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1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This service manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding, the manual is divided into the following sections.

SECTION 1 GENERAL

This section explains the safety hints and gives the specification of the machine and major components.

SECTION 2 STRUCTURE AND FUNCTION

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

SECTION 3 HYDRAULIC SYSTEM

This section explains the hydraulic circuit, single and combined operation.

SECTION 4 ELECTRICAL SYSTEM

This section explains the electrical circuit, monitoring system and each component. It serves not only to give an understanding electrical system, but also serves as reference material for trouble shooting.

SECTION 5 MECHATRONICS SYSTEM

This section explains the computer aided power optimization system and each component.

SECTION 6 TROUBLESHOOTING

This section explains the troubleshooting charts correlating **problems** to **causes**.

SECTION 7 MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

SECTION 8 DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

SECTION 9 COMPONENT MOUNTING TORQUE

This section shows bolt specifications and standard torque values needed when mounting components to the machine.

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your HD Hyundai Construction Equipment distributor for the latest information.

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

Any additions, amendments or other changes will be sent to HD Hyundai Construction Equipment distributors.

Get the most up-to-date information before you start any work.

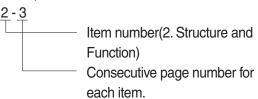
Filing method

1. See the page number on the bottom of the page.

File the pages in correct order.

2. Following examples shows how to read the page number.

Example 1



3. Additional pages: Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.

Revised edition mark(123...)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

Revisions

Revised pages are shown at the list of revised pages on the between the contents page and section 1 page.

Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

Symbol	Item	Remarks
Λ	Cofoty	Special safety precautions are necessary when performing the work.
	Safety	Extra special safety precautions are necessary when performing the work because it is under internal pressure.
*	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.

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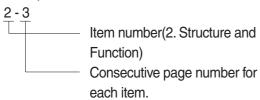
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Example 1



3. Additional pages: Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.

10 - 4 10 - 4 - 1 10 - 4 - 2 Added pages 10 - 5

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3. CONVERSION TABLE

Method of using the Conversion Table

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

Example

1. Method of using the Conversion Table to convert from millimeters to inches

Convert 55mm into inches.

- (1) Locate the number 50in the vertical column at the left side, take this as ⓐ, then draw a horizontal line from ⓐ.
- (2) Locate the number 5in the row across the top, take this as ⓑ, then draw a perpendicular line down from ⓑ.
- (3) Take the point where the two lines cross as ©. This point © gives the value when converting from millimeters to inches. Therefore, 55mm = 2.165 inches.

2. Convert 550mm into inches.

- (1) The number 550 does not appear in the table, so divide by 10(Move the decimal point one place to the left) to convert it to 55mm.
- (2) Carry out the same procedure as above to convert 55mm to 2.165 inches.
- (3) The original value(550mm) was divided by 10, so multiply 2.165 inches by 10(Move the decimal point one place to the right) to return to the original value.

 This gives 550mm = 21.65 inches.

	Millimete	rs to inche	es				<u> </u>			1mm =	0.03937 in
		0	1	2	3	4	5	6	7	8	9
	0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
	10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
	20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
	30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
	40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
							©				
a	50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
	60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
	70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
	80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
	90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Millimeters to inches 1mm = 0.03937in

										0.00007111
	0	1	2	3	4	5	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound 1kg = 2.2046lb

	0	1	2	3	4	5	6	7	8	9	
0		2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84	
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89	
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.5.	61.73	63.93	
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98	
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03	
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07	
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12	
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17	
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21	
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26	

Liter to U.S. Gallon 1 l = 0.2642 U.S.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.6076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon 1 ι = 0.21997 U.K.Gal

	0	1	2	3	4	5	6	7	8	9	
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980	
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179	ı
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379	l
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579	l
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778	ı
											Ì
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978	Ì
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178	Ì
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378	Ì
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577	l
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777	ı

	0	1	2	3	4	5	6	7	8	9
		7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	396.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	10005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kgf/cm² to lbf/in² 1 kgf / cm² = 14.2233 lbf / in²

	Tkgi/ (III- = 14.2233bi/ III									
	0	1	2	3	4	5	6	7	8	9
		14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721		1749	1764	1778	1792	1806	1821	
130	1849	2863	1735 1877	1892	1906	1920	1934	1949	1963	1835 1977
					2048					
140	1991	2005	2020	2034	2040	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	5603	2617	2631	2646	2660	2674	2688
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	3371	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

TEMPERATURE

Fahrenheit-Centigrade Conversion.

A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	35	95.0	21.1	70	158.0	51.7	125	257.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	172	347.0

SECTION 1 GENERAL

Group	1	Safety Hints	1-1
Group	2	Specifications	1-10

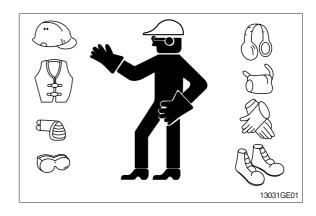
GROUP 1 SAFETY

FOLLOW SAFE PROCEDURE

Unsafe work practices are dangerous. Understand service procedure before doing work; Do not attempt shortcuts.

WEAR PROTECTIVE CLOTHING

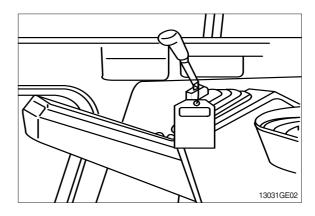
Wear close fitting clothing and safety equipment appropriate to the job.



WARN OTHERS OF SERVICE WORK

Unexpected machine movement can cause serious injury.

Before performing any work on the excavator, attach a 「Do Not Operate」 tag on the right side control lever.



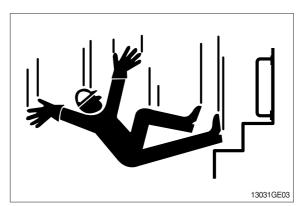
USE HANDHOLDS AND STEPS

Falling is one of the major causes of personal injury.

When you get on and off the machine, always maintain a three point contact with the steps and handrails and face the machine. Do not use any controls as handholds.

Never jump on or off the machine. Never mount or dismount a moving machine.

Be careful of slippery conditions on platforms, steps, and handrails when leaving the machine.

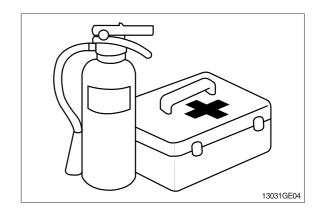


PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

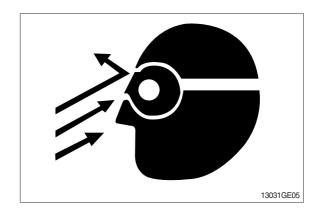
Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



PROTECT AGAINST FLYING DEBRIS

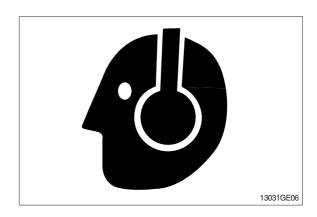
Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.



PROTECT AGAINST NOISE

Prolonged exposure to loud noise can cause impairment or loss of hearing.

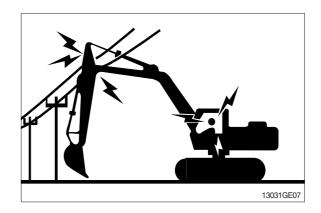
Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



AVOID POWER LINES

Serious injury or death can result from contact with electric lines.

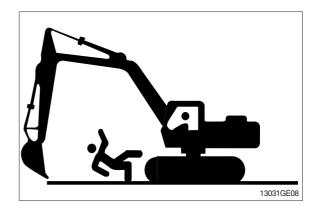
Never move any part of the machine or load closer to electric line than 3m(10ft) plus twice the line insulator length.



KEEP RIDERS OFF EXCAVATOR

Only allow the operator on the excavator. Keep riders off.

Riders on excavator are subject to injury such as being struck by foreign objects and being thrown off the excavator. Riders also obstruct the operator's view resulting in the excavator being operated in an unsafe manner.

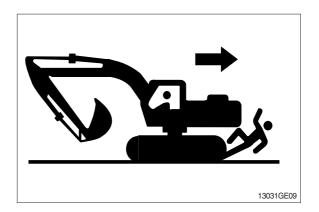


MOVE AND OPERATE MACHINE SAFELY

Bystanders can be run over. Know the location of bystanders before moving, swinging, or operating the machine.

Always keep the travel alarm in working condition. It warns people when the excavator starts to move.

Use a signal person when moving, swinging, or operating the machine in congested areas. Coordinate hand signals before starting the excavator.



OPERATE ONLY FORM OPERATOR'S SEAT

Avoid possible injury machine damage. Do not start engine by shorting across starter terminals.

NEVER start engine while standing on ground. Start engine only from operator's seat.



PARK MACHINE SAFELY

Before working on the machine:

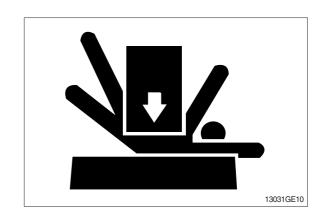
- · Park machine on a level surface.
- · Lower bucket to the ground.
- · Turn auto idle switch off.
- · Run engine at 1/2 speed without load for 2 minutes.
- Turn key switch to OFF to stop engine. Remove key from switch.
- · Move pilot control shutoff lever to locked position.
- · Allow engine to cool.

SUPPORT MACHINE PROPERLY

Always lower the attachment or implement to the ground before you work on the machine. If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load.

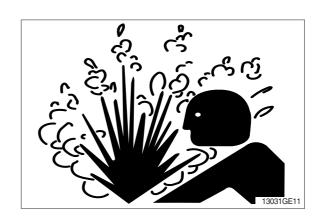
Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.



SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

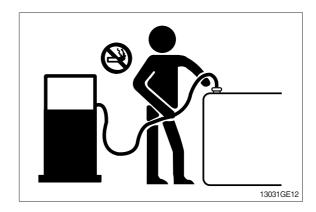
Shut off engine. Only remove filler cap when cool enough to touch with bare hands.



HANDLE FLUIDS SAFELY-AVOID FIRES

Handle fuel with care; It is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks. Always stop engine before refueling machine.

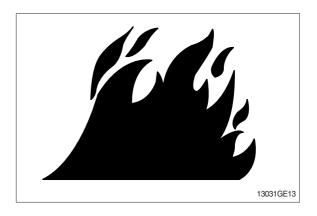
Fill fuel tank outdoors.



Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; They can ignite and burn spontaneously.



BEWARE OF EXHAUST FUMES

Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.

If you must operate in a building, be positive there is adequate ventilation. Either use an exhaust pipe extension to remove the exhaust fumes or open doors and windows to bring enough outside air into the area.

REMOVE PAINT BEFORE WELDING OR HEATING

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

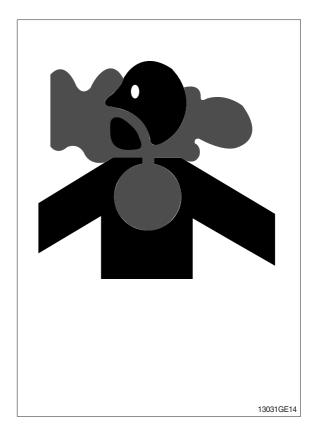
 If you sand or grind paint, avoid breathing the dust.

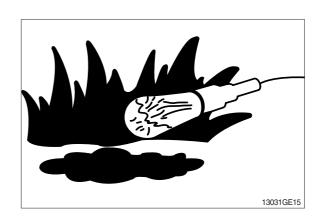
Wear an approved respirator.

 If you use solvent or paint stripper, remove stripper with soap and water before welding.
 Remove solvent or paint stripper containers and other flammable material from area.
 Allow fumes to disperse at least 15 minutes before welding or heating.

ILLUMINATE WORK AREA SAFELY

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

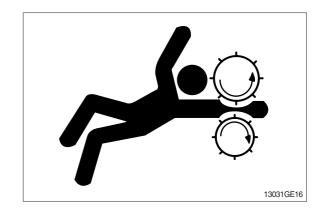




SERVICE MACHINE SAFELY

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

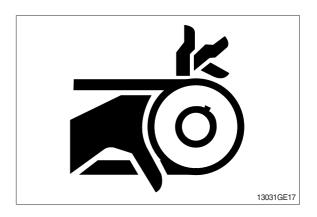
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

To prevent accidents, use care when working around rotating parts.



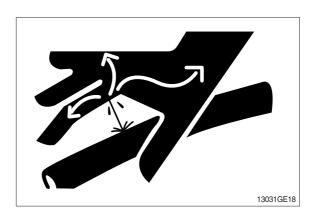
AVOID HIGH PRESSURE FLUIDS

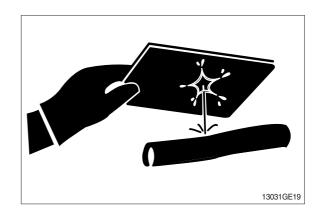
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.





AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials.

Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area. Install fire resisting guards to protect hoses or other materials.



PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; It may explode. Warm battery to 16° C (60° F).



PREVENT ACID BURNS

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

- 1. Filling batteries in a well-ventilated area.
- 2. Wearing eye protection and rubber gloves.
- 3. Avoiding breathing fumes when electrolyte is added.
- 4. Avoiding spilling of dripping electrolyte.
- 5. Use proper jump start procedure.

If you spill acid on yourself:

- 1. Flush your skin with water.
- 2. Apply baking soda or lime to help neutralize the acid.
- Flush your eyes with water for 10-15 minutes. Get medical attention immediately.

If acid is swallowed:

- 1. Drink large amounts of water or milk.
- 2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
- 3. Get medical attention immediately.

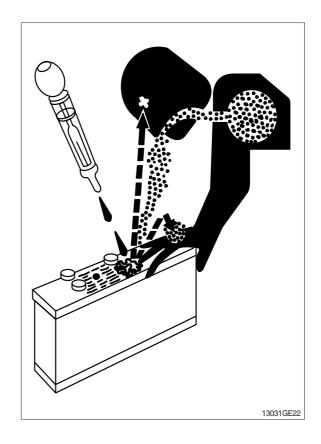
USE TOOLS PROPERLY

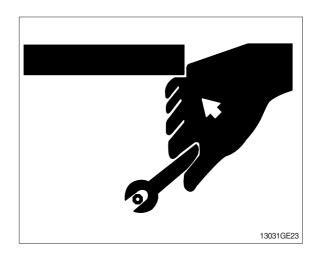
Use tools appropriate to the work. Makeshift tools, parts, and procedures can create safety hazards.

Use power tools only to loosen threaded tools and fasteners.

For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only recommended replacement parts. (See Parts catalogue.)



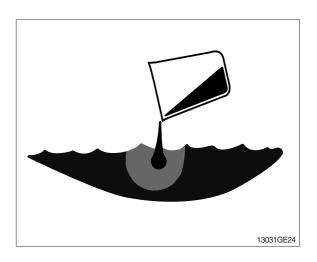


DISPOSE OF FLUIDS PROPERLY

Improperly disposing of fluids can harm the environment and ecology. Before draining any fluids, find out the proper way to dispose of waste from your local environmental agency.

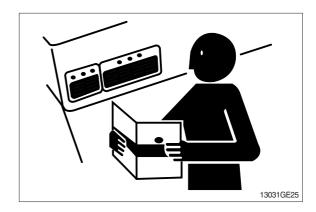
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

DO NOT pour oil into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters, batteries, and other harmful waste.



REPLACE SAFETY SIGNS

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

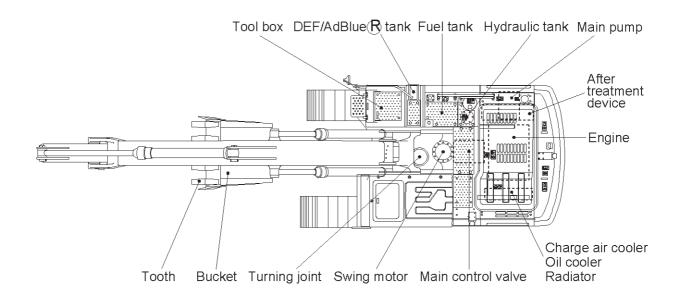


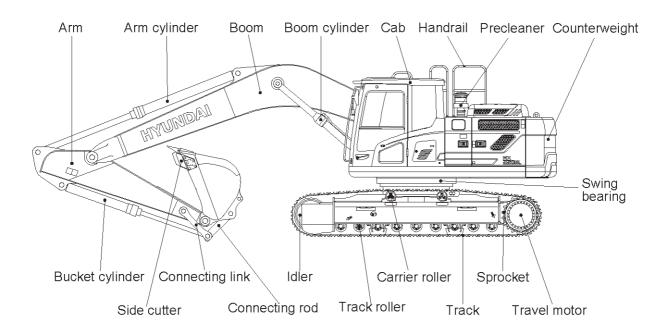
LIVE WITH SAFETY

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

GROUP 2 SPECIFICATIONS

1. MAJOR COMPONENT



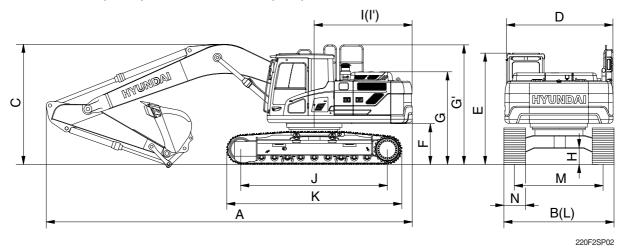


220F2SP01

2. SPECIFICATIONS

1) HX220 NL

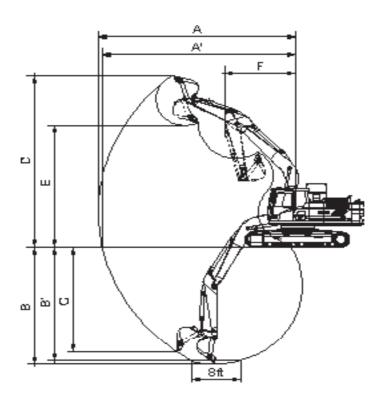
 \cdot 5.65 m (18' 6") BOOM and 2.92 m (9' 7") ARM



Description		Unit	Specification		
Operating weight		kg (lb)	22300 (49160)		
Bucket capacity (SAE heaped), standard		m³ (yd³)	0.87 (1.14)		
Overall length	Α		9510 (31' 2")		
Overall width, with 500mm shoe	В		2500 (8' 2")		
Overall height of boom	С		3100 (10' 2")		
Superstructure width	D		2530 (8' 4")		
Overall height of cab	Е		3000 (9' 10")		
Ground clearance of counterweight	F		1060 (3' 6")		
Overall height of engine hood	G		2468 (8' 1")		
Overall height of guardrail	G'	mm (ft in)	3211 (10' 6")		
Minimum ground clearance	Н	mm (ft-in)	480 (1' 7")		
Rear-end distance	I		2770 (9' 1")		
Rear-end swing radius	ľ		2850 (9' 4")		
Distance between tumblers	J		3650 (12' 0")		
Undercarriage length	K		4440 (14' 7")		
Undercarriage width	L		2500 (8' 2")		
Track gauge	М		2000 (6' 7")		
Track shoe width, standard	N		500 (20")		
Travel speed (low/high)		km/hr (mph)	3.4/5.3 (2.1/3.3)		
Swing speed		rpm	12.0		
Gradeability		Degree (%)	35 (70)		
Ground pressure (600 mm shoe)		kgf/cm² (psi)	0.57 (8.11)		
Max traction force		kg (lb)	21100 (46500)		

3. WORKING RANGE

· 5.65 m (18' 6") MONO BOOM

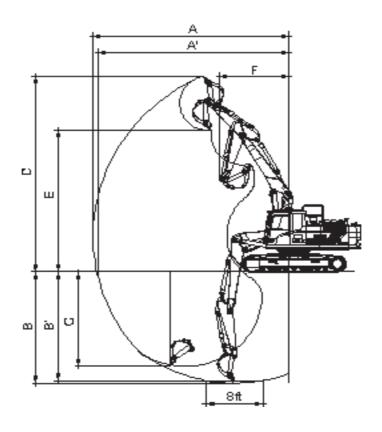


220NF2SP02

Description		2.0 m (6' 7") Arm	2.4 m (7' 10") Arm	2.92 m (9' 7") Arm
Max digging reach	Α	9140 mm (30' 0")	9510 mm (31' 2")	9960 mm (32' 8")
Max digging reach on ground	A'	8960 mm (29' 5")	9340 mm (30' 8")	9800 mm (32' 2")
Max digging depth	В	5750 mm (18'10")	6150 mm (20' 2")	6640 mm (21' 9")
Max digging depth (8 ft level)	B'	5520 mm (18' 1")	5950 mm (19' 6")	6470 mm (21' 3")
Max vertical wall digging depth	С	5320 mm (17' 5")	5780 mm (19' 0")	6250 mm (20' 6")
Max digging height	D	9270 mm (30' 5")	9500 mm (31' 2")	9740 mm (31'11")
Max dumping height	Е	6450 mm (21' 2")	6660 mm (21' 10")	6900 mm (22' 8")
Min swing radius	F	3710 mm (12' 2")	3630 mm (11' 11")	3580 mm (11' 9")
		133.4 [144.8] kN	133.4 [144.8] kN	133.4 [144.8] kN
	SAE	13600 [14770] kgf	13600 [14770] kgf	13600 [14770] kgf
Bucket digging force		29980 [32550] lbf	29980 [32550] lbf	29980 [32550] lbf
Bucket digging force		152.0 [165.0] kN	152.0 [165.0] kN	152.0 [165.0] kN
	ISO	15500 [16830] kgf	15500 [16830] kgf	15500 [16830] kgf
		34170 [37100] lbf	34170 [37100] lbf	34170 [37100] lbf
		144.2 [156.5] kN	102.0 [110.7] kN	119.6 [129.9] kN
	SAE	14700 [15960] kgf	10400 [11290] kgf	12200 [13250] kgf
Arm diaging force		32410 [35190] lbf	22930 [24900] lbf	26900 [29210] lbf
Arm digging force		151.0 [164.0] kN	106.9 [116.1] kN	125.5 [136.3] kN
	ISO	15400 [16720] kgf	10900 [11830] kgf	12800 [13900] kgf
		33950 [36860] lbf	24030 [26090] lbf	28220 [30640] lbf

[]: Power boost

2) $5.65\,\mathrm{m}\,(18'\,6")$ HYDRAULIC ADJUSTABLE BOOM



220NF2SP03

Description		2.0 m (6' 7") Arm	2.4 m (7' 10") Arm	2.92 m (9' 7") Arm
Max digging reach	Α	9120 mm (29' 11")	9530 mm (31' 3")	10020 mm (32' 10")
Max digging reach on ground	A'	8940 mm (29' 4")	9360 mm (30' 9")	9860 mm (32' 4")
Max digging depth	В	5480 mm (18' 0")	5890 mm (19' 4")	6400 mm (21' 0")
Max digging depth (8 ft level)	B'	5360 mm (17' 7")	5770 mm (18' 11")	6300 mm (20' 8")
Max vertical wall digging depth	С	4560 mm (15' 0")	4990 mm (16' 4")	5530 mm (18' 2")
Max digging height	D	10300mm (33' 10")	10670 mm (35' 0")	11080 mm (36' 4")
Max dumping height	Е	7390 mm (24' 3")	7740 mm (25' 5")	8160 mm (26' 9")
Min swing radius	F	2870 mm (9' 5")	2670 mm (8' 9")	2540 mm (8' 4")
		133.4 [144.8] kN	133.4 [144.8] kN	133.4 [144.8] kN
	SAE	13600 [14770] kgf	13600 [14770] kgf	13600 [14770] kgf
Dualest diaging force		29980 [32550] lbf	29980 [32550] lbf	29980 [32550] lbf
Bucket digging force		152.0 [165.0] kN	152.0 [165.0] kN	152.0 [165.0] kN
	ISO	15500 [16830] kgf	15500 [16830] kgf	15500 [16830] kgf
		34170 [37100] lbf	34170 [37100] lbf	34170 [37100] lbf
		144.2 [156.5] kN	119.6 [129.9] kN	102.0 [110.7] kN
	SAE	14700 [15960] kgf	12200 [13250] kgf	10400 [11290] kgf
Arm diaging force		32410 [35190] lbf	26900 [29210] lbf	22930 [24900] lbf
Arm digging force		151.0 [164.0] kN	125.5 [136.3] kN	106.9 [116.1] kN
	ISO	15400 [16720] kgf	12800 [13900] kgf	10900 [11830] kgf
		33950 [36860] lbf	28220 [30640] lbf	24030 [26090] lbf

[]: Power boost

4. WEIGHT

1) HX220 NL

li	HX2	220 NL
Item	kg	lb
Upper structure assembly		
· Main frame weld assembly	1720	3800
· Engine assembly	1485	3270
· Main pump assembly	136	300
· Main control valve assembly	220	490
· Swing motor assembly	250	550
· Hydraulic oil tank assembly	165	360
· Fuel tank assembly	138	304
· Counterweight	4700	10360
· Cab assembly	500	1100
Lower chassis assembly	·	
· Track frame weld assembly	2525	5570
· Swing bearing	290	640
· Travel motor assembly	300	660
· Turning joint	57	126
· Track recoil spring	140	310
· Idler	151	333
· Carrier roller	20	45
· Track roller	48	106
· Sprocket	56	123
Track-chain assembly (500 mm standard triple grouser shoe)	1309	2886
Front attachment assembly		
· 5.65 m boom assembly	1370	3020
· 2.92 m arm assembly	760	1680
· 0.87 m³ SAE heaped bucket	800	1760
· Boom cylinder assembly	180/1EA	400/1EA
· Arm cylinder assembly	290	640
· Bucket cylinder assembly	175	390
· Bucket control link assembly	170	370

^{**} This information is different with operating and transportation weight because it is not including harness, pipe, oil, fuel so on.

^{*} Refer to Transportation for actual weight information and Specifications for operating weight.

5. LIFTING CAPACITIES

1) HX220 NL

(1) 5.65 m (18' 6") boom, 2.00 m (6' 7") arm equipped with 0.87 m³ (SAE heaped) bucket, 500 mm (20") triple grouser shoe.

· 🖟 : Rating over-front · 🖶 : Rating over-side or 360 degree

					Load	radius				At	max. rea	ch
Load po	oint	3.0 m	(10 ft)	4.5 m (15 ft)		6.0 m (20 ft)		7.5 m (25 ft)		Сар	acity	Reach
height						H		l l		H		m (ft)
7.5 m (25 ft)	kg lb									*4000 *8820	3810 8400	6.61 (21.7)
6.0 m (20 ft)	kg lb					*4420 *9740	4380 9660			*4060 *8950	2800 6170	7.75 (25.4)
4.5 m (15 ft)	kg lb			*5670 *12500	*5670 *12500	*4840 *10670	4230 9330			*4200 *9260	2340 5160	8.41 (27.6)
3.0 m (10 ft)	kg lb			*7430 *16380	6170 13600	*5600 *12350	3990 8800	*4830 *10650	2750 6060	*4360 *9610	2130 4700	8.71 (28.6)
1.5 m (5 ft)	kg lb			*8990 *19820	5700 12570	*6390 *14090	3760 8290	*5190 *11440	2640 5820	4330 9550	2080 4590	8.71 (28.6)
Ground Line	kg lb			*9720 *21430	5490 12100	*6930 *15280	3610 7960	5380 11860	2570 5670	4570 10080	2190 4830	8.40 (27.6)
-1.5 m (-5 ft)	kg lb	*14170 *31240	10580 23320	*9690 *21360	5460 12040	*7030 *15500	3560 7850			*4930 *10870	2540 5600	7.73 (25.4)
-3.0 m (-10 ft)	kg lb	*12680 *27950	10790 23790	*8900 *19620	5570 12280	*6390 *14090	3650 8050			*4910 *10820	3380 7450	6.58 (21.6)

Note

- 1. Lifting capacity are based on SAE J1097 and ISO 10567.
- 2. Lifting capacity of the HX series does not exceed 75% of tipping load with the machine on firm, level ground or 87% of full hydraulic capacity.
- 3. The load point is a hook located on the back of the bucket.
- 4. *indicates load limited by hydraulic capacity.
- Lifting capacities are based upon a standard machine conditions.

Lifting capacities will vary with different work tools, ground conditions and attachments.

The difference between the weight of a work tool attachment must be subtracted.

Consult your HD Hyundai Construction Equipment dealer regarding the lifting capacities for specific work tools and attachments.

▲ Failure to comply to the rated load can cause possible personal injury or property damage. Make adjustments to the rated load as necessory for non-standard configurations.

(2) 5.65 m (18' 6") boom, 2.40 m (7' 10") arm equipped with 0.87 m 3 (SAE heaped) bucket and 500 mm (20") triple grouser shoe.

: Rating over-front : Rating over-side or 360 degree

			Load radius									Atı	max. rea	ach
Load po	oint	1.5 m	(5 ft)	3.0 m (10 ft)		4.5 m	(15 ft)	6.0 m	(20 ft)	7.5 m	(25 ft)	Cap	acity	Reach
height		ľ		F						ľ		ľ		m (ft)
7.5 m (25 ft)	kg Ib											*3690 *8140	3360 7410	7.12 (23.4)
6.0 m (20 ft)	kg lb							*3990 *8800	*3990 *8800			*3780 *8330	2540 5600	8.18 (26.8)
4.5 m (15 ft)	kg lb							*4460 *9830	4280 9440	*4050 *8930	2860 6310	*3910 *8620	2140 4720	8.80 (28.9)
3.0 m (10 ft)	kg lb					*6850 *15100	6280 13850	*5260 *11600	4020 8860	*4560 *10050	2760 6080	*4080 *8990	1950 4300	9.09 (29.8)
1.5 m (5 ft)	kg lb					*8540 *18830	5750 12680	*6120 *13490	3760 8290	*4980 *10980	2630 5800	4030 8880	1910 4210	9.08 (29.8)
Ground	kg lb			*9080 *20020	*9080 *20020	*9520 *20990	5470 12060	*6760 *14900	3580 7890	*5310 *11710	2540 5600	4220 9300	2000 4410	8.79 (28.8)
-1.5 m (-5 ft)	kg lb	*9930 *21890	*9930 *21890	*13780 *30380	10400 22930	*9710 *21410	5400 11900	*6990 *15410	3510 7740	11710		*4670 *10300	2280 5030	8.16 (26.8)
-3.0 m (-10 ft)	kg lb	*14320 *31570	*14320 *31570	*13400 *29540	10600 23370	*9170 *20220	5470 12060	*6630 *14620	3550 7830			*4750 *10470	2940 6480	7.09 (23.3)
-4.5 m (-15 ft)	kg lb	3.070	3.0.0	*10790 *23790	*10790 *23790	*7470 *16470	5710 12590		1000			15.116	3.00	(=0.0)

(3) 5.65 m (18' 6") boom, 2.92 m (9' 7") arm equipped with 0.87 m³ (SAE heaped) bucket and 500 mm (20") triple grouser shoe.

· 🖟 : Rating over-front · 🛨 : Rating over-side or 360 degree

						Load	radius					At max. reach		ach
Load po	oint	1.5 m	(5 ft)	3.0 m	(10 ft)	4.5 m	(15 ft)	6.0 m	(20 ft)	7.5 m	(25 ft)	Cap	acity	Reach
heigh	ıt			J										m (ft)
7.5 m	kg											*3350	2890	7.76
(25 ft)	lb											*7390	6370	(25.5)
6.0 m	kg									*2140	*2140	*3440	2250	8.73
(20 ft)	lb									*4720	*4720	*7580	4960	(28.6)
4.5 m	kg							*3970	*3970	*3810	2900	*3580	1920	9.30
(15 ft)	lb							*8750	*8750	*8400	6390	*7890	4230	(30.5)
3.0 m	kg			*9630	*9630	*6090	*6090	*4810	4060	*4210	2770	3730	1750	9.58
(10 ft)	lb			*21230	*21230	*13430	*13430	*10600	8950	*9280	6110	8220	3860	(31.4)
1.5 m	kg			*9210	*9210	*7920	5830	*5730	3780	*4700	2630	3680	1710	9.57
(5 ft)	lb			*20300	*20300	*17460	12850	*12630	8330	*10360	5800	8110	3770	(31.4)
Ground	kg			*9810	*9810	*9160	5460	*6490	3560	*5120	2510	3830	1780	9.29
Line	lb			*21630	*21630	*20190	12040	*14310	7850	*11290	5530	8440	3920	(30.5)
-1.5 m	kg	*8950	*8950	*12850	10220	*9630	5320	*6880	3450	5250	2450	4250	2000	8.71
(-5 ft)	lb	*19730	*19730	*28330	22530	*21230	11730	*15170	7610	11570	5400	9370	4410	(28.6)
-3.0 m	kg	*12340	*12340	*14120	10360	*9380	5340	*6770	3450			*4490	2490	7.73
(-10 ft)	lb	*27210	*27210	*31130	22840	*20680	11770	*14930	7610			*9900	5490	(25.4)
-4.5 m	kg			*12010	10690	*8180	5510					*4360	3750	6.14
(-15 ft)	lb			*26480	23570	*18030	12150					*9610	8270	(20.1)

(4) 5.65 m (18' 6") Adjustable boom, 2.00 m (6' 7") arm equipped with 0.87 m³ (SAE heaped) bucket and 500 mm (20") triple grouser shoe.

· P : Rating over-front · □ : Rating over-side or 360 degree

					Load	adius				At max. reach		
Load po	oint	3.0 m ((10.0 ft)	4.5 m (15.0 ft)		6.0 m (20.0 ft)		7.5 m (25.0 ft)	Capa	acity	Reach
height		J		J								m (ft)
10.5 m (35.0 ft)	kg lb									*6200 *13670	*6200 *13670	4.64 (15.2)
9.0 m (30.0 ft)	kg lb									*6560 *14460	*6560 *14460	4.60 (15.1)
7.5 m (25.0 ft)	kg lb			*6750 *14880	*6750 *14880					*5330 *11750	3710 8180	6.66 (21.9)
6.0 m (20.0 ft)	kg lb			*6910 *15230	*6910 *15230	*5910 *13030	4340 9570			*4920 *10850	2720 6000	7.79 (25.6)
4.5 m (15.0 ft)	kg lb	*11400 *25130	*11400 *25130	*7810 *17220	6710 14790	*6200 *13670	4190 9240			4680 10320	2270 5000	8.45 (27.7)
3.0 m (10.0 ft)	kg lb			*9020 *19890	6090 13430	*6670 *14700	3930 8660	*5380 *11860	2700 5950	4350 9590	2060 4540	8.75 (28.7)
1.5 m (5 ft)	kg lb			*9720 *21430	5600 12350	*6990 *15410	3690 8140	*5410 *11930	2590 5710	4300 9480	2020 4450	8.75 (28.7)
Ground Line	kg lb			*9430 *20790	5390 11880	*6900 *15210	3540 7800	*5130 *11310	2520 5560	*4020 *8860	2140 4720	8.43 (27.7)
-1.5 m (-5 ft)	kg lb	*10050 *22160	*10050 *22160	*8270 *18230	5380 11860	*6170 *13600	3500 7720			*3440 *7580	2490 5490	7.77 (25.5)
-3.0 m (-10 ft)	kg lb			*6160 *13580	5520 12170	*4350 *9590	3610 7960					

(5) 5.65 m (18' 6") Adjustable boom, 2.40 m (7' 10") arm equipped with 0.87 m 3 (SAE heaped) bucket and 500 mm (20") triple grouser shoe.

· 🖟 : Rating over-front · 🛨 : Rating over-side or 360 degree

					Load	adius				At	max. rea	ch
Load poi	nt	3.0 m (10.0 ft)	4.5 m (15.0 ft)		6.0 m (20.0 ft)		7.5 m (25.0 ft)	Capa	acity	Reach
height												m (ft)
	kg lb									*5730 *12630	5470 12060	5.39 (17.7)
1 1	kg lb			*5870 *12940	*5870 *12940					*4900 *10800	3260 7190	7.18 (23.6)
6.0 m	kg lb			*6440 *14200	*6440 *14200	*5570 *12280	4420 9740			*4570 *10080	2460 5420	8.23 (27.0)
4.5 m	kg lb	*10330 *22770	*10330 *22770	*7350 *16200	6840 15080	*5920 *13050	4240 9350	*4360 *9610	2820 6220	4330 9550	2070 4560	8.84 (29.0)
3.0 m	kg lb			*8630 *19030	6210 13690	*6450 *14220	3960 8730	*5240 *11550	2710 5970	4040 8910	1890 4170	9.13 (30.0)
1.5 m	kg lb			*9550 *21050	5650 12460	*6870 *15150	3700 8160	*5360 *11820	2580 5690	3990 8800	1850 4080	9.13 (30.0)
Ground I	kg lb	*8600 *18960	*8600 *18960	*9560 *21080	5370 11840	*6920 *15260	3510 7740	*5230 *11530	2490 5490	*3840 *8470	1950 4300	8.83 (29.0)
-1.5 m	kg lb	*11450 *25240	10280 22660	*8660 *19090	5310 11710	*6390 *14090	3450 7610	*4540 *10010	2470 5450	*3390 *7470	2230 4920	2.21 (26.9)
	kg lb			*6840 *15080	5400 11900	*4980 *10980	3510 7740					

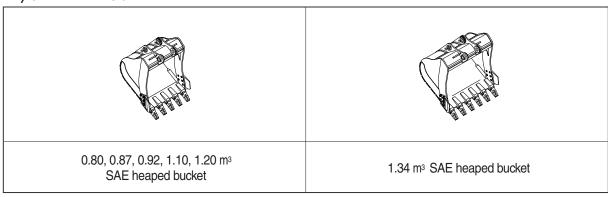
(6) 5.65 m (18' 6") Adjustable boom, 2.92 m (9' 7") arm equipped with 0.87 m³ (SAE heaped) bucket and 500 mm (20") triple grouser shoe.

: Rating over-front : Rating over-side or 360 degree

				Load	adius				At	max. rea	ch
Load poin	3.0 m	(10.0 ft)	4.5 m (15.0 ft)	6.0 m (20.0 ft)	7.5 m (25.0 ft)	Capa	acity	Reach
height	Į.		J								m (ft)
9.0 m kg	1		*3290	*3290					*4600	4260	6.28
(30.0 ft) lb			*7250	*7250					*10140	9390	(20.6)
7.5 m kg					*3530	*3530			*4030	2800	7.83
(25.0 ft) lb					*7780	*7780			*8880	6170	(25.7)
6.0 m kg			*5170	*5170	*4870	4510	*2440	*2440	*3800	2170	8.78
(20.0 ft) lb			*11400	*11400	*10740	9940	*5380	*5380	*8380	4780	(28.8)
4.5 m kg			*6720	*6720	*5540	4310	*4390	2860	*3740	1850	9.36
(15.0 ft) lb			*14820	*14820	*12210	9500	*9680	6310	*8250	4080	(30.7)
3.0 m kg	*12710	12080	*8080	6370	*6130	4020	*5040	2720	3690	1690	9.63
(10.0 ft) lb	*28020	26630	*17810	14040	*13510	8860	*11110	6000	8140	3730	(31.6)
1.5 m kg	*8700	*8700	*9240	5740	*6660	3720	*5240	2570	3640	1650	9.63
(5.0 ft) lb	*19180	*19180	*20370	12650	*14680	8200	*11550	5670	8020	3640	(31.6)
Ground kg	*9390	*9390	*9580	5360	*6880	3490	*5260	2450	*3610	1720	9.35
Line Ib	*20700	*20700	*21120	11820	*15170	7690	*11600	5400	*7960	3790	(30.7)
-1.5 m kg	*12500	10070	*9020	5230	*6570	3380	*4860	2400	*3270	1950	8.77
(-5.0 ft) lb		22200	*19890	11530	*14480	7450	*10710	5290	*7210	4300	(28.8)
-3.0 m kg	*10150	*10150	*7560	5270	*5530	3400					
(-10.0 ft) lb		*22380	*16670	11620	*12190	7500					

6. BUCKET SELECTION GUIDE

1) GENERAL BUCKET



					Recommendation								
Сар	acity	Wi	dth	Weight		65 m (18' (Mono boo		5.65 m (18' 6") Adjustable Boom					
SAE heaped	CECE heaped	Without side cutter	With side cutter		2.0 m arm (6' 7")	2.4 m arm (7' 10")	2.92 m arm (9' 7")	2.0 m arm (6' 7")	2.4 m arm (7' 10")	2.92 m arm (9' 7")			
0.80 m ³ (1.05 yd ³)	0.70 m ³ (0.92 yd ³)	1070 mm (42.1")	1160 mm (45.7")	770 kg (1700 lb)	0	0	0	0	0	•			
0.87 m ³ (1.14 yd ³)	0.76 m ³ (0.99 yd ³)	1140 mm (44.9")	1230 mm (48.4")	800 kg (1760 lb)	0	0	0	0	0	•			
0.92 m ³ (1.20 yd ³)	0.80 m ³ (1.05 yd ³)	1190 mm (46.9")	1280 mm (50.4")	820 kg (1810 lb)	0	0	•	0	0	•			
1.10 m ³ (1.44 yd ³)	0.96 m ³ (1.26 yd ³)	1375 mm (54.1")	1465 mm (57.7")	890 kg (1960 lb)	0	•	•	•	•	•			
1.20 m ³ (1.57 yd ³)	1.05 m ³ (1.37 yd ³)	1390 mm (54.7")	1480 mm (58.3")	920 kg (2030 lb)	0	•		•	•				
1.34 m ³ (1.75 yd ³)	1.17 m ³ (1.53 yd ³)	1525 mm (60.0")	1615 mm (63.6")	990 kg (2180 lb)	•	•		•					

Applicable for materials with density of 2000 kg/m³ (3370 lb/yd³) or less
 Applicable for materials with density of 1600 kg/m³ (2700 lb/yd³) or less
 Applicable for materials with density of 1100 kg/m³ (1850 lb/yd³) or less

* These recommendations are for general conditions and average use.

Work tools and ground conditions have effects on machine performance.

Select an optimum combination according to the working conditions and the type of work that is being done.

Consult your HD Hyundai Construction Equipment dealer for information on selecting the correct boom-arm-bucket combination.

2) HEAVY DUTY AND ROCK-HEAVY DUTY BUCKET

Heavy duty bucket	Rock-Heavy duty bucket
◆ 0.90, 1.05 m³ SAE heaped bucket	 ⊙ 0.87 m³ SAE heaped bucket

			Width		Recommendation					
Capa	acity	Wi			Width Weight		5.65 m (18' 6") boom		5.65 m (18' 6") Adjustable boom	
SAE heaped	CECE heaped	Without side cutter	With side cutter		2.0 m arm (6' 7")	2.4 m arm (7' 10")	2.92 m arm (9' 7")	2.0 m arm (6' 7")	2.4 m arm (7' 10")	2.92 m arm (9' 7")
◆0.90m³(1.18 yd³)	0.79 m³ (1.03 yd³)	1210 mm (47.6")	-	880 kg (1940 lb)	0	0	•	0	0	•
♦1.05 m³ (1.37 yd³)	0.92 m³ (1.2 yd³)	1355 mm (53.3")	-	940 kg (2070 lb)	0	•	•	•	•	•
◆0.87 m³ (1.14 yd³)	0.77 m ³ (1.01 yd ³)	1195 mm (47.0")	-	940 kg (2070 lb)	0	0	•	0	0	•

♦ : Heavy duty bucket
• : Rock-Heavy duty bucket

Applicable for materials with density of 2000 kg/m³ (3370 lb/yd³) or less

Applicable for materials with density of 1600 kg/m³ (2700 lb/yd³) or less

Applicable for materials with density of 1100 kg/m³ (1850 lb/yd³) or less

7. UNDERCARRIAGE

1) TRACKS

X-leg type center frame is integrally welded with reinforced box-section track frames. The design includes dry tracks, lubricated rollers, idlers, sprockets, hydraulic track adjusters with shock absorbing springs and assembled track-type tractor shoes with triple grousers.

2) TYPES OF SHOES

	Shapes		Triple grouser			
Model						
	Shoe width	mm (in)	500 (20)	600 (24)	700 (28)	
HX220 NL	Operating weight	kg (lb)	22300 (49160)	22400 (49380)	22870 (50420)	
MONO BOOM	Ground pressure	kgf/cm² (psi)	0.57 (8.11)	0.48 (6.83)	0.42 (5.97)	
	Overall width	mm (ft-in)	2500 (8' 2")	2600 (8' 6")	2700 (8'10")	
	Shoe width	mm (in)	500 (20)	600 (24)	-	
HX220 NL ADJUST BOOM	Operating weight	kg (lb)	23000 (50710)	23100 (50930)	-	
	Ground pressure	kgf/cm² (psi)	0.59 (8.39)	0.49 (6.97)	-	
	Overall width	mm (ft-in)	2500 (8' 2")	2600 (8' 6")	-	

3) NUMBER OF ROLLERS AND SHOES ON EACH SIDE

Item	Quantity
Carrier rollers	2 EA
Track rollers	9 EA
Track shoes	49 EA

4) SELECTION OF TRACK SHOE

Suitable track shoes should be selected according to operating conditions.

Method of selecting shoes

Confirm the category from the list of applications in **table 2**, then use **table 1** to select the shoe. Wide shoes (categories B and C) have limitations on applications. Before using wide shoes, check the precautions, then investigate and study the operating conditions to confirm if these shoes are suitable.

Select the narrowest shoe possible to meet the required flotation and ground pressure. Application of wider shoes than recommendations will cause unexpected problem such as bending of shoes, crack of link, breakage of pin, loosening of shoe bolts and the other various problems.

* Table 1

Track shoe	Specification	Category
500 mm triple grouser	Standard	А
600 mm triple grouser	Option	В
700 mm triple grouser	Option	С

*** Table 2**

Category	Applications	Precautions
А	Rocky ground, river beds, normal soil	Travel at low speed on rough ground with large obstacles such as boulders or fallen trees
В	Normal soil, soft ground	 These shoes cannot be used on rough ground with large obstacles such as boulders or fallen trees Travel at high speed only on flat ground Travel slowly at low speed if it is impossible to avoid going over obstacles
С	Extremely soft ground (swampy ground)	 Use the shoes only in the conditions that the machine sinks and it is impossible to use the shoes of category A or B These shoes cannot be used on rough ground with large obstacles such as boulders or fallen trees Travel at high speed only on flat ground Travel slowly at low speed if it is impossible to avoid going over obstacles

8. SPECIFICATIONS FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Cummins QSB6.7
Туре	4-cycle turbocharged, charger air cooled diesel engine
Cooling method	Water cooling
Number of cylinders and arrangement	6 cylinders, in-line
Firing order	1-5-3-6-2-4
Combustion chamber type	Direct injection type
Cylinder bore × stroke	107 × 124 mm (4.2" × 4.9")
Piston displacement	6700 cc (409cu in)
Compression ratio	17.3:1
Rated net horse power (SAE J1349)	173 Hp at 1950 rpm (129 kW at 1950 rpm)
Rated gross horse power (SAE J1995)	182.6 Hp at 1950 rpm (136 kW at 1950 rpm)
Maximum torque at 1500 rpm	85.7 kgf · m (620 lbf · ft)
Engine oil quantity	23.7 ℓ (6.26 U.S. gal)
Wet weight	520 kg (1146 lb)
High idling speed	1900 ± 50 rpm
Low idling speed	$850\pm100~\mathrm{rpm}$
Rated fuel consumption	158 g/Hp · hr at 1950 rpm
Starting motor	Denso (24 V-4.8 kW)
Alternator	Denso (24 V-95 A)
Battery	2 × 12 V × 100 Ah

2) MAIN PUMP

Item	Specification
Туре	Variable displacement tandem axis piston pumps
Capacity	2 × 117cc/rev
Maximum pressure	350kgf/cm² (4980psi) [380 kgf/cm² (5400 psi)]
Rated oil flow	$2 \times$ 228.15 ℓ /min (60.3U.S. gpm/ 50.2U.K. gpm)
Rated speed	1950 rpm

^{[]:} Power boost

3) GEAR PUMP

Item	Specification
Туре	Fixed displacement gear pump single stage
Capacity	15 cc/rev
Maximum pressure	40 kgf/cm² (570 psi)
Rated oil flow	29.3 ℓ /min (7.7 U.S. gpm/6.4 U.K. gpm)

4) MAIN CONTROL VALVE

lane	Specification		
ltem	HX220 NL	HX220 NL Long reach	
Туре	9 spools two-block		
Operating method	Hydraulic pilot system		
Main relief valve pressure	350 kgf/cm² (4980 psi) [380 kgf/cm² (5400 psi)]		
Overload relief valve pressure	400 kgf/cm² (5690 psi)		

[]: Power boost

5) SWING MOTOR

Item	Specification
Туре	Two fixed displacement axial piston motor
Capacity	142.8 cc/rev
Relief pressure	265 kgf/cm² (3770 psi)
Braking system	Automatic, spring applied hydraulic released
Braking torque	63.3 kgf.m (458 ibf.ft)
Brake release pressure	20.9~35.5 kgf/cm² (297~505 psi)
Reduction gear type	2 - stage planetary

6) TRAVEL MOTOR

Item	Specification
Туре	Variable displacement axial piston motor
Relief pressure	350 kgf/cm² (4980 psi)
Reduction gear type	2-stage planetary
Braking system	Automatic, spring applied hydraulic released
Brake release pressure	16.1 kgf/cm² (229 psi)
Braking torque	68.8 kgf · m (498 lbf · ft)

7) REMOTE CONTROL VALVE

Item		Specification
Туре		Pressure reducting type
Operating proceure	Minimum	6.5 kgf/cm² (92 psi)
Operating pressure	Maximum	25 kgf/cm² (360 psi)
Cingle eneration stroke	Lever(1, 3 port)	90 mm (3.5 in)
Single operation stroke	Pedal(2, 4 port)	130 mm (4.4 in)

8) CYLINDER

	Specification		
Decree Parks		Bore dia \times Rod dia \times Stroke	Ø120ר 85×1290 mm
Boom cylinder		Cushion	Extend only
Arm ordindor		Bore dia \times Rod dia \times Stroke	Ø140ר100×1510 mm
Arm cylinder		Cushion	Extend and retract
Puokot avlindor		Bore dia \times Rod dia \times Stroke	Ø120ר 85×1055 mm
Bucket cylinder		Cushion	Extend only
	1st	Bore dia \times Rod dia \times Stroke	∅120×∅ 85×1290 mm
Adjust been evilinder	151	Cushion	Extend only
Adjust boom cylinder	Ond	Bore dia \times Rod dia \times Stroke	Ø160ר100×1060 mm
	2nd	Cushion	-

^{**} Discoloration of cylinder rod can occur when the friction reduction additive of lubrication oil spreads on the rod surface.

9) SHOE

Iten	n	Width	Width Ground pressure Link quantity		Overall width
LINGOOAH	Standard	500 mm (20")	0.57 kgf/cm² (8.11 psi)	49	2500 mm (8' 2")
MONO BOOM Option	600 mm (24")	0.48 kgf/cm² (6.83 psi)	49	2600 mm (8' 6")	
	Option	700 mm (28")	0.42 kgf/cm² (5.97 psi)	49	2700 mm (8' 10")
HX220 NL	Standard	500 mm (20")	0.59 kgf/cm² (8.39 psi)	49	2500 mm (8' 2")
ADJUST BOOM	Option	600 mm (24")	0.49 kgf/cm² (6. 97psi)	49	2600 mm (8' 6")

^{*} Discoloration does not cause any harmful effect on the cylinder performance.

10) BUCKET

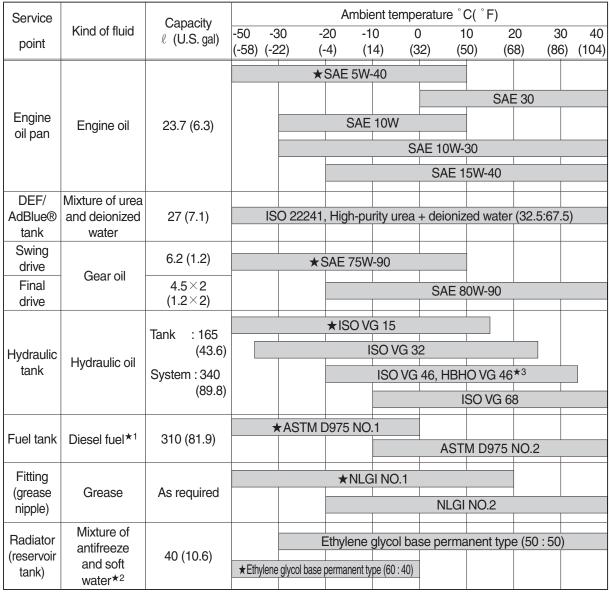
Itom	Capa	acity	Tooth	Width		
Item	SAE heaped	CECE heaped	quantity	Without side cutter	With side cutter	
	0.80 m³ (1.05 yd³)	0.70 m ³ (0.92 yd ³)	5	1070 mm (42.1")	1160 mm (45.7")	
	0.87 m³ (1.14 yd³)	0.76 m ³ (0.99 yd ³)	5	1140 mm (44.9")	1230 mm (48.4")	
	0.92 m³ (1.20 yd³)	0.80 m³ (1.05 yd³)	5	1190 mm (46.9")	1280 mm (50.4")	
	1.10 m³ (1.44 yd³)	0.96 m ³ (1.26 yd ³)	5	1375 mm (54.1")	1465 mm (57.7")	
HX220 NL	1.20 m³ (1.57 yd³)	1.05 m³ (1.37 yd³)	5	1390 mm (54.7")	1480 mm (58.3")	
	1.34 m³ (1.75 yd³)	1.17 m³ (1.53 yd³)	6	1525 mm (60.0")	1615 mm (63.6")	
	◆0.90 m³ (1.18 yd³)	0.79 m³ (1.03 yd³)	5	1210 mm (47.6")	_	
	€1.05 m³ (1.37 yd³)	0.92 m³ (1.20 yd³)	5	1355 mm (53.3")	_	
	⊙0.87 m³ (1.14 yd³)	0.77 m³ (1.01 yd³)	5	1195 mm (47.0")	_	

: Heavy duty bucket : Rock-heavy duty bucket

9. RECOMMENDED OILS

HD Hyundai Construction Equipment genuine lubricating oils have been developed to offer the best performance and service life for your equipment. These oils have been tested according to the specifications of HD Hyundai Construction Equipment and, therefore, will meet the highest safety and quality requirements.

We recommend that you use only HD Hyundai Construction Equipment genuine lubricating oils and grease officially approved by HD Hyundai Construction Equipment.



SAE : Society of Automotive Engineers

API : American Petroleum Institute

ISO: International Organization for Standardization

NLGI: National Lubricating Grease Institute

ASTM: American Society of Testing and Material

UTTO: Universal Tractor Transmission Oil

DEF: Diesel Exhaust Fluid, DEF compatible with AdBlue®

★ : Cold regionRussia, CIS, Mongolia

★1: Ultra low sulfur diesel

- sulfur content ≤ 15 ppm

★2: Soft water

City water or distilled water

★3: HD Hyundai Construction Equipment Bio Hydraulic Oil

- We Using any lubricating oils other than HD Hyundai Construction Equipment genuine products may lead to a deterioration of performance and cause damage to major components.
- * Do not mix HD Hyundai Construction Equipment genuine oil with any other lubricating oil as it may result in damage to the systems of major components.
- * Do not use any engine oil other than that specified above, as it may clog the diesel particulate filter(DPF).
- * For HD Hyundai Construction Equipment genuine lubricating oils and grease for use in regions with extremely low temperatures, please contact HD Hyundai Construction Equipment dealers.

SECTION 2 STRUCTURE AND FUNCTION

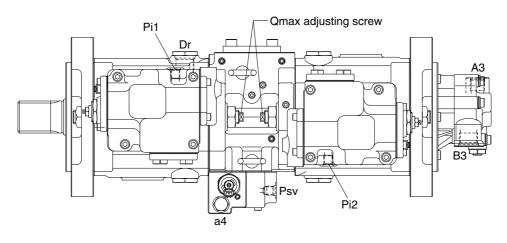
Group	1 Pump Device ·····	2-1
Group	2 Main Control Valve	2-20
Group	3 Swing Device	2-47
Group	4 Travel Device	2-58
Group	5 RCV Lever	2-72
Group	6 RCV Pedal ·····	2-79

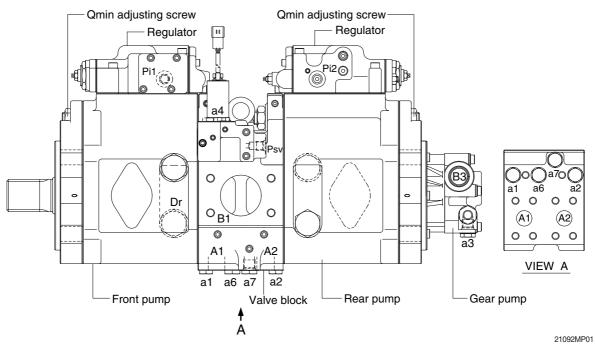
SECTION 2 STRUCTURE AND FUNCTION

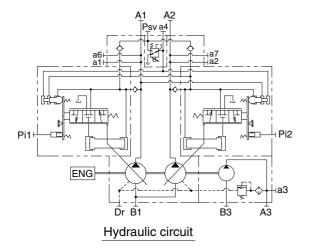
GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, regulator and gear pump.



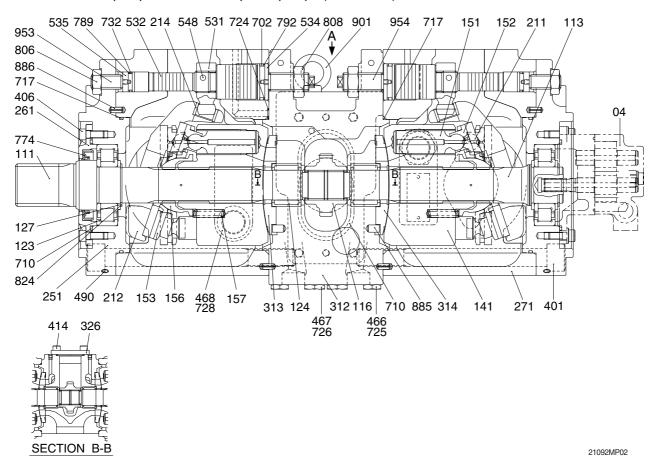




Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 1"
B1	Suction port	SAE2500psi 2 1/2"
Dr	Drain port	PF 3/4 - 20
Pi1,i2	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
a1,2,4	Gauge port	PF 1/4 - 15
a6, 7	Gauge port	PF 3/8-17
аЗ	Gauge port	PF 1/4-14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

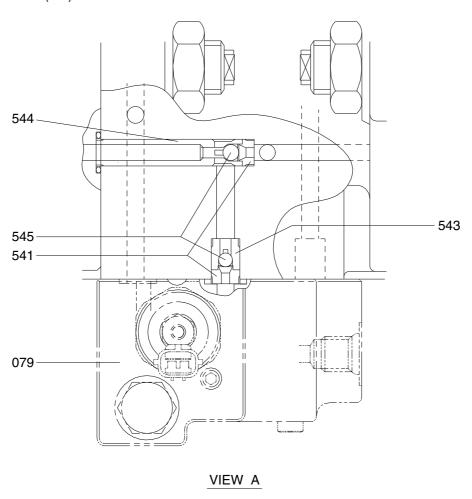
1) MAIN PUMP (1/2)

The main pump consists of two piston pumps (front & rear) and valve block.



04	Gear pump	271	Pump casing	710	O-ring
	• •		. •		•
111	Drive shaft (F)	312	Valve block	717	O-ring
113	Drive shaft (R)	313	Valve plate (R)	724	O-ring
116	Gear	314	Valve plate (L)	725	O-ring
123	Roller bearing	326	Cover	726	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Bearing spacer	406	Hexagon socket bolt	732	O-ring
141	Cylinder block	414	Hexagon socket bolt	774	Oil seal
151	Piston	466	VP Plug	789	Back up ring
152	Shoe	467	VP plug	792	Back up ring
153	Set plate	468	VP Plug	806	Hexagon head nut
156	Bushing	490	Plug	808	Hexagon head nut
157	Cylinder spring	531	Tilting pin	824	Snap ring
211	Shoe plate	532	Servo piston	885	Pin
212	Swash plate	534	Stopper (L)	886	Spring pin
214	Bushing	535	Stopper (S)	901	Eye bolt
251	Support	548	Pin	953	Set screw
261	Seal cover (F)	702	O-ring	954	Set screw

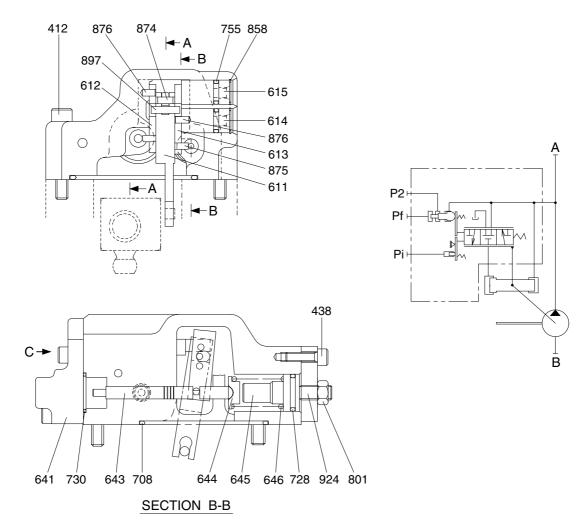
MAIN PUMP (2/2)



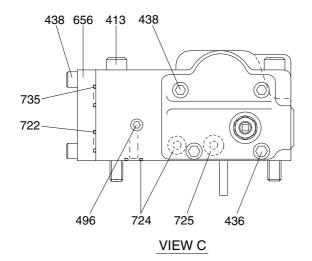
21092MP08

O79 Proportional reducing valve
543 Stopper 1
545 Steel ball
541 Seat
544 Stopper 2

2) REGULATOR (1/2)

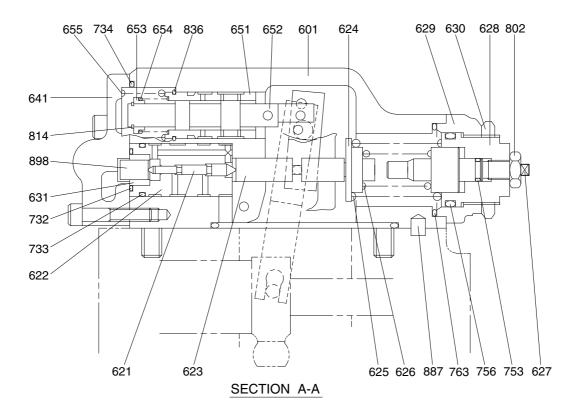






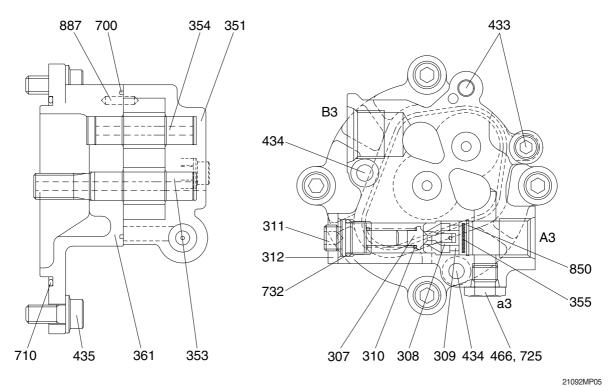
Port	Port name	Port size
Α	Delivery port	1"
В	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
Pf	Power shift port	-
P2	Companion delivery port	-

REGULATOR (2/2)



412	Hexagon socket screw	630	Lock nut	733	O-ring
413	Hexagon socket screw	631	Sleeve, pf	734	O-ring
436	Hexagon socket screw	641	Pilot cover	735	O-ring
438	Hexagon socket screw	643	Pilot piston	753	O-ring
496	Plug	644	Spring seat (Q)	755	O-ring
601	Casing	645	Adjust stem (Q)	756	O-ring
611	Feed back lever	646	Pilot spring	763	O-ring
612	Lever (1)	651	Sleeve	801	Nut
613	Lever (2)	652	Spool	802	Nut
614	Fulcrum plug	653	Spring seat	814	Snap ring
615	Adjust plug	654	Return spring	836	Snap ring
621	Compensator piston	655	Set spring	858	Snap ring
622	Piston case	656	Block cover	874	Pin
623	Compensator rod	708	O-ring	875	Pin
624	Spring seat (C)	722	O-ring	876	Pin
625	Outer spring	724	O-ring	887	Pin
626	Inner spring	725	O-ring	897	Pin
627	Adjust stem (C)	728	O-ring	898	Pin
628	Adjust screw (C)	730	O-ring	924	Set screw
629	Cover (C)	732	O-ring		

3) GEAR PUMP



307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Spring seat	355	Filter	710	O-ring
310	Spring	361	Front case	725	O-ring
311	Screw	433	Flange socket	732	O-ring
312	Nut	434	Flange socket	850	Snap ring
351	Gear case	435	Flange socket	887	Pin

2. FUNCTION

1) MAIN PUMP

The pumps may classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

(1) Rotary group

The rotary group consists of drive shaft (F) (111), cylinder block (141), piston shoes (151,152), set plate (153), spherical bushing (156) and cylinder spring (157). The drive shaft is supported by bearing (123,124) at its both ends.

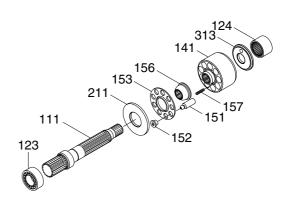
The shoe is caulked to the piston to from a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and the take hydraulic balance so that it slides lightly over the shoe plate (211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush. Similarly, the cylinder block is pressed against valve plate (313) by the action of the cylinder spring.

(2) Swash plate group

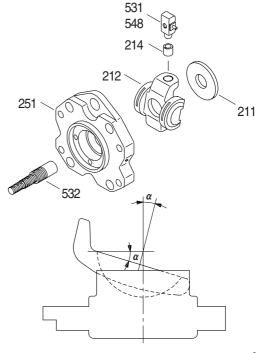
The swash plate group consists of swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and servo piston (532).

The swash plate is a cylindrical part formed on the opposite side of the sliding surface of the shoe and is supported by the swash support.

If the servo piston moves to the right and left as hydraulic force controlled by the regulator is admitted to hydraulic chamber located on both sides of the servo piston, the swash plate slides over the swash plate support via the spherical part of the tilting pin to change the tilting angle ()



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2-7

(3) Valve block group

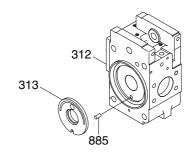
The valve block group consists of valve block (312), valve plate (313) and valve plate pin(885).

The valve plate having two melon-shaped ports is fixed to the valve block and feeds and collects oil to and from the cylinder block.

The oil changed over by the valve plate is connected to an external pipeline by way of the valve block.

Now, if the drive shaft is driven by a prime mover (electric motor, engine, etc), it rotates the cylinder block via a spline linkage at the same time. If the swash plate is tilted as in Fig (previous page) the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block.

If you pay attention to a single piston, it performs a motion away from the valve plate (oil sucking process) within 180 degrees, and makes a motion towards the valve plate (or oil discharging process) in the rest of 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.



2) REGULATOR

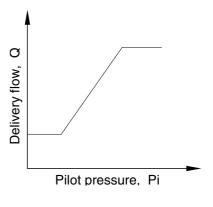
Regulator consists of the positive flow control, constant horse power control and variable horse power control function.

(1) Positive flow control

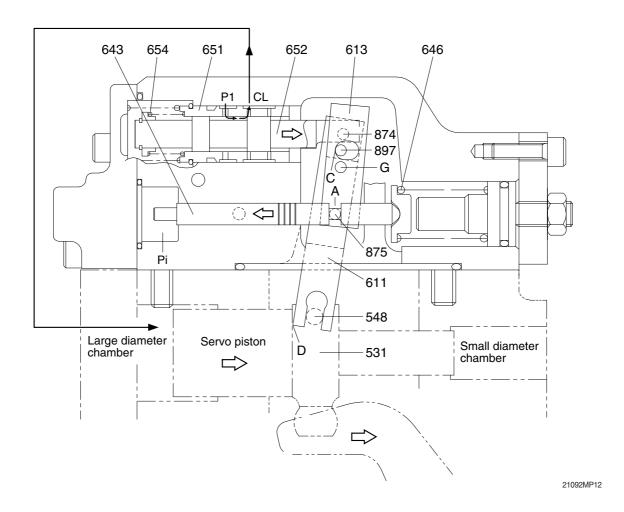
By changing the pilot pressure Pi, the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

This regulator is of the positive flow control in which the delivery flow Q increases as the pilot pressure Pi rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.



① Flow reducing function



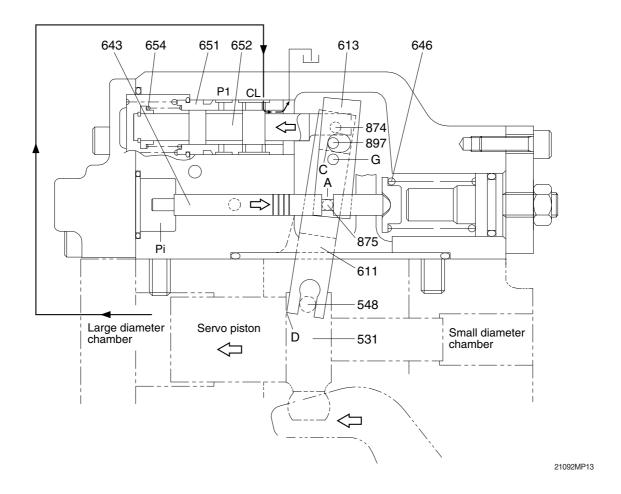
As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point G. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the right.

The movement of the spool causes the delivery pressure P1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P1 that is constantly admitted to the small diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring (654) and is tensioned to the left at all times, and so the pin (897) is pressed against the large hole section (C) of lever 2.

Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve (651) and spool (652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

② Flow increasing function



As the pilot pressure Pi rises, the pilot piston (643) moves to the right to a position where the force of the pilot spring (646) balances with the hydraulic force.

The groove (A) in the pilot piston is fitted with the pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point G [fixed by the fulcrum plug (614) and pin (875)]. Since the large hole section (C) of lever 2 contains a protruding pin (897) fixed to the feedback lever (611), the pin (897) moves to the left as lever 2 rotates.

Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P1 in the small diameter section, resulting in an increase in the flow rate.

As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

Adjustment of flow control characteristic

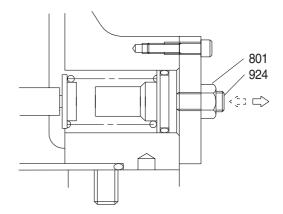
The flow control characteristic can be adjusted with the adjusting screw.

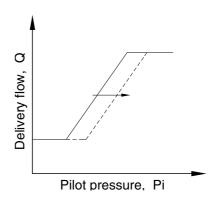
Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the hexagonal socket head screw (924).

Tightening the screw shifts the control chart to the right as shown in the figure.

* Adjusting value

		nent of flow characteristic	
Speed	Tightening amount of adjusting screw(924)	Flow control starting pressure change amount	Flow change amount
(min ⁻¹)	(Turn)	(kgf/cm²)	(l /min)
1900	+1/4	+1.0	-17.6





(2) Constant horsepower control

The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump.

(The input horsepower is constant when the speed is constant.)

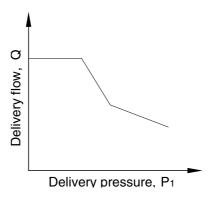
Since the regulator is of the simultaneous constant horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.

Since this regulator is of the simultaneous constant horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation:

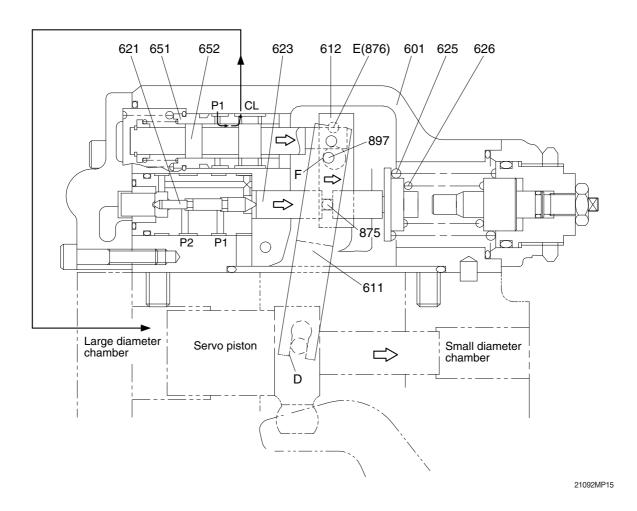
$$Tin = P1xq/2 + P2xq/2$$

= $(P1+P2)xq/2$

The horsepower control function is the same as the flow control function and is summarized in the following. (for detailed behaviors of respective parts, refer to the section of flow control).



① Overload preventive function

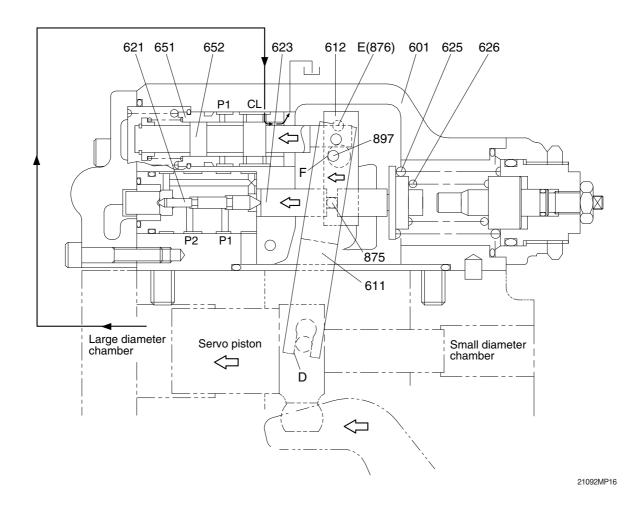


When the self pump delivery pressure P1 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1 (612) via pin (875).

Lever 1 rotates around the pin (876) (E) fixed to the casing (601).

Since the large hole section (F) of lever 1 contains a protruding pin (897) fixed to the feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded. The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool (652) and sleeve (651) is closed.

② Flow reset function



As the self pump delivery pressure P1, the compensating rod (623) is pushed back by the action of the springs (625 & 626) to rotate lever 1 (612) around point E. Rotating of lever 1 causes the feedback lever (611) to rotate around the fulcrum of point D and then the spool (652) to move to the left. As a result, port CL opens a way to the tank port.

This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

3 Low tilting angle (low flow) command preferential function

As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins (\emptyset 4) protruding from the large hole (\emptyset 8), only the lever lessening the tilting angle contacts the pin (897); the hole (\emptyset 8) in the lever of a larger tilting angle command is freed without contacting the pin (897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

Adjustment of input horsepower

4

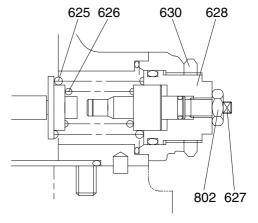
a. Adjustment of outer spring

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure.

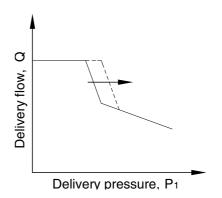
Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting stem C (627) by N×A turns at first.(A=1.78)

* Adjusting value

	Adjustment of input horsepower						
Speed	Tightening amount of adjusting screw(627)	Compensating control starting pressure change amount	Input torque change amount				
(min ⁻¹)	(Turn)	(kgf/cm ²)	(kgf·m)				
1900	+1/4 +15.9 +4.0						



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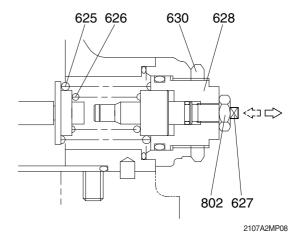
b. Adjustment of inner spring

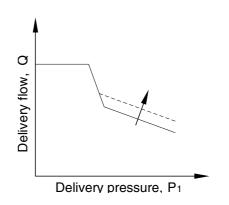
Adjust it by loosening the hexagon nut (802) and by tightening (or loosening) the adjusting stem C (627).

Tightening the screw increases the flow and then the input horsepower as shown in the figure.

* Adjusting valve

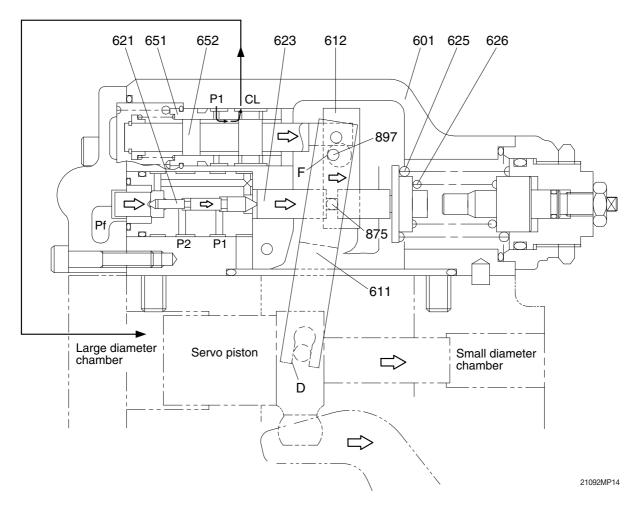
	Adjustment of input horsepower			
Speed	Tightening amount of adjusting stem (C) (627)	Flow change amount	Input torque change amount	
(min ⁻¹)	(Turn)	(l /min)	(kgf·m)	
1900	+1/4	+11.3	+4.7	





(3) Variable horsepower control

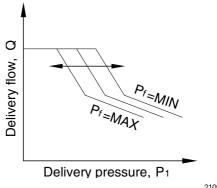
Variable horsepower control can be obtained by supplying pilot pressure.



The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.

Only one proportional pressure reducing valve is provided.

However, the secondary pressure Pf (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.



21002MP20

This function permits arbitrary setting of the pump output power, thereby providing the optimum power level according to the operating condition.

The power shift pressure Pf controls the set horsepower of the pump to a desired level, as shown in the figure.

As the power shift pressure Pf rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621).

This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure Pf falls.

(4) Adjustment of maximum and minimum flows

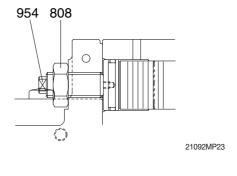
The regulator can adjust the maximum and minimum flows with the adjusting screws.

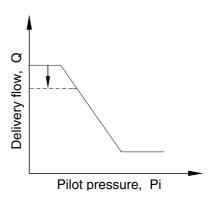
① Adjustment of maximum flow

Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

The maximum flow only is adjusted without changing other control characteristics.

01	Adjustment of max flow			
Speed	Tightening amount of adjusting screw (954)	Flow change amount		
(min -1)	(Turn)	(l /min)		
1900 +1/4		-5.5		





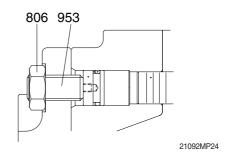
21092MP21

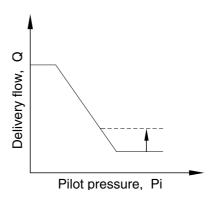
2 Adjustment of minimum flow

Adjust it by loosening the hexagon nut (806) and by tightening (or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.

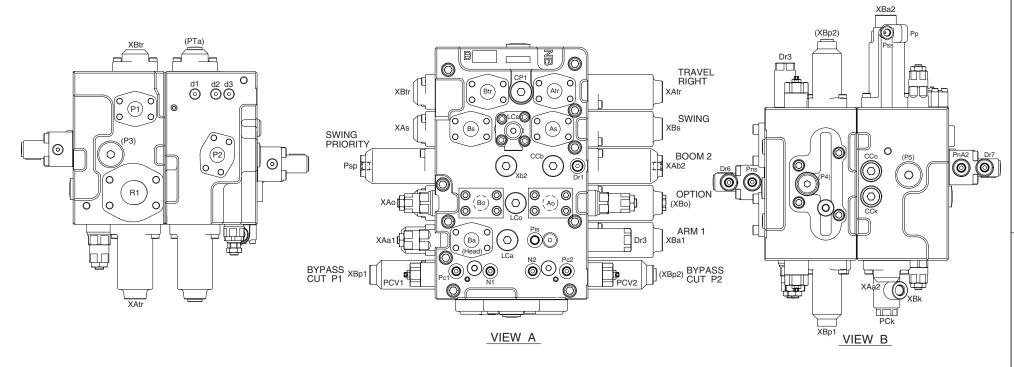
	Adjustment of min flow		
Speed	Tightening amount of adjusting screw (953)	Flow change amount	
(min -1)	(Turn)	(½ /min)	
1900	+1/4	+4.4	

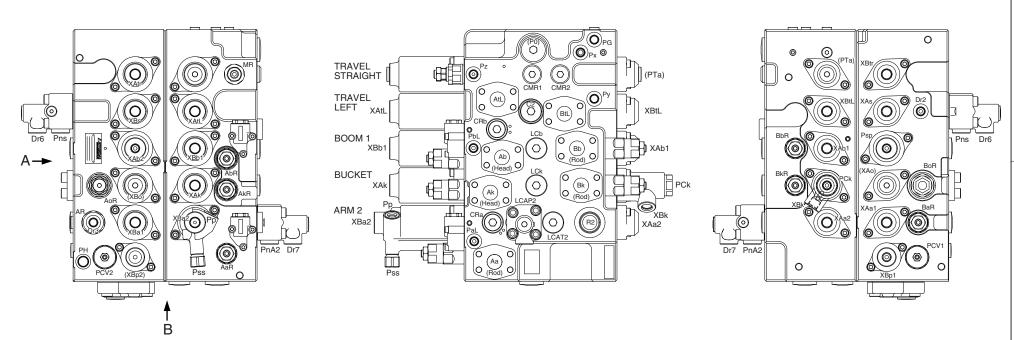




GROUP 2 MAIN CONTROL VALVE

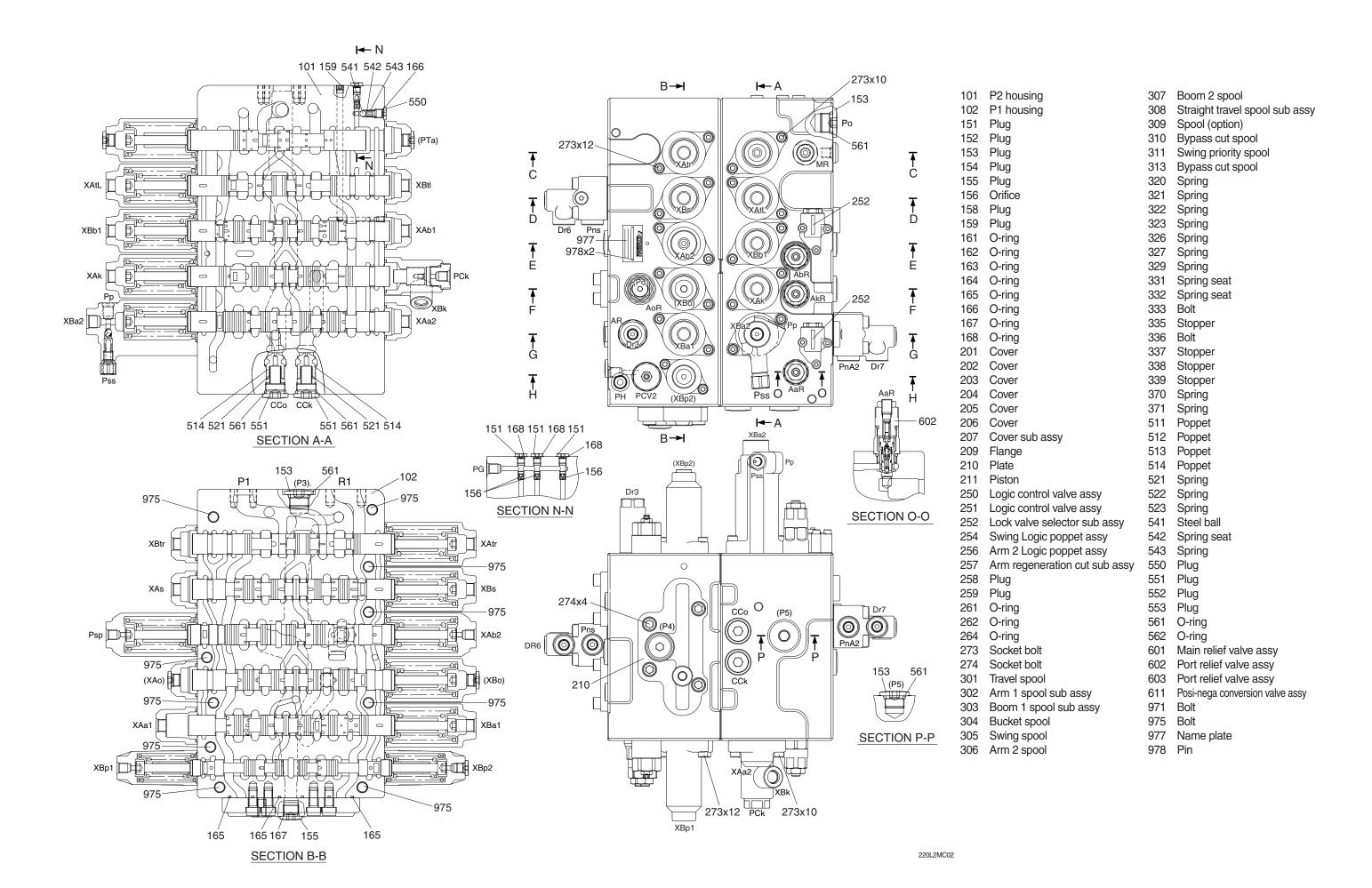
1. STRUCTURE

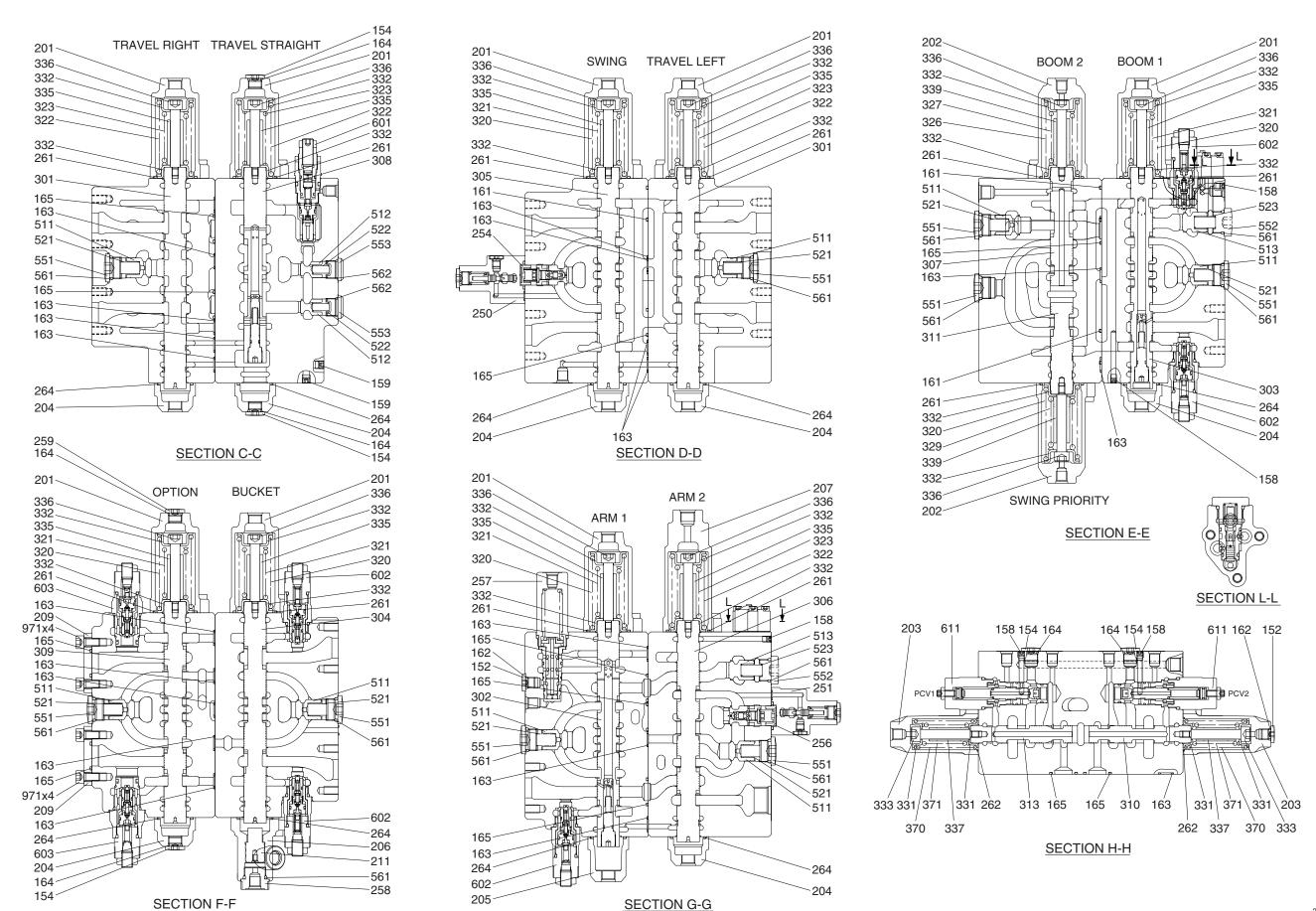




Mark	Port name	Port size	Tightening torque
R2	Make up port for swing	PF 1	20~25kgf · m (115~180lbf · ft)
XAtr XBtr (XAo) (XBo) XAk XBk XAb1 XBa2 XAtL XBs XBs XAa1 XBs XAa1 PH Dr1	Travel right (reverse) pilot port Travel right (forward) pilot port Optional pilot port Optional pilot port Bucket in pilot port Bucket out pilot port Boom up pilot port Boom down pilot port Arm out confluence pilot port Arm in confluence pilot port Travel left (reverse) pilot port Travel left (forward) pilot port Swing left pilot port Arm out pilot port Arm out pilot port Pilot port Arm in pilot port Arm in pilot port Arm in pilot port Arm in pilot port Pilot pressure port Drain port	PF 3/8	7~8kgf · m (50.6~57.8lbf · ft)
Px Py Pz PG Dr3 Dr6 Dr7 Pns PaL PbL XAb2 Psp XBp1 (XBp2) Pc1 Pc2 PCk Pis N1 N2 Psp PnA2 Psp PnA2 Psp PnA2 Psp	Pressure port for attachment Pressure port for travel Main relief pilot pressure port Pilot pressure port Drain port Drain port Drain port Drain port Swing logic valve pilot port Lock valve pilot port (arm rod side) Lock valve pilot port (boom head side) Boom up confluence pilot port Swing priority pilot port Bypass cut spool pilot port (P1 side) Bypass cut spool pilot port (P2 side) Posi-nega pressure port (P1 side) Posi-nega pressure port (P2 side) Bucket in stroke limiter pilot port Arm regeneration cut pilot port Arm1 Nega-con pressure port Boom1 Nega-con pressure port Arm2 logic valve pilot signal Swing pilot signal	PF 1/4	3.5~3.9kgf ⋅ m (25.3~28.2lbf ⋅ ft)
Atr Btr (Ao) (Bo) Ak Bk Ab Bb AtL BtL As Bs Aa Ba P1	Travel motor right side (reverse) port Travel motor right side (forward) port Optional port Optional port Bucket cylinder head side port Bucket cylinder rod side port Boom cylinder head side port Boom cylinder rod side port Travel motor left side (reverse) port Travel motor left side (forward) port Swing motor left port Swing motor right port Arm cylinder rod side port Arm cylinder head side port Pump port (P1 side) Pump port (P2 side)	M10	5~6.6kgf · m (36.1~47.7lbf · ft)
R1	Return port	M12	8.5~11.2kgf · m (61.5~81.1lbf · ft)

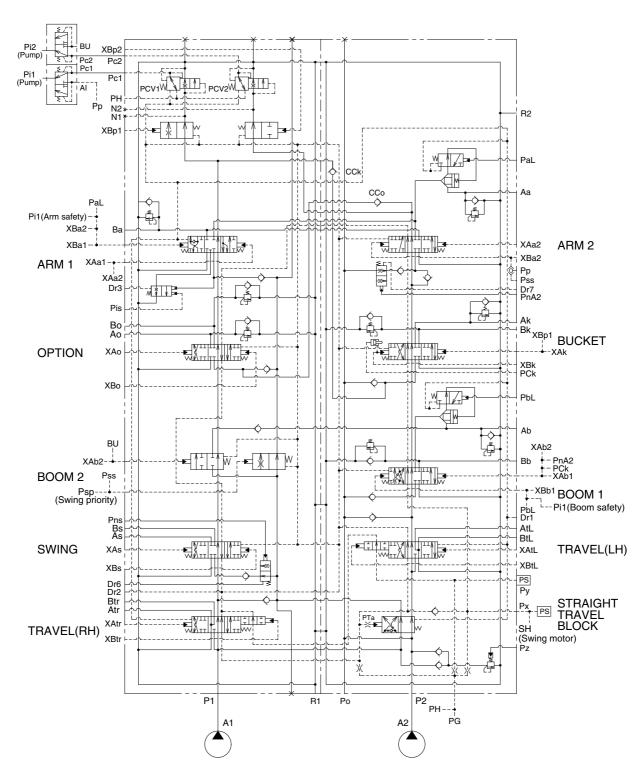
220L2MC01





220L2MC03

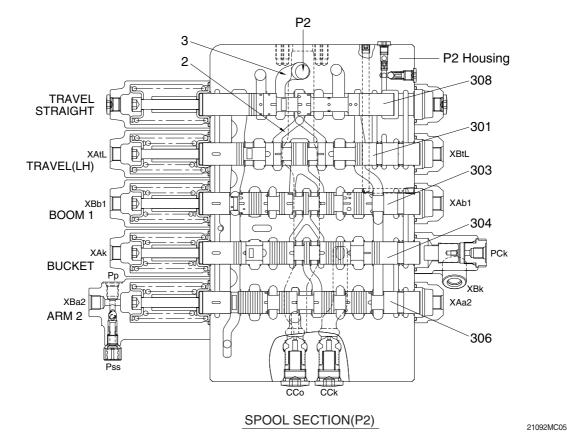
2. HYDRAULIC CