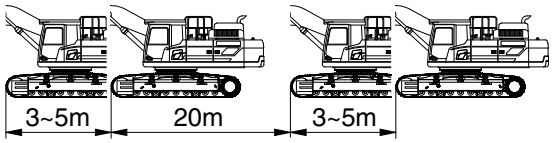
· Power mode switch : P mode

③ Start traveling the machine in the acceleration zone with the travel levers at full stroke.

④ Measure the time required to travel 20 m.

⑤ After measuring the forward travel speed, turn the upperstructure 180˚ and measure the reverse travel speed.

⑥ Repeat steps ④ and ⑤ three times in each direction and calculate the average values.



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(4) Evaluation

The average measured time should meet the following specifications.

Unit : Seconds / 20 m

Model	Travel speed	Standard	Maximum allowable	Remarks
HX900 L	1 Speed	29.5±2.0	37.3	
	2 Speed	20.5±1.0	26.0	

4) TRACK REVOLUTION SPEED

(1) Measure the track revolution cycle time with the track raised off ground.

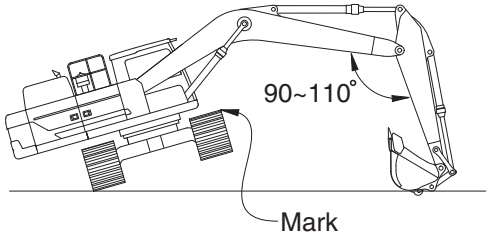
(2) Preparation

① Adjust the tension of both side tracks to be equal.

② On the track to be measured, mark one shoe with chalk.

③ Swing the upperstructure 90˚ and lower the bucket to raise the track off ground. Keep the boom-arm angle between 90 to 110˚ as shown. Place blocks under machine frame.

④ Keep the hydraulic oil temperature at 50±5˚C.



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(3) Measurement

① Select the following switch positions.

· Travel mode switch : 1 or 2 speed

· Power mode switch : P mode

· Auto idle switch : OFF

② Operate the travel control lever of the raised track in full forward and reverse.

③ Rotate 1 turn, then measure time taken for next 3 revolutions.

④ Raise the other side of machine and repeat the procedure.

⑤ Repeat steps ③ and ④ three times and calculate the average values.

(4) Evaluation

The revolution cycle time of each track should meet the following specifications.

Unit : Seconds / 3 revolutions

Model	Travel speed	Standard	Maximum allowable
HX900 L	1 Speed	59.0±2.0	72.5
	2 Speed	41.0±1.0	49.9

5) TRAVEL DEVIATION

(1) Measure the deviation by the tracks from a 20 m straight line.

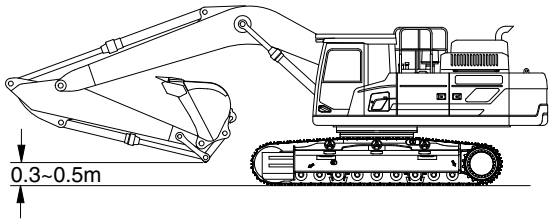
(2) Preparation

① Adjust the tension of both tracks to be equal.

② Provide a flat, solid test yard 20 m in length, with extra length of 3 to 5 m on both ends for machine acceleration and deceleration.

③ Hold the bucket 0.3 to 0.5 m above the ground with the arm and bucket rolled in.

④ Keep the hydraulic oil temperature at 50±5˚C.



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(3) Measurement

① Measure the amount of mistracking at high and low travel speeds.

② Before beginning each test, select the following switch positions.

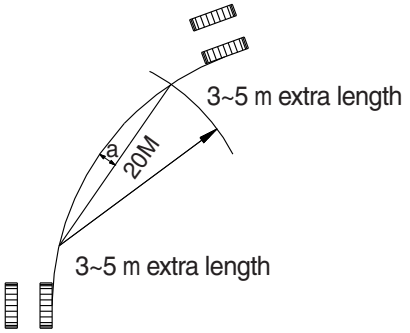
· Power mode switch : P mode

③ Start traveling the machine in the acceleration zone with the travel levers at full stroke.

④ Measure the distance between a straight 20 m line and the track made by the machine. (Dimension a)

⑤ After measuring the tracking in forward travel, turn the upperstructure 180˚ and measure that in reverse travel.

⑥ Repeat steps ④ and ⑤ three times and calculate the average values.



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(4) Evaluation

Mistrack should be within the following specifications.

Unit : mm / 20 m

Model	Standard	Maximum allowable	Remarks
HX900 L	200 below	250	-

6) SWING SPEED

(1) Measure the time required to swing three complete turns.

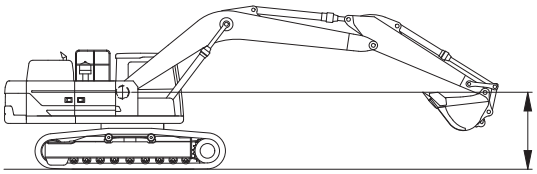
(2) Preparation

① Check the lubrication of the swing gear and swing bearing.

② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.

③ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin. The bucket must be empty.

④ Keep the hydraulic oil temperature at 50±5˚C.



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(3) Measurement

① Select the following switch positions.

· Power mode switch : P mode

② Operate swing control lever fully.

③ Swing 1 turn and measure time taken to swing next 3 revolutions.

④ Repeat steps ② and ③ three time and calculate the average values.

(4) Evaluation

The time required for 3 swings should meet the following specifications.

Unit : Seconds / 3 revolutions

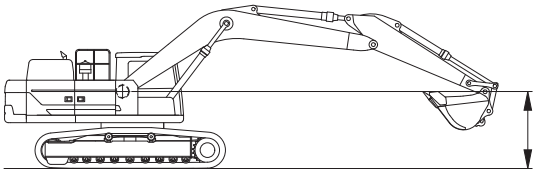
Model	Power mode switch	Standard	Maximum allowable
HX900 L	P mode	29±1.5	36.8

7) SWING FUNCTION DRIFT CHECK

(1) Measure the swing drift on the bearing outer circumference when stopping after a 360˚ full speed swing.

(2) Preparation

① Check the lubrication of the swing gear and swing bearing.
② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
③ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin. The bucket must be empty.
④ Make two chalk marks: one on the swing bearing and one directly below it on the track frame.
⑤ Swing the upperstructure 360˚.
⑥ Keep the hydraulic oil temperature at 50±5˚C.



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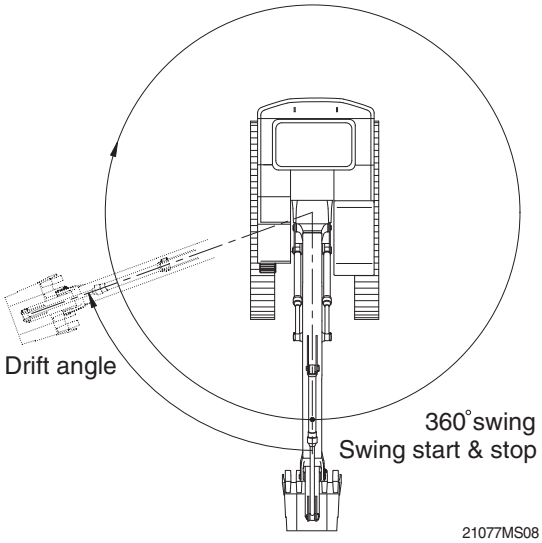
(3) Measurement

① Conduct this test in the M mode.
② Select the following switch positions.
· Power mode switch : P mode
③ Operate the swing control lever fully and return it to the neutral position when the mark on the upperstructure aligns with that on track frame after swinging 360 ˚
④ Measure the distance between the two marks.
⑤ Align the marks again, swing 360 ˚, then test the opposite direction.
⑥ Repeat steps ④ and ⑤ three times each and calculate the average values.



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(4) Evaluation

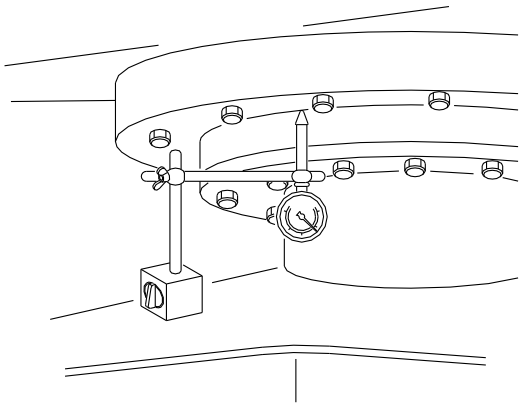
The measured drift angle should be within the following specifications.

Unit : Degree

Model	Power mode switch	Standard	Maximum allowable	Remarks
HX900 L	P mode	90 below	112.5	

8) SWING BEARING PLAY

(1) Measure the swing bearing play using a dial gauge to check the wear of bearing races and balls.



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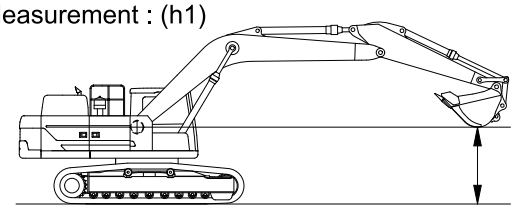
(2) Preparation

① Check swing bearing mounting cap screws for loosening.
② Check the lubrication of the swing bearing. Confirm that bearing rotation is smooth and without noise.
③ Install a dial gauge on the track frame as shown, using a magnetic base.
④ Position the upperstructure so that the boom aligns with the tracks facing towards the front idlers.
⑤ Position the dial gauge so that its needle point comes into contact with the bottom face of the bearing outer race.
⑥ Bucket should be empty.

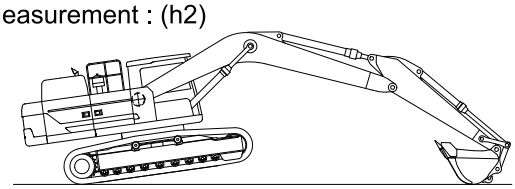
(3) Measurement

① With the arm rolled out and bucket rolled in, hold the bottom face of the bucket to the same height of the boom foot pin.
Record the dial gauge reading (h1).
② Lower the bucket to the ground and use it to raise the front idler 50 ㎝.
Record the dial gauge reading (h2).
③ Calculate bearing play (H) from this data (h1 and h2) as follows.
H=h2-h1

Measurement : (h1)



Measurement : (h2)



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(4) Evaluation

The measured drift should be within the following specifications.

Unit : mm

Model	Standard	Maximum allowable	Remarks
HX900 L	0.5 ~ 1.5	3.0	

9) HYDRAULIC CYLINDER CYCLE TIME

(1) Measure the cycle time of the boom, standard arm, and standard bucket cylinders.

(2) Preparation

① To measure the cycle time of the boom cylinders:
With the arm rolled out and the empty bucket rolled out, lower the bucket to the ground, as shown.

② To measure the cycle time of the arm cylinder.
With the empty bucket rolled in, position the arm so that it is vertical to the ground. Lower the boom until the bucket is 0.5 m above the ground.

③ To measure the cycle time of the bucket cylinder.
The empty bucket should be positioned at midstroke between roll-in and roll-out, so that the sideplate edges are vertical to the ground.

④ Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Select the following switch positions.

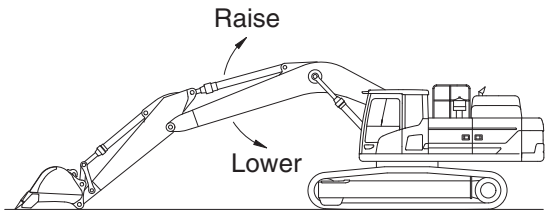
· Power mode switch : P mode

② To measure cylinder cycle times.

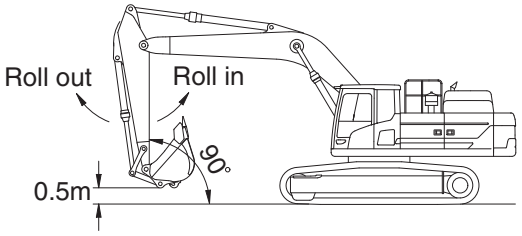
- Boom cylinders.
Measure the time it takes to raise the boom, and the time it takes to lower the boom. To do so, position the boom at one stroke end then move the control lever to the other stroke end as quickly as possible.

- Arm cylinder.
Measure the time it takes to roll in the arm, and the time it takes to roll out the arm. To do so, position the bucket at one stroke end, then move the control lever to the other stroke end as quickly as possible.

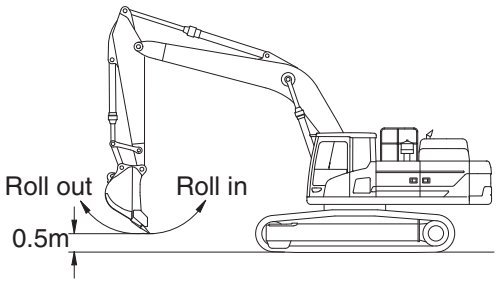
Boom cylinder



Arm cylinder



Bucket cylinder



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- Bucket cylinders
  Measure the time it takes to roll in the bucket, and the time it takes to roll out the bucket. To do so, position the bucket at one stroke end, then move the control lever to the other stroke end as quickly as possible.
- Repeat each measurement 3 times and calculate the average values.

(4) Evaluation

The average measured time should meet the following specifications.

Unit : Seconds

Model	Function	Standard	Maximum allowable	Remarks
HX900 L	Boom raise	6.0±0.4	6.9	
	Boom lower	4.2±0.4	4.9	
	Arm in	4.0±0.4	5.1	
	Arm out	3.7±0.4	4.3	
	Bucket load	4.1±0.4	4.8	
	Bucket dump	3.1±0.4	3.8	

10) DIG FUNCTION DRIFT CHECK

(1) Measure dig function drift, which can be caused by oil leakage in the control valve and boom, standard arm, and standard bucket cylinders, with the loaded bucket.
When testing the dig function drift just after cylinder replacement, slowly operate each cylinder to its stroke end to purge air.

(2) Preparation

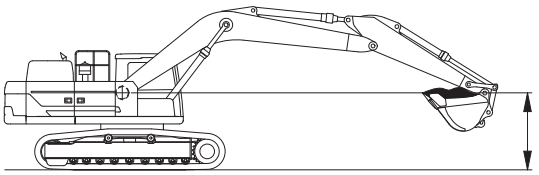
① Load bucket fully. Instead of loading the bucket, weight(W) of the following specification can be used.
- W=M^3 × 1.5
  Where :
  M^3 = Bucket heaped capacity (m^3)
  1.5 = Soil specific gravity

② Position the arm cylinder with the rod 20 to 30 ㎜ extended from the fully retracted position.

③ Position the bucket cylinder with the rod 20 to 30 ㎜ retracted from the fully extended position.

④ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin.

⑤ Keep the hydraulic oil temperature at 50±5˚C.



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(3) Measurement

① Stop the engine.

② Five minutes after the engine has been stopped, measure the changes in the positions of the boom, arm and bucket cylinders.

③ Repeat step ② three times and calculate the average values.

(4) The measured drift should be within the following specifications.

Unit : ㎜ / 5min

Model	Drift to be measured	Standard	Maximum allowable	Remarks
HX900 L	Boom cylinder	10 below	15	
	Arm cylinder	10 below	15	
	Bucket cylinder	40 below	50	

11) CONTROL LEVER OPERATING FORCE

(1) Use a spring scale to measure the maximum resistance of each control lever at the middle of the grip.

(2) Preparation

① Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Start the engine.
② Select the following switch positions.
· Power mode switch : P mode
③ Operate each boom, arm, bucket and swing lever at full stroke and measure the maximum operating force for each.
④ Lower the bucket to the ground to raise one track off the ground. Operate the travel lever at full stroke and measure the maximum operating force required. When finished, lower the track and then jack-up the other track.
⑤ Repeat steps ③ and ④ three times and calculate the average values.

(4) Evaluation

The measured operating force should be within the following specifications.

Unit : kgf

Model	Kind of lever	Standard	Maximum allowable	Remarks
HX900 L	Boom lever	1.3 or below	1.7	
	Arm lever	1.3 or below	1.7	
	Bucket lever	1.3 or below	1.7	
	Swing lever	1.3 or below	1.7	
	Travel lever	2.1 or below	3.15	

12) CONTROL LEVER STROKE

(1) Measure each lever stroke at the lever top using a ruler.

※ When the lever has play, take a half of this value and add it to the measured stroke.

(2) Preparation

Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Stop the engine.

② Measure each lever stroke at the lever top from neutral to the stroke end using a ruler.

③ Repeat step ② three times and calculate the average values.

(4) Evaluation

The measured drift should be within the following specifications.

Unit : mm

Model	Kind of lever	Standard	Maximum allowable	Remarks
HX900 L	Boom lever	90±10	115	
	Arm lever	90±10	115	
	Bucket lever	90±10	115	
	Swing lever	90±10	115	
	Travel lever	142±10	178	

13) PILOT PRIMARY PRESSURE

(1) Preparation

① Keep the hydraulic oil temperature at 50±5˚C.

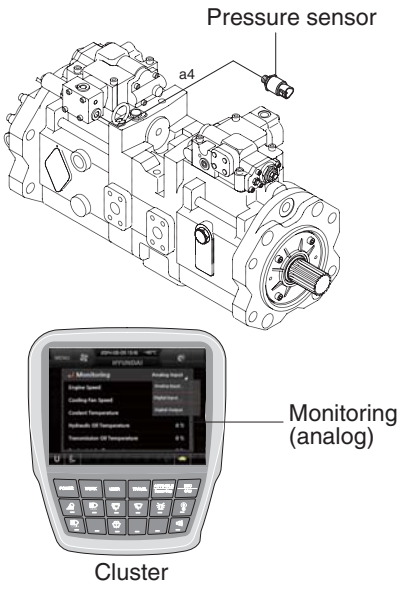
(2) Measurement

① Select the following switch positions.

· Power mode switch : P mode

· Auto decel switch : OFF

② Measure the primary pilot pressure by the monitoring menu of the cluster.



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(3) Evaluation

The average measured pressure should meet the following specifications:

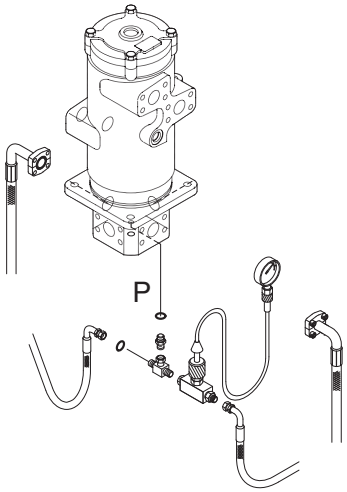
Unit : kgf / cm²

Model	Engine speed	Standard	Allowable limits	Remarks
HX900 L	P mode	40^{+2}_{0}	-	

14) FOR TRAVEL SPEED SELECTING PRESSURE:

(1) Preparation

① Stop the engine.
② Loosen the cap and relieve the pressure in the tank by pushing the top of the air breather.
③ To measure the speed selecting pressure: Install a connector and pressure gauge
④ assembly to turning joint P port as shown. Start the engine and check for on leakage from the adapter.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



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(2) Measurement

① Select the following switch positions.
· Power mode switch : P mode
· Travel mode switch : 1 speed
2 speed
② Measure the travel speed selecting pressure in the Hi or Lo mode.
③ Lower the bucket to the ground to raise the track off the ground. Operate the travel lever at full stroke and measure the fast speed pressure.
④ Repeat steps ② and ③ three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

Unit : kgf / cm^2

Model	Travel speed mode	Standard	Maximum allowable	Remarks
HX900 L	1 Speed	0	-	
	2 Speed	40±5	-	

15) SWING PARKING BRAKE RELEASING PRESSURE

(1) Preparation

① Stop the engine.

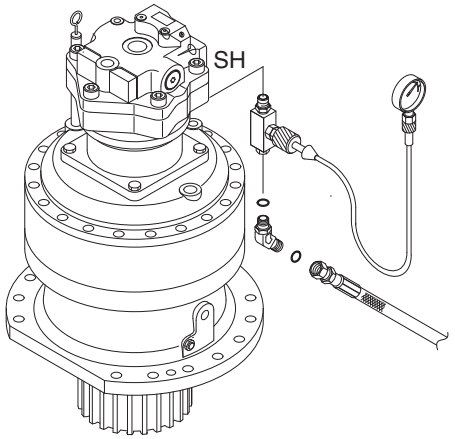
② Loosen the cap and relieve the pressure in the tank by pushing the top of the air breather.

③ The pressure release L wrench to bleed air.

④ Install a connector and pressure gauge assembly to swing motor SH port, as shown.

⑤ Start the engine and check for oil leakage from the adapter.

⑥ Keep the hydraulic oil temperature at 50±5˚C.



900L7MS10

(2) Measurement

① Select the following switch positions.

· Power mode switch : P mode

② Operate the swing function or arm roll in function and measure the swing brake control pressure with the brake disengaged. Release the control lever to return to neutral and measure the control pressure when the brake is applied.

Repeat step ② three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

Unit : kgf / cm^2

Model	Description	Standard	Allowable limits	Remarks
HX900 L	Brake disengaged	40	31~42	
	Brake applied	0	-	

16) MAIN PUMP DELIVERY PRESSURE

(1) Preparation

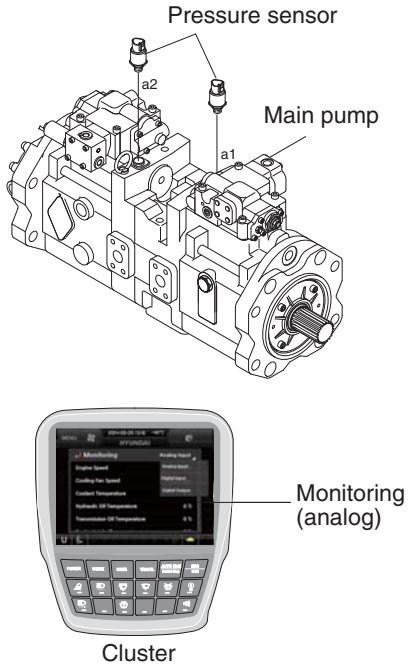
① Keep the hydraulic oil temperature at 50±5˚C.

(2) Measurement

① Select the following switch positions.

· Power mode switch : P mode

② Measure the main pump delivery pressure in the P mode (high idle).



900L7MS11

(3) Evaluation

The average measured pressure should meet the following specifications.

Unit : kgf / cm²

Model	Engine speed	Standard	Allowable limits	Remarks
HX900 L	High idle	40±5	-	

17) SYSTEM PRESSURE REGULATOR RELIEF SETTING

(1) Preparation

① Keep the hydraulic oil temperature at 50±5˚C.

(2) Measurement

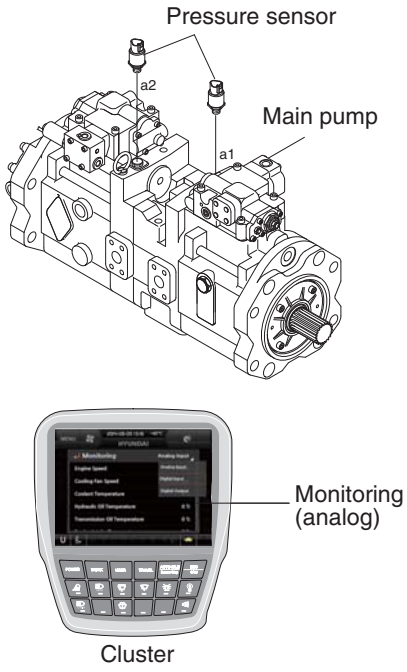
① Select the following switch positions.

· Power mode switch : P mode

② Slowly operate each control lever of boom, arm and bucket functions at full stroke over relief and measure the pressure.

③ In the swing function, place bucket against an immovable object and measure the relief pressure.

④ In the travel function, lock undercarriage with an immovable object and measure the relief pressure.



