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# **1. HYDRAULIC CIRCUIT**

1) MANUAL TYPE



# **SECTION 6 HYDRAULIC SYSTEM**

2) FINGERTIP TYPE (OPT)



3ZBD-02000-00

### 3) LIFT ASCENDING, TILTING REAR



25BX6HS02

When pulling lift and tilt operation lever, spools of first and second blocks move to position of lift ascending tilting backward. Hydraulic oil of hydraulic pump (1) flows into main control valve (4) to push rod check valve of spool to large chamber of lift cylinder and small chamber of tilt cylinder. At the same time, hydraulic oil from small chamber of lift cylinder and large chamber of tilt cylinder returns to hydraulic oil tank (5). This hydraulic oil flow forms lift ascending and tile backward.

\* The circuit diagram may differ from the equipment, so please check before a repair.

# 4) LIFT DESCENDING, TILTING FORWARD



25BX6HS03

When pushing lift and tilt operation lever, spools of first and second blocks move to position of lift descending tilting forward. Hydraulic oil of hydraulic pump (1) flows into main control valve (4) to push rod check valve of spool to move to large chamber of tilt cylinder.

Large and small chambers of lift cylinder are connected to return path to let return of hydraulic oil, and mast descends with weight of forks.

Hydraulic oil from small chamber of tilt cylinder is returned to hydraulic oil tank (5). This hydraulic oil flow forms tilting forward.

<sup>\*</sup> The circuit diagram may differ from the equipment, so please check before a repair.

# 2. HYDRAULIC GEAR PUMP

# 1) STRUCTURE



25BX6HS06

1 Piston shaft

Housing

Cover

Pin

Internal gear

Cover plate

Pinion segment

Internal gear segment

2

3

4

6

7

8

9

### 10 Seal

- 11 Segment spring
- 12 Segment spring
- 14 Bearing bushing
- 15 Plate
- 16 Plate
- 17 Seal
- 18 Backup ring

- 20 Shaft seal
- 21 Retainer ring
- 23 Pin
- 24 O-ring
- 27 Screw
- 29 Washer

6-5

# 3. MAIN CONTROL VALVE

# 1) STRUCTURE

# (1) 3 Spool (manual type)



25BX6HS07

Port	Port name	ne Dimensions	Fastening torque
FOIL	Full flame		kgf · m
A	Lift	7/8-14 UNF	7
A1, B1	Tilting	3/4-16 UNF	5
A-, B-	Aux.	3/4-16 UNF	5
Р	Inlet	7/8-14 UNF	7
Т	Outlet	1 1/16-12 UN	9.5
G	Gauge, pilot	9/16-18UNF	3
	Cutoff solenoid	-	4
	Coil	-	0.7



Port	Port Port name Po	Port name	Tightening torque
FOIL		Fort dimensions	kgf · m
А	Lift	7/8-14 UNF	7
A1, B1	Tilting	3/4-16 UNF	5
A-, B-	Aux.	3/4-16 UNF	5
Р	Inlet	7/8-14 UNF	7
Т	Outlet	1 1/16-12 UN	9.5
G	Gauge	9/16-18UNF	3

### 2) FUNCTIONS

### (1) Emergency mast lowering

In case that the mast can't be lowered due to a problem in the controller, activate the emergency lowering valve on the MCV assy by rotating the valve (a).

- ▲ Manual override features are intended for emergency use, not for continuous-duty operation.
- 1) Loosen and remove the MCV cover connecting bolts.
  - $\cdot$  Tightening torque : 0.8 1.2 kgf  $\cdot$  m
- 2) Use the L-wrench (3 mm) to loosen the bolts counterclockwise until lowering of the mast begins.
- \* Do not undo the bolts more than 1.5 turns.
- If lowering still does not begin, there is a mechanical block . Do not under any circumstances continue to unscrew the emergency lowering feature.
- 3) After lowering is complete, the valve must be screwed back in again.
- ※ Do not exceed a tightening torque of maximum 0.25 kgf · m.
- ▲ When operating the emergency lowering valve in order to lower the mast inevitably, always make certain that any person should not stand or pass under the mast, the fork and platform so as to avoid from unexpected accident such severe personal injury or death.







### (2) Cutoff solenoid for blocking hydraulic pressure

This equipment is a mast interlock that preventing activation of hydraulic functions of main control valve until operator sits on the seat. The system is also a key-lowering interlock system that prevents fork descending while start key is kept on OFF position. This safety function is defined in ISO 3691-1, and should not discretionally be deactivated on main control valve.

### (3) Relief valve

### ① Primary relief valve (DV1)

Primary relief valve limits max. pressure of lifting and tilting function. When lifting or tilting function operates simultaneously with aux. function, max. pressure of lifting or tilting function is limited by pressure setup of secondary relief valve. Primary relief valve does, typically, not require field adjustment. Refer to testing and adjustment of relief valve for further information of adjustment.

### ② Secondary relief valve (DV2)

Secondary relief valve limits max. pressure of aux. (attachment) function, and pressure setting of the valve is lower than primary relief valve. Secondary relief valve may require pressure adjustment dependent upon types of attachments. If it is required to adjust pressure, adjustment within 90% of primary relief valve pressure is recommended (e.g.,  $210 \times 0.9=190$  bar). If pressure of secondary relief valve is to close to pressure of primary relief valve, interference between circuits may take place. Refer to testing and adjustment of relief valve for further information of adjustment. Up to 2 optional functions are provided.

### 3) RELIEF VALVE PRESSURE TESTING AND ADJUSTMENT

### (1) Test specifications

- · Hydraulic motor speed : High rpm
- · Oil temperature :  $50\pm5^{\circ}$ C (122 $\pm9^{\circ}$ F)
- · Relief valve pressure setting
  - Primary : 210±3 bar (3045±43 psi)
  - Secondary :165 $\pm$ 3 bar (2393 $\pm$ 43 psi)
- · Tools : 10-mm spanner, 3-mm hexagonal wrench
- A Primary relief valve (DV1) should not be used for pressure boosting at field. When boosting pressure of primary relief valve higher than specified setting, system may be damaged.
- A Check relief valves in safe and clean environment.
- A Make sure there is no bystanders or other workers in the vicinity of system during operation and testing.
- ▲ Pressurized hydraulic oil may remain in hydraulic system after turning off. Fully lower folks onto the ground to prevent personal safety accident. Loosened mast chain indicates fully lowering of forks.
- ▲ Turn engine off before disassembling, fastening, removing or adjusting piping parts (e.g., fitting, plug and hose), and fully move main control valve lever forward and backward two or three times to fully discharge hydraulic oil from circuits. Open tank oiling cap to relieve pressure. When air breather filter inside hydraulic oil tank is clogged, pressure may reside inside tank.
- ▲ Hot hydraulic oil may cause severe burn. Never touch components or hydraulic oil during testing. Make sure that hydraulic oil is cooled down to safe temperature before installing or removing testing systems.
- ▲ Your skin may make contact with pressurized hydraulic oil. Fully lower forks onto the ground before removing test plug from valve, and then relieve pressure from all of circuits.

- ① Operate hydraulic system until oil temperature reaches specified value in test specifications.
- ② Lower forks onto the ground, stop engine, and then apply parking brake.
- ③ Open cover of main control valve.
- ④ Connect pressure gauge to pressure check port(G) of main control valve.
- (5) Operate pump motor in accordance with test specifications.
- <sup>(6)</sup> Pull lift lever to raise forks to the top, and keep the conditions as they are.
- ⑦ Read pressure gauge. Compare value on the gauge with specifications.
- ⑧ Loosen lock nuts of main control valve and relief valve, and turn adjustment screw to adjust pressure.
  - · Fastening torque : 0.25 kgf · m
  - If pressure is lower than specification, turn relief valve adjustment screw clockwise.
  - · If pressure is higher than specifications, turn relief valve counterclockwise.
- ▲ Adjustment screw of MCV relief valve is very sensitive. Rotate the screw by a quarter turn to prevent overpressure.
- (9) Repeat Steps (7) and (8). When pressure is compliant with the specifications, remove testing equipment.





# 4. LIFT CYLINDER

1) V MAST



D255HS18

22B9FHS20

- 1 Tube assembly
- 2 Rod
- 3 Piston
- 4 Piston seal
- 5 Backup ring

# 2) VF MAST

- 6 Abrasion ring
- 7 Retainer ring8 Gland
- 9 Dust wiper
- 10 Dust wiper

- 11 Gland
- 12 Guide
- 13 DU bushing
- 14 Spacer
- 15 O-ring



- 1 Tube assembly
- 2 Rod assembly
- 3 Rod cover
- 4 Rod bushing
- 5 U packing

- 6 Backup ring
- 7 Dust wiper
- 8 O-ring
- 9 Backup ring
- 10 Backup ring

- 11 Cushion seal
- 12 Retainer ring
- 13 Spacer
- 14 Steel ball
- 15 Set screw

# 3) TF AND TS MASTS



- Tube assembly 1
- 2 Rod
- 3 Piston
- 4 U packing
- Backup ring 5
- Abrasion ring 6
- 7 Check valve

# 4) QF MAST (LEFT)

- Spacer 8
- 9 Retainer ring
- 10 Stop ring
- 11 Cushion seal
- 12 Retainer ring
- Rod cover 13
- 14 U packing

- Dust wiper 15
- Retainer ring 16
- 17 Rod bushing
- Spacer 18
- 19 O-ring
- Fastening ring 20



- Tube assembly 1
- 2 Rod assembly
- 3 Stop ring
- 4 Set screw
- 5 Piston
- 6 U packing
- 7 Backup ring

- Abrasion ring 8
- 9 Check valve
- 10 Retainer ring
- Cushion seal 11
- 12 Retainer ring
- 13 Rod cover
- 14 U packing

- Dust wiper 15
- Fastening ring 16
- 17 Abrasion ring
- 18 Dust ring
- 19 O-ring

22B9FHS22

22B9FHS21

# 5) TF AND TS MASTS



- 1 Tube assembly
- 2 Rod
- 3 Rod end
- 4 O-ring
- 5 Backup ring
- 6 O-ring
- 7 Backup ring
- 8 Inner rod assembly
- 9 Stop ring

- 10 Set screw
- 11 Piston
- 12 Backup ring
- 13 U packing
- 14 Abrasion ring
- 15 Check valve
- 16 Retainer ring
- 17 O-ring
- 18 Backup ring

19 Cushion seal

22B9FHS23

- 20 Retainer ring
- 21 Rod cover
- 22 U packing
- 23 Dust wiper
- 24 Retainer ring
- 25 Abrasion ring
- 26 Dust ring
- 27 O-ring

# 6. TILT CYLINDER



- 1 Tube assembly
- 2 Rod
- 3 Piston
- 4 Piston seal
- 5 Abrasion ring
- 6 O-ring
- 7 Nylon nut
- 8 Rod cover
- 9 Rod bushing

- 11 U packing
- 11 Backup ring
- 12 Dust wiper
- 13 Stop ring
- 14 O-ring
- 15 Backup ring
- 16 O-ring
- 17 Lock washer

6-13

18 Rod eye

- Spherical bearing
- 20 Hexagonal bolt
- 21 Spring washer
- 22 Lock nut
- 23 Grease nipple
- 24 Dust cap
- 25 O-ring
- 26 O-ring

31FH-08771

25

19

# 5. PRE-LIFT CYLINDER

### 1) VF AND TF MASTS (30/32/35B-X)



2) TF MAST (25B-X)



37B1-07612

- 1 Tube assembly
- 2 Rod
- 3 Piston
- 4 U packing
- 5 Abrasion ring
- 6 Check valve

- 7 Retainer ring
- 8 Set screw
- 9 Rod cover
- 10 U packing
- 11 Dust wiper
- 12 Retainer ring

- 13 O-ring
- 14 Backup ring
- 15 Pipe
- 16 Backup ring
- 17 U packing



# 4) QF MAST



- Tube assembly 1
- 2 Rod
- 3 Piston
- 4 U packing
- 5 Abrasion ring
- 6 Check valve

- 7 Retainer ring
- 8 Set screw
- 9 Rod cover
- 10 U packing
- 11 Dust wiper
- 12 Retainer ring

13 O-ring

3CHN-07503

- 14 Backup ring
- Pipe 15
- 16 Backup ring

# **GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING**

# **1. OPERATIONAL CHECK**

# 1) INSPECTION ITEMS

- (1) Visually check rod for deformation, crack or destruction.
- (2) Place mast in horizontal direction, and lift it from the ground by 1 m. Measure hydraulic drift (distance for fork lowering, and mast tilting forward) 10 minutes later.
  - · Inspection conditions
  - Hydraulic oil temperature :  $45\pm5^{\circ}C$
  - Rated load
  - Mast kept vertical
  - · Hydraulic drift
  - Lowering : Within 100 mm
  - Tilting forward : Within 5° or 40 mm
- (3) If hydraulic drift is greater than specified value, replace control valve or cylinder packing.





# 2) HYDRAULIC OIL

- (1) Make use of dipstick to measure oil level, and make it up, if required.
- (2) Clean suction strainer fixed on outlet port pipe with screw when exchanging hydraulic oil.



# 3) MAIN CONTROL VALVE

 Raise forks to the highest position, and measure hydraulic pressure. Make sure that pressure of hydraulic oil is 210 bar.

# 2. FAILURE DIAGNOSIS AND TROUBLESHOOTING

# 1) HYDRAULIC SYSTEM

Trouble	Possible cause	Troubleshooting
Sudden drop of forks	· Defective seal inside control valve	· Replacing spool or valve body.
	<ul> <li>Oil leak from joint or hose.</li> </ul>	· Replacing
	· Defective seal inside cylinder.	· Packing exchange.
Large tilting angle by tare	· Leaning backward : Defective check valve.	· Cleaning or replacing.
weight of mast	$\cdot$ Leaning forward : Defective tilting lock valve.	· Cleaning or replacing.
	<ul> <li>Oil leak from joint or hose.</li> </ul>	· Replacing.
	· Defective seal inside cylinder.	· Seal replacing.
Slow speed of fork lifting or	· Insufficient hydraulic oil.	· Oil making up.
mast tilting	· Intrusion of air in hydraulic oil.	· Air bleeding
	· Oil leak from joint or hose.	· Replacing.
	· Excessive restriction on oil flow on	· Filter cleaning.
	pump suction.	
	<ul> <li>Relief valve failed in keeping at</li> </ul>	· Relief valve adjusting.
	specified pressure.	
	· Defective seal inside cylinder.	· Packing exchange.
	<ul> <li>High viscosity of hydraulic oil</li> </ul>	<ul> <li>Replacing with ISO VG46.</li> </ul>
	<ul> <li>Mast not moving smoothly.</li> </ul>	· Adjusting rolls in rail interval
	· Oil leak on lift control valve spool.	<ul> <li>Replacing spool or valve body.</li> </ul>
	· Oil leak on tilting control valve spool.	· Replacing spool or valve body.
Abnormal noise from	$\cdot$ Excessive restriction on oil flow on	· Filter cleaning.
hydraulic system	pump suction.	
	· Defective hydraulic pump gear or	· Gear or bearing replacing.
	bearing.	
Control valve lever locked	$\cdot$ Foreign substance between spool and	· Cleaning.
	valve body.	
	· Defective valve body.	· Evenly tightening body mounting bolt.
Rise of oil temperature	· Insufficient hydraulic oil.	· Oil making up.
	· High viscosity of hydraulic oil.	<ul> <li>Replacing with ISO VG46.</li> </ul>
	· Oil filter clogged.	· Filter cleaning.

# 2) HYDRAULIC GEAR PUMP

Trouble	Possible cause	Troubleshooting
Oil leak from oil seal	<ul> <li>Backlashing</li> <li>Abnormally high pressure on suction port</li> <li>Seal damaged by foreign substance</li> <li>Damage or abrasion of seal of shaft</li> <li>Defective centering of shaft</li> </ul>	<ul> <li>Rotating pump in correct direction</li> <li>Keeping pressure proper</li> <li>Replacing oil seal with new part</li> <li>Centering adjustment.</li> <li>Pump replacing.</li> </ul>
Oil leak on cover or body interface	<ul> <li>Bolt loosened or damaged on cover and body</li> <li>Deterioration or damage of oil seal by thermosetting of gasket</li> </ul>	<ul> <li>Bolt fastening or keeping pressure proper.</li> <li>Replacing gasket with new part</li> <li>Pump replacing.</li> </ul>
Oil leak on port	<ul> <li>Port fitting damaged or loosened</li> <li>Port seal damaged</li> <li>Port damaged</li> </ul>	<ul> <li>Port tightening and keeping design pressure intact</li> <li>Port seal replacing</li> <li>Pump replacing</li> </ul>
Discharge flow insufficient, or pressure not established	<ul> <li>Insufficient oil in tank</li> <li>Internal oil leak by abnormally high pressure, or improper oil viscosity</li> <li>Capability degraded by oil contamination</li> <li>Cavitation by negative pressure</li> <li>Internal part destructed</li> <li>Backlashing</li> </ul>	<ul> <li>Suppling oil of proper type and capacity into tank, and cooling system replacing.</li> <li>Exchanging contaminated oil.</li> <li>Using suction pipe of proper length and width, and replacing filter to prevent negative pressure.</li> <li>Suction valve opening</li> <li>Pump replacing</li> <li>Rotating pump in correct direction, and preventing abnormally high temperature on suction side.</li> </ul>
Rise of tank or oil temperature	<ul> <li>Abnormal heat generated by frequent operation of pressure control valve</li> <li>Internal part destructed</li> </ul>	<ul> <li>Setting to proper pressure.</li> <li>Pump replacing.</li> </ul>
Noise and vibration	<ul> <li>Poor mounting</li> <li>Cavitation</li> <li>Air induced</li> <li>Vibration of piping or mounted flange</li> <li>Chattering of relief valve</li> <li>Internal part destructed</li> </ul>	<ul> <li>Centering adjustment</li> <li>Using suction pipe of proper length and width, and replacing filter to prevent negative pressure.</li> <li>Filling tank with oil, and preventing air inducing with suction pipe.</li> <li>Reinforcing pipe and mounting flange, and preventing resonance.</li> <li>Replacing relieve valve.</li> <li>Pump replacing.</li> </ul>

\* Capability of disassembled pump may not be restored after reassembling.

% If pump is destructed, replace the assembly.

\* If it is inevitable to disassemble pump, consult with the authorized shop or dealer of Hyundai.

# 3) LIFT CYLINDER

Trouble	Possible cause	Troubleshooting
Oil leak on rod cover through	· Foreign substance on packing.	· Packing replacing.
rod	· Severe flaw on rod.	· Grinding rod surface with oil stone.
	· Abnormal distortion of dust seal.	· Dust seal replacing.
	· Chromium plating damaged	· Rod replacing.
Oil leak on cylinder rod cover thread	· O-ring damaged.	· O-ring replacing.
Rod shrunken	· Flaw on internal surface of tube.	· Grinding rod surface with oil stone.
	$\cdot$ Very serious flaw on internal surface of tube.	· Cylinder tube replacing.
	· Foreign substance into piston seal.	· Piston seal replacing.
Abrasion (play between cylin-	· Serious play between cylinder tube	· Abrasion ring replacing.
der tube and abrasion ring)	and abrasion ring.	
Abnormal noise when tilting	· Insufficient lubricant on anchor pin or	· Applying lubricant or replacing.
operation	bushing or pin abraded.	
	· Tilt cylinder rod bent.	· Replacing.

# **GROUP 3 DISASSEMBLY AND ASSEMBLY**

Always work in clean environment, and comply with the followings:

- Make sure that there is no damage of parts immediately after accepting them.
- All of components should be cleaned with solvent, and dried with compressed air before reassembling.
- Care should be exercised for protecting rubber seal from damage.
- Care should be exercised for protecting precise-machined surface from damage.
- Components should be inserted into housing not exercising large force. If large force is required, dimensional tolerances of parts are not complied with or misaligned.
- If force of hands is not sufficient, use press or rubber mallet.
- Never strike part with iron hammer.
- Proper press should be used for metal bushing.
- Do not use mallet for mounting bearings.
- Always pay attention to rotation direction when assembling parts.

# **1. MAIN CONTROL VALVE**

### 1) STRUCTURE



25BX6HS17

- 1 OPSS cutoff solenoid
- 2 Primary relief valve (DV1)
- 3 Secondary relief valve (DV2)4 Manual descending of mast
- Adjusting mast descending speed

5

### 2) DISASSEMBLING AND ASSEMBLING

### (1) Cutoff solenoid

- The photos are for reference only. MCV shapes may vary.
- ① Safety park forklift truck, and fully lower fork carriage onto the ground.
- ② Operate lever with engine turned off to discharge hydraulic oil from main control valve.
- ③ Open the cover of main control valve and loosen the nut of solenoid coil to remove coil from check valve.
- ④ Clean check valve and valve block to protect open valve block from contamination.
- (5) Loosen check valve with 17-mm spanner. Apply thin film of lubricant on O-ring of new check valve. Insert new check valve, and fasten it at fastening torque.
  - · Fastening torque : 4 kgf · m
- ⑥ Mount solenoid coil in correct direction, and fasten the coil with O-ring of nut facing the coil.
  - $\cdot$  Fastening torque : 0.7 kgf  $\cdot$  m





# 2. LIFT CYLINDER

# 1) STRUCTURE









Descending safety valve

Dimensions (V330	), standard)			Unit : mm
Model	Inner diameter	Outer diameter	Stroke	Rod (outer diameter)
25B-X	50	58	1630	40
30/32/35B-X	55	63	1630	45

25B9UHS26

- 1 Tube assembly
- 2 Rod assembly
- 3 Piston
- 4 Piston seal
- 5 Backup ring

- 6 Abrasion ring
- 7 Retainer ring
- 8 Gland
- 9 Dust wiper
- 10 Dust wiper

- 11 O-ring
- 12 Guide
- 13 DU bushing
- 14 Spacer
- 15 O-ring

# 2) DISASSEMBLING

(1) Hold cylinder tube in vice, and loosen and remove cylinder head.

Remove space from cylinder tube, and pull bushing out. Connect wrench to the hole of retainer at the end of piston, and turn the wrench. Lift the edge of guide and turn guide to move guide.



### 3) CHECKING AND INSPECTION

Inspection items	Standard dimensions	Limit on repair	Troubleshooting
<u> </u>			
Gap between cylinder rod and bushing	0.072 - 0.288	0.5	Bushing Replacing
Gap between piston ring and tube	0.05 - 0.030	0.5	Piston ring Replacing

### 4) ASSEMBLING

 Put piston ring in hydraulic oil of 40-50°C, and expand inner diameter of the ring, and assemble it on piston. Install piston seal.

Bend and turn the edge of guide install guide.



mm

# **3. TILT CYLINDER**

# 1) STRUCTURE



220/11020

- 1 Tube assembly
- 2 Rod assembly
- 3 Piston
- 4 Piston seal
- 5 Abrasion ring
- 6 O-ring
- 7 Nylon nut
- 8 Rod cover
- 9 Rod bushing

- 10 U packing
- 11 Backup ring
- 12 Dust wiper
- 13 Stop ring
- 14 O-ring
- 15 Backup ring
- 16 O-ring
- 17 Lock washer
- 18 Rod eye

- 19 Spherical bearing
- 20 Hexagonal bolt
- 21 Spring washer
- 22 Lock nut
- 23 Grease nipple
- 24 Dust cap
- 25 O-ring
- 26 O-ring

### 2) DISASSEMBLING

(1) Hold flat area on the bottom of cylinder tube in vice, mark fastening torque on the end of rod head, and then separate rod head. Hook wrench on the notch of cylinder head, and then separate cylinder head from cylinder tube.

Wind valleys of thread of rod with adhesive tape to protect dust seal and rod seal inside cylinder head from damage.



Inspection items	Standard dimensions	Limit on repair	Troubleshooting
Gap between cylinder rod and bushing	0.072 - 0.288	0.5	Replacing bushing
Gap between rod head bushing and pin	0.10 - 0.35	0.6	Replacing bushing

# 3) CHECKING AND INSPECTION