900L7MS11

(3) Evaluation

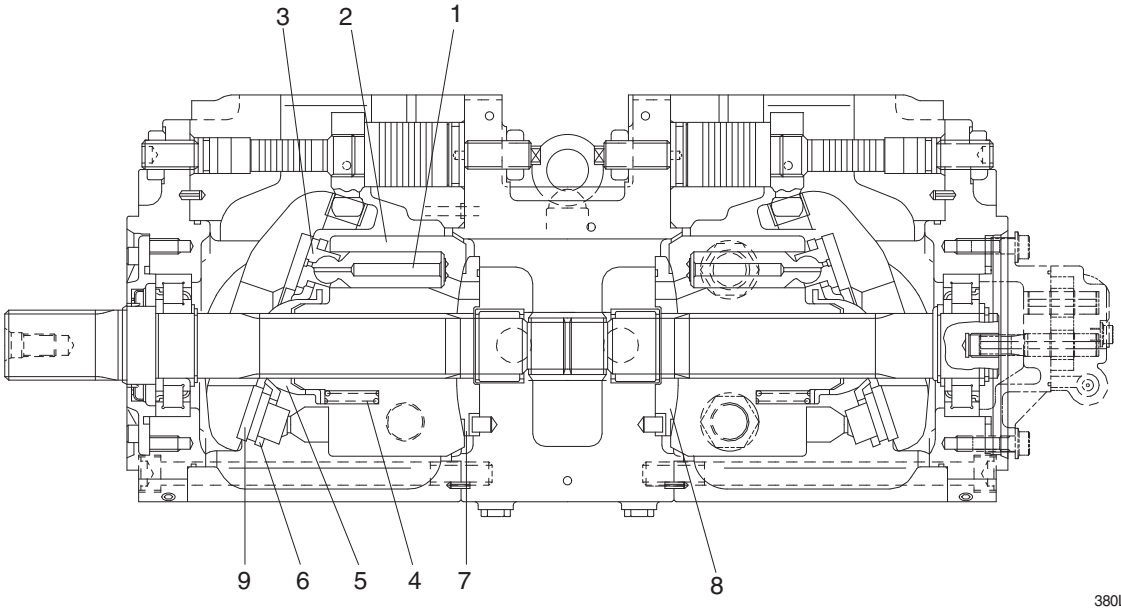
The average measured pressure should be within the following specifications.

Unit : kgf / cm²

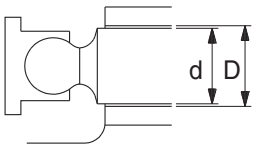
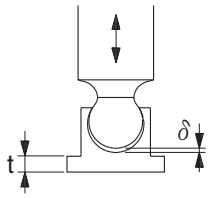
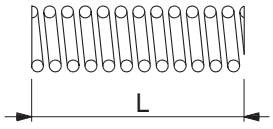
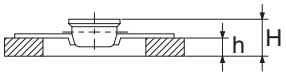
Model	Function to be tested	Standard	Port relief setting
HX900 L	Boom	330(360)±10	380
	Arm	330(360)±10	380
	Bucket	330(360)±10	380
	Travel	350±10	350
	Swing	300±10	300

( ) : Power boost

1. MAIN PUMP



380L7MS01

Part name & inspection item		Standard dimension	Recommended replacement value	Counter measures
Clearance between piston(1) & cylinder bore(2) (D-d)		0.043	0.070	Replace piston or cylinder.
Play between piston(1) & shoe caulking section(3) (δ)		0-0.1	0.3	Replace assembly of piston & shoe.
Thickness of shoe (t)		5.4	5.0	
Free height of cylinder spring(4) (L)		47.9	47.1	Replace cylinder spring.
Combined height of set plate(5) & spherical bushing(6) (H-h)		23.8	22.8	Replace retainer or set plate.
Surface roughness for valve plate (sliding face) (7,8), swash plate (shoe plate area) (9), & cylinder(2) (sliding face)	Surface roughness necessary to be corrected	3z		Lapping
	Standard surface roughness (corrected value)	0.4z or lower		

2. MAIN CONTROL VALVE

Part name	Inspection item	Criteria & measure
Casing	· Existence of scratches, rust or corrosion.	· In case of damage in following section, replace casing. - Sliding sections of casing hole and spool, especially land sections applied with held pressure. - Seal pocket section where spool is inserted. - Sealing section of port where O-ring contacts. - Sealing section of each relief valve for main and port. - Sealing section of plug. - Other damages that may damage normal function.
Spool	· Existence of scratch, gnawing, rusting or corrosion. · O-ring seal sections at both ends. · Insert spool into casing hole, rotate and reciprocate it.	· Replacement when its outside sliding section has scratch (especially on seals-contacting section). · Replacement when its sliding section has scratch. · Correction or replacement when O-ring is damaged or when spool does not move smoothly.
Poppet	· Damage of spring · Damage of poppet · Insert poppet into casing and function it.	· Replacement. · Correction or replacement when sealing is incomplete. · Normal when it can function lightly and smoothly without sticking.
Spring and related parts	· Rusting, corrosion, deformation or breakage of spring, spring seat, plug or cover.	· Replacement for significant damage.
Around seal for spool	· External oil leakage. · Rusting, corrosion or deformation of seal plate.	· Correction or replacement. · Correction or replacement.
Main relief valve, port relief valve & negative control valve	· External rusting or damage. · Contacting face of valve seat. · Contacting face of poppet. · O-rings and back up rings.	· Replacement. · Replacement when damaged. · Replacement when damaged. · Replacement in principle.

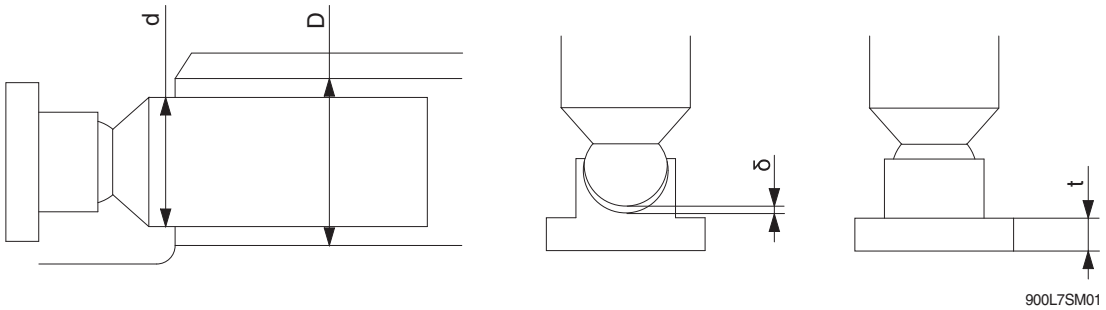
3. SWING DEVICE

1) HYDRAULIC MOTOR

(1) Service limit

Replace parts in accordance with the standards. However, if a part is damaged significantly in terms of its appearance, replace it irrespective of the standards.

Part name and inspection item	Standard dimension	Recommended value for replacement	Remedy
Clearance between piston & cylinder bore	D - d = 0.033 mm	D - d = 0.045 mm	Replace piston or cylinder block
Clearance caulked part between piston & shoe	δ = 0.0 mm	δ = 0.3 mm	Replace assembly of piston & shoe
Thickness of shoe	t = 7.0 mm	t = 6.8 mm	Replace assembly of piston & shoe
Thickness of friction plate	2.2 mm	2.1 mm	Replace friction plate



(2) Renovation limit

If the face roughness is found exceed the renovation limit, renovate or replace the parts.

Part name	Normal face roughness	Renovation limit
Shoe	1.6-Z (Ra=0.4) (lapping)	3-Z (Ra=0.8)
Shoe plate	0.4-Z (Ra=0.1) (lapping)	3-Z (Ra=0.8)
Cylinder	1.6-Z (Ra=0.4) (lapping)	12.5-Z (Ra=3.2)
Valve plate	0.8-Z (Ra=0.2) (lapping)	6.3-Z (Ra=1.6)

※ 1. Renovate face of parts by lapping below normal face roughness.
2. If set plate and retainer's face is no good, replace those parts as an assembly.

(3) Causes of troubles and remedies

① The hydraulic motor not rotate

Phenomenon	Possible cause	Remedy
Pressure does not increase	· Safety valve in circuit is not correctly. · Relief valve does not function well. a) Sticking of plunger b) Clogging of plunger throttle. · Seat of plunger does not funtion well.	· Set valve at correct valvue. · a) Repair or replace stuck section. b) Disassemble and repair plunger. · Check seat section. Replace it, if damaged.
Pressure rises	· Overload. · Seizure of moving parts. · Brake is not applied with release perssure. · Brake piston sticks. · Spool sticks. · Fricrtion plate is seized.	· Remove load. · Check and repair. piston/shoes, cylinder, valve plate, etc. · a) Check and repair circuit. b) Check time delay valve for brake. · Disassemble and check it. · Disassemble and check it. · Disassemble and check it. Replace seized one.

② The motor rotates reversely

Phenomenon	Possible cause	Remedy
Motor rotates reversely.	· Motor is assembled to rotate reversely. · Piping is connected to inlet and outlet reversely	· Confirm this, and reassemble it · Correct piping.

③ The speed does not reach set value

Phenomenon	Possible cause	Remedy
Speed does not reach set value	· Oil flow rate is insufficient. · Oil temp is high and oil leaks abnormally. · Sliding parts are worn or damaged.	· Check pump's delivery flow and circuit to motor. · Reduce oil temp. · Replace damaged parts.

④ The braking torque is insufficient

Phenomenon	Possible cause	Remedy
Brake torque is insuffcient.	· Friction plate is worn.	· Disassemble and check it. Replace it, if worn more than criterion.
	· Breke piston sticks.	· Disassemble and check it.
	· Brake release pressure cannot be removed.	· a) Check and repair circuit. b) Check time delay valve for brake.
	· Spline for frition plate is damaged.	· Disassemble and check it. Replace it, if damaged.

⑤ The hydraulic motor slips too much

Investigate the drain flow rate of the motor. If it is about 500 cm^3/min or lower, the motor is considered to be normal.

Phenomenon	Possible cause	Remedy
When external driving torque is applied to motor, it slips too much	· Relief valve does not function well. Same as item ①	· Replace it. Same as item ①
	· Seat of plunger does not function well.	· Replace it.
	· Anti-reaction valve don't function well.	· Replace it.

⑥ Oil leakage

a. Oil leaks from oil seal

Phenomenon	Possible cause	Remedy
Oil leaks from oil seal	· Lip catches particles of dirt and is damaged.	· Replace oil seal.
	· Shaft is scratched or worn.	· Shift lip/shaft contact position or replace them.
	· Because of excessively-high casing internal pressure, lip of oil seal is turned up.	· If drain piping is clogged, clean it out.
	· Shaft is rusted.	· Disassemble and repair it.

b. Oil leaks through mating faces

Phenomenon	Possible cause	Remedy
Oil leaks through mating face.	· O-ring forgotten to be fitted.	· Fit it correctly and carry out reassembling.
	· O-ring is scratched.	· Replace it.
	· Seal surface is scratched.	· Disassemble and repair it.
	· Bolts are loose or damaged.	· Tighten then with specified torque or replace them.

2) REDUCTION GEAR

(1) Causes of troubles and remedies

The troubles and remedies of the reduction gear are shown here mainly.
Therefore, in case of trouble, refer also to the hydraulic motor part.

① Reduction gear will not rotate

Phenomenon	Possible cause	Remedy
Hyd motor inlet pressure is sufficiently high	· Overload · Damage of reduction gear · Negative brake is ON	· Reduce load · Replace reduction gear · Inspect brake release pressure · Inspect brake pilot pressure · Inspect brake parts
Hyd motor inlet pressure is not sufficiently high Rotation noise is heard in hydraulic motor	· Motor shaft breakage · Damage of reduction gear	· Replace hydraulic motor · Replace reduction gear
No rotation noise is heard in hydraulic motor	· Abnormality in pump, valve or so on	· Check for abnormality and remedy

② Reduction gear will not rotate

Phenomenon	Possible cause	Remedy
Oil leakage through mating faces	· Careless omission to apply liquid packing · Mating faces has slipped due to insufficient tightening or loosening of bolts · Scratch on mating face	· Disassemble gear and re-apply it. · Disassemble them, re-apply liquid packing and reassemble them as specified · Replace parte
Leakage around shaft	· Oil seal is damaged	· Disassemble reduction gear and replace oil seal

③ Temperature is too high

Phenomenon	Possible cause	Remedy
Reduction gear casing temperature is too high	· Gear oil is insufficient · Grease is insufficient · Gear, bearing or so on is damaged	· Check level and supply oil to specified level · Supply grease · Replace reduction gear

(2) Simultaneously replaced parts

This reduction gear is so designed that the parts are few in quantity and the life-spans of section are balanced with each other. Therefore, many parts should be replaced simultaneously as combinations due to constructional or functional reason, though any parts can be supplied independently. These are shown in table below.

			Part to be replaced simultaneously														
			201	401	402	203	230	282	286	910	210	231	283	285	287	403	909
			Drive shaft	Spherical roller bearing	Spherical roller bearing	Planetary gear No.2	Carrier No.2	Pin No.2	Thrust washer	Spring pin	Planetary gear No.1	Carrier No.1	Pin No.1	Side plate	Thrust plate	Needle cage	Spring pin
Part to be replaced	201	Drive shaft	-	o	o												
	401	Spherical roller bearing	x	-	x												
	402	Spherical roller bearing	x	x	-												
	203	Planetary gear No.2				-	x	o	x	o							
	230	Carrier No.2				x	-	o	x	o							
	282	Pin No.2				x	x	-	x	o							
	286	Thrust washer				x	x	o	-	o							
	910	Spring pin				x	x	o	x	-							
	210	Planetary gear No.1									-	x	o	x	x	x	o
	231	Carrier No.1									x	-	o	x	x	x	o
	283	Pin No.1									x	x	-	x	x	x	o
	285	Side plate									x	x	o	-	x	x	o
	287	Thrust washer									x	x	o	x	-	x	o
	403	Needle cage									x	x	o	x	x	-	o
	909	Spring pin									x	x	o	x	x	x	-

※ 1. Mark "O" show the part that must be replaced simultaneously.

2. Mark "X" show the part that is desirable to be replaced simultaneously.

(3) Part inspection and replacement criteria

① Tooth faces of sun, planetary and ring gears:

When pitting is found, replace the gear.
(If the pit size is 1mm or larger in diameter, and the area ratio 5% or more))

② Oil Seal

When the lip face is damaged or worn away, replace the oil seal.
When the reduction gear is disassembled for inspection, it is recommended to replace oil seals without fail.

※ The following parts art those of the drive shaft assembly. Except case of any abnormality found, do not disassemble it and inspect it as assembly.

③ Bearing (the front side of the reduction gear)

Check the bearings without removing from the drive shaft, following the procedures mentioned below.

a. Check the outer race and rollers and confirm that they are free of pitting and flaking.
b. Since the inner race is behind the retainer and connot be seen, check it as follows:
   - Aren't there large wear particles in gear oil?
   - Don't large wear particles stick between the rollers and retainer?
   - Can the inner race be rotated smoothly by hand?

   If any abnormality is found during the above check, replace it. Any bearing removed from the shaft should not be reused.

④ Bearing (the rear side of the reduction gear)

When they are pitting or flaking on the outer race and rollers, replace the bearing.

⑤ Planetary gear No.2

Check the radial play of the planetary gear No.2
If this play is 0.5 mm or more, replace the pin.

⑥ Thrust washer, thrust plate

When sliding face of thrust washer and thrust plate is scratched considerably, replace them.

⑦ Needle cage and pin No.1

When they art pitting or flaking, replace the needle cage and pin No.1.

4. TRAVEL MOTOR

Wash all parts disassembly in treated oil and dry in the compressed air.

Perform maintenance including replacement or corrections in accordance with the following criterion.

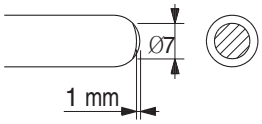
No.	Parts Name	Appearance	Allowance	Replacement parts
6	Piston sub assembly	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness : 0.8a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Cylinder block kit / Perform lapping (#1000). Replace if flaws cannot be completely removed.
		When remarkable flaws or high surface roughness are found on surface of piston.	Roughness : 1.2a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	
		When clearance between piston sub assembly and cylinder block bore is great.	Clearance : 0.060 mm	Cylinder block kit
		When looseness in shoe ball parts is great.	Looseness : 0.4 mm	
4	Cylinder Block	When remarkable flaws or high surface roughness are found on the surface with the valve plate.	Roughness : 0.8a	Cylinder block kit / Perform lapping(#1000). Replace if flaws cannot be completely removed.
		When wear inside bore is great.	Roughly : 1.6a	Cylinder block kit
		When clearance between piston sub assembly and cylinder block bore is great.	Looseness : 0.4 mm	
		When abnormal wear and breakage develop on mating teeth.		
5	Valve plate	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness : 0.8 a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	Cylinder block kit
7 8	Retainer plate Retainer holder	When remarkable flaws or high surface roughness are found on each sliding surface.	Roughness : 0.8 a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	7 Retainer plate 8 Retainer holder

No.	Parts Name	Appearance	Allowance	Replacement parts
9	Swash plate	When remarkable flaws or high surface roughness are found on sliding surface with shoe.	Roughness : 0.8 a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	Swash plate / Perform lapping (#1000). Replace if flaws cannot be completely removed.
		When remarkable flaws or high surface roughness are found on sliding surface with steel ball.	Roughness : 1.6 a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	Swash plate
		When remarkable flaws or seizure are found on contact surface with steel balls.	Sphere depth : 19.06 mm	
3	Shaft	When remarkable flaws or high surface roughness are found on sliding surface of oil seal.	Roughness : 1.6 a There should be no seizure andremarkable flaws (over 0.02 mm in thickness).	Shaft
		When abnormal wear and breakage develop on mating teeth.		
21	Brake piston	When remarkable flaws or high surface roughness are found in each sliding surface	Height : 50.5 mm Roughness : 3.2 a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	Brake piston Friction plate
19	Disk plate	When remarkable flaws or abrasion are found on disks(friction material)	Thickness : 3.2 mm	Disk plate
13 14	Roller Bearing Roller Bearing	When flaking and abrasion develop on rolling surface.	-	Roller Bearing
		When indentation is found on rolling surface	-	
		When abnormality is found in rotation (abnormal noise, irregular rotation)	-	

No.	Parts Name	Appearance	Allowance	Replacement parts
11	Piston sub assembly	When remarkable flaws or high surface roughness are found on sliding surface with swash plate.	Roughness : 1.6 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Case kit / Perform lapping (#1000). Replace if flaws cannot be completely removed.
		When remarkable flaws or high surface roughness are found on surface with case.	Roughness : 1.2a There should be no seizure and remarkable flaws(over 0.02 mm in thickness).	Case kit
		When clearance between piston sub assembly and case bore is great.	Clearance : 0.030 mm	
		When looseness in shoe ball parts is great.	Looseness : 0.7 mm	
2-2	Spool Assy	When remarkable flaws or high surface roughness are found on each sliding surface	Roughness : 0.8 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Base plate sub assembly
		When clearance between piston sub assembly and case bore is great.	Clearance : 0.050 mm	
2-1	Base plate	When remarkable flaws or high surface roughness are found on each sliding surface with spool assy.	Roughness : 0.8 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Base plate sub assembly
		When clearance between spool assy and base plate bore is great.	Clearance : 0.050 mm	
		When remarkable flaws or high surface roughness are found on each sliding surface with valve assy.	Roughness : 0.8 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	
		When clearance between valve assy and base plate bore is great.	Clearance : 0.040 mm	
		When remarkable flaws or high surface roughness are found on each sliding surface with spool assy.	There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	

No.	Parts Name	Appearance	Allowance	Replacement parts
9	Valve assy	When remarkable flaws or high surface roughness are found on each sliding surface with spool assy.	Roughness : 0.8 a There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Base plate sub assembly
		When clearance between valve assy and base plate bore is great.	Clearance : 0.040 mm	
2-7-10	Free piston	When remarkable flaws or high surface roughness are found on each sliding surface with base plate.	There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	Relief valve assy
2-7-2	Housing	When remarkable flaws or high surface roughness are found on each sliding surface with free piston.	There should be no seizure and remarkable flaws (over 0.02 mm in thickness).	

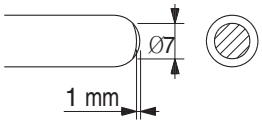
5. RCV LEVER

Maintenance check item	Criteria	Remark
Leakage	The valve is to be replaced when the leakage becomes more than 1000 cc/m at neutral handle position, or more than 2000 cc/m during operation.	Conditions : Primary pressure : 30 kgf/cm^2 Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than 10 μm, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	 This is to be replaced when the top end has worn more than 1 mm.	
Play at operating section	The pin, shaft, and joint of the operating section are to be replaced when their plays become more than 2 mm due to wears or so on.	When a play is due to looseness of a tightened section, adjust it.
Operation stability	When abnormal noises, hunting, primary pressure drop, etc. are generated during operation, and these cannot be remedied, referring to section 6. Troubleshooting, replace the related parts.	

Notes 1. It is desirable to replace seal materials, such as O-rings, every disassembling. However, they may be reused, after being confirmed to be free of damage.

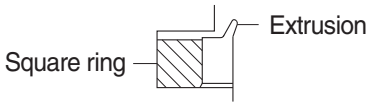
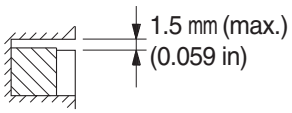
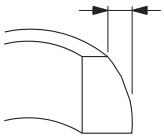
2. When loosening the hexagon socket head cap screw (125), replace the seal washers (121) without fail.

6. RCV PEDAL

Maintenance check item	Criteria	Remark
Leakage	The valve is to be replaced when the leakage effect to the system. For example, the primary pressure drop.	Conditions : Primary pressure : 30 kgf/cm^2 Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than 10 μm, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	 This is to be replaced when the top end has worn more than 1 mm.	
Play at operating section	The pin, shaft, and joint of the operating section are to be replaced when their plays become more than 2 mm due to wears or so on.	When a play is due to looseness of a tightened section, adjust it.
Operation stability	When abnormal noises, hunting, primary pressure drop, etc. are generated during operation, and these cannot be remedied, referring to section 6. Troubleshooting, replace the related parts.	

Notes 1. It is desirable to replace seal materials, such as O-rings, every disassembling. However, they may be reused, after being confirmed to be free of damage.

7. TURNING JOINT

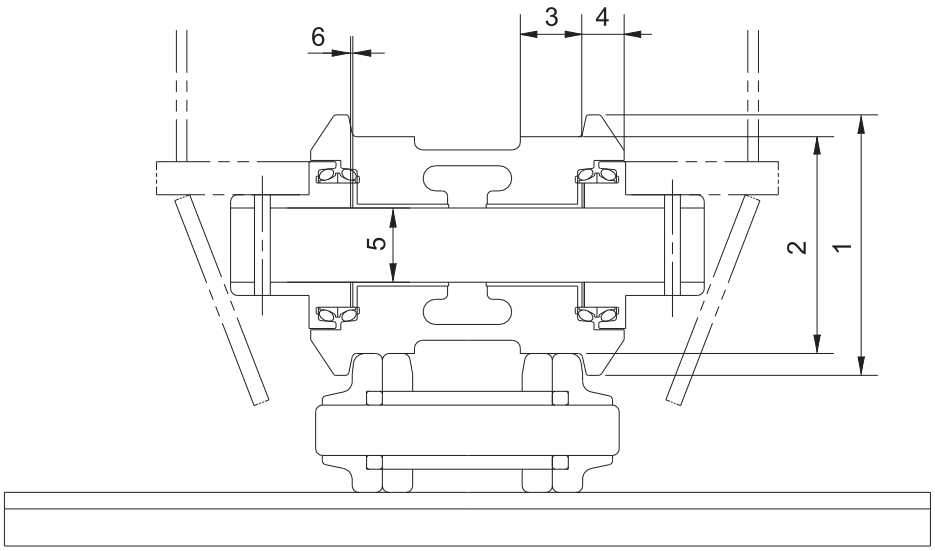
Part name		Maintenance standards	Remedy
Body, Stem	Sliding surface with sealing sections.	Plating worn or peeled due to seizure or contamination.	Replace
	Sliding surface between body and stem other than sealing section.	· Worn abnormality or damaged more than 0.1 mm (0.0039 in) in depth due to seizure contamination.	Replace
		· Damaged more than 0.1 mm (0.0039 in) in depth.	Smooth with oilstone.
	Sliding surface with thrust plate.	· Worn more than 0.5 mm (0.02 in) or abnormality.	Replace
		· Worn less than 0.5 mm (0.02 in).	Smooth
		· Damage due to seizure or contamination remediable within wear limit (0.5 mm) (0.02 in).	Smooth
Cover	Sliding surface with thrust plate.	· Worn more than 0.5 mm (0.02 in) or abnormality.	Replace
		· Worn less than 0.5 mm (0.02 in).	Smooth
		· Damage due to seizure or contamination remediable within wear limit (0.5 mm) (0.02 in).	Replace
Seal set	-	· Extruded excessively from seal groove square ring. 	Replace
	-	· Slipper ring 1.5 mm (0.059 in) narrower than seal groove, or narrower than back ring. 	Replace
	-	· Worn more than 0.5 mm (0.02 in) ~ 1.5 mm (MAX.) (0.059 in) 	Replace

8. CYLINDER

Part name	Inspecting section	Inspection item	Remedy
Piston rod	· Neck of rod pin	· Presence of crack	· Replace
	· Weld on rod hub	· Presence of crack	· Replace
	· Stepped part to which piston is attached.	· Presence of crack	· Replace
	· Threads	· Presence of crack	· Recondition or replace
	· Plated surface	· Plating is not worn off to base metal.	· Replace or replate
		· Rust is not present on plating.	· Replace or replate
		· Scratches are not present.	· Recondition, replate or replace
	· Rod	· Wear of O.D.	· Recondition, replate or replace
	· Bushing at mounting part	· Wear of I.D.	· Replace
Cylinder tube	· Weld on bottom	· Presence of crack	· Replace
	· Weld on head	· Presence of crack	· Replace
	· Weld on hub	· Presence of crack	· Replace
	· Tube interior	· Presence of faults	· Replace if oil leak is seen
	· Bushing at mounting part	· Wear on inner surface	· Replace
Gland	· Bushing	· Flaw on inner surface	· Replace if flaw is deeper than coating

1. TRACK

1) TRACK ROLLER

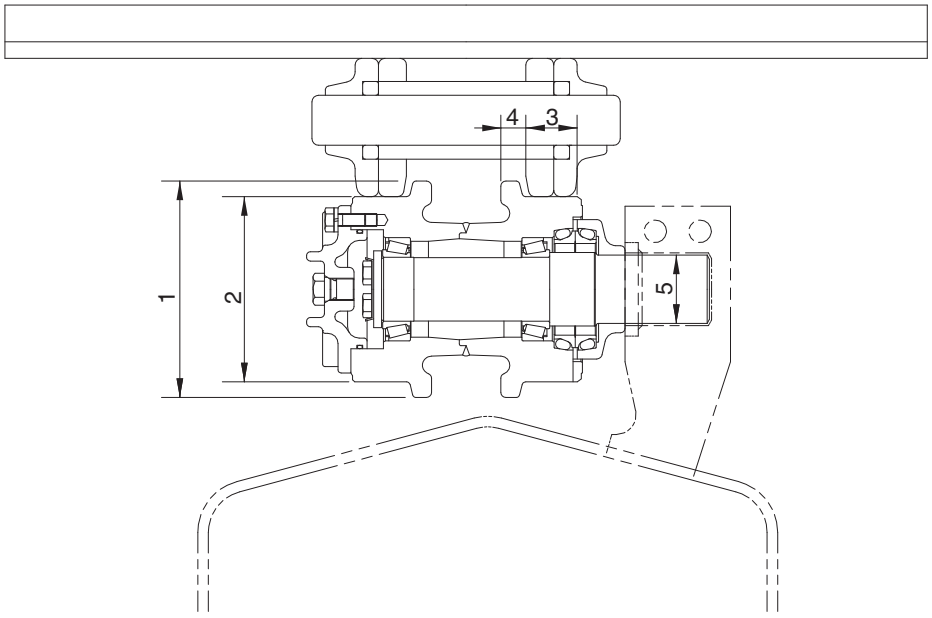


32077MS01

Unit : mm

No.	Check item	Criteria				Remedy
1	Outside diameter of flange	Standard size		Repair limit		Rebuild or replace
		Ø320		–		
2	Outside diameter of tread	Ø270		Ø258		
3	Width of tread	73.5		79.5		
4	Width of flange	49		-		
5	Clearance between shaft and bushing	Standard size & tolerance		Standard clearance	Clearance limit	Replace bushing
		Shaft	Hole			
		Ø115 -0.25 -0.35	Ø115 +0.15 +0.03	0.28 to 0.5	2.0	
6	Side clearance of roller (Both side)	Standard clearance		Clearance limit		Replace
		0.34~1.678		2.5		

2) CARRIER ROLLER

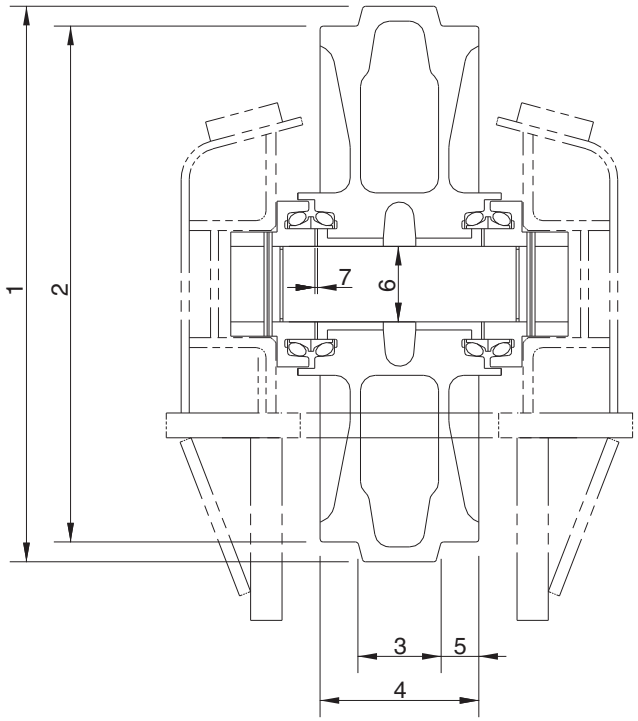


4507AMS04

Unit : mm

No.	Check item	Criteria				Remedy
1	Outside diameter of flange	Standard size		Repair limit		Rebuild or replace
		Ø250		–		
2	Outside diameter of tread	Ø218		Ø208		
3	Width of tread	71		76		
4	Width of flange	23		–		
5	Clearance between shaft and bushing	Ø96 $^{0.036}_{-0.09}$	Ø96 $^{+0.3}_{+0.1}$	0.136~0.39	1.2	Replace

3) IDLER

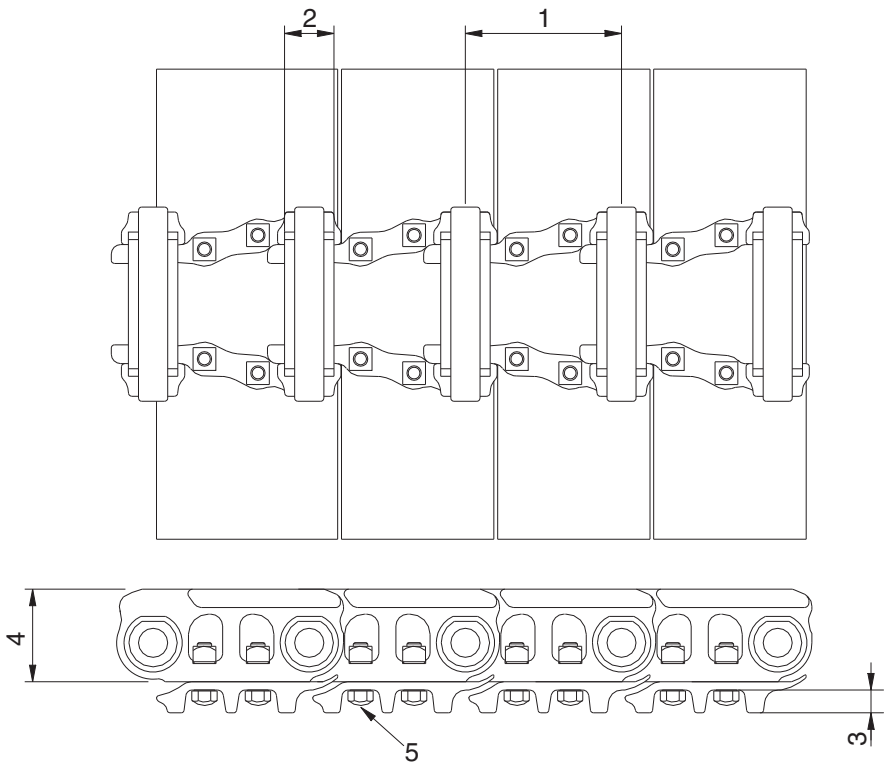


8007A7MS05

Unit : mm

No.	Check item	Criteria				Remedy
1	Outside diameter of protrusion	Standard size		Repair limit		Rebuild or replace
		Ø875		–		
2	Outside diameter of tread	Ø830		Ø816		
3	Width of protrusion	127		–		
4	Total width	266		–		
5	Width of tread	69.5		76.5		
6	Clearance between shaft and bushing	Standard size & tolerance		Standard clearance	Clearance limit	Replace bushing
		Shaft	bushing			
		Ø120 $^{0}_{-0.03}$	Ø120 $^{+0.4}_{+0.35}$	0.35 to 0.43	2.0	
7	Side clearance of idler (Both side)	Standard clearance		Clearance limit		Replace
		0.4 to 1.4		2.0		

4) TRACK

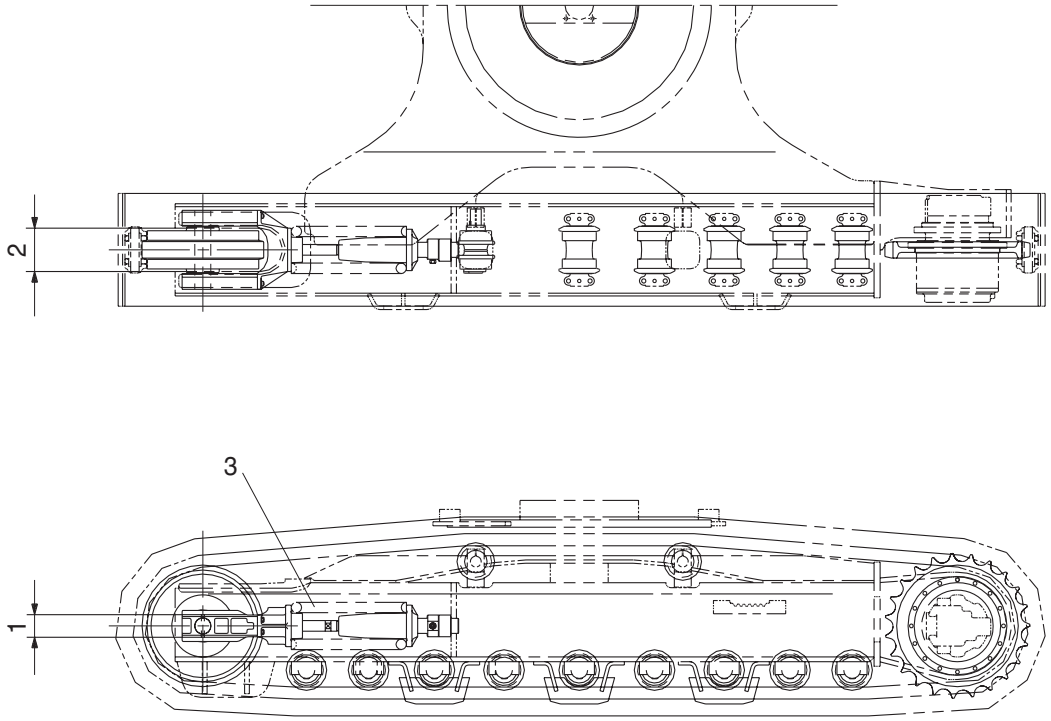


32077MS04

Unit : mm

No.	Check item	Criteria		Remedy
1	Link pitch	Standard size	Repair limit	Turn or replace
		260.35	265.75	
2	Outside diameter of bushing	Ø85.725	Ø73.725	Rebuild or replace
3	Height of grouser	52	28	
4	Height of link	155.5	141.5	
5	Tightening torque	Initial tightening torque : 180.3~212.2 kgf · m		Retighten

5) TRACK FRAME AND RECOIL SPRING

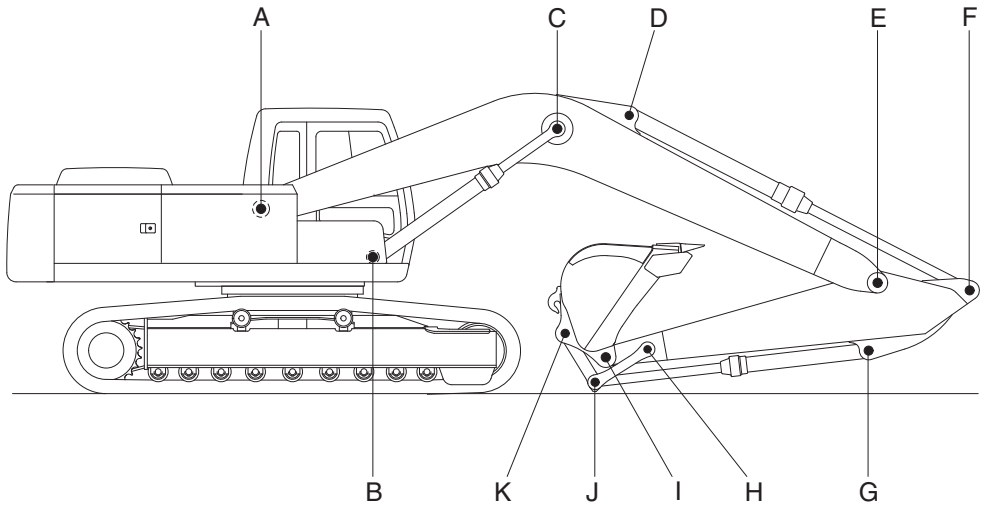


21073MS05

Unit : mm

No.	Check item	Criteria					Remedy
1	Vertical width of idler guide		Standard size	Tolerance	Repair limit		Rebuild or replace
		Track frame	193	+2 0	197		
		Idler support	190	0 -1.5	186		
2	Horizontal width of idler guide	Track frame	342	+2 0	346		
		Idler support	340	-	337		
3	Recoil spring	Standard size			Repair limit		Replace
		Free length	Installation length	Installation load	Free length	Installation load	
		310×1553	1290	49.986 kg	-	39.990kg	

2. WORK EQUIPMENT



21077MS20

Unit : mm

Mark	Measuring point (Pin and Bushing)	Normal value	Pin		Bushing		Remedy & Remark
			Recomm. service limit	Limit of use	Recomm. service limit	Limit of use	
A	Boom Rear	155	154	153.5	155.5	156	Replace
B	Boom Cylinder Head	130	129	128.5	130.5	131	
C	Boom Cylinder Rod	130	129	128.5	130.5	131	
D	Arm Cylinder Head	140	139	138.5	140.5	141	
E	Boom Front	150	149	148.5	150.5	151	
F	Arm Cylinder Rod	140	139	138.5	140.5	141	
G	Bucket Cylinder Head	130	129	128.5	130.5	131	
H	Arm Link	120	119	118.5	120.5	121	
I	Bucket and Arm Link	140	139	138.5	140.5	141	
J	Bucket Cylinder Rod	150	149	148.5	150.5	151	
K	Bucket Link	140	139	138.5	140.5	141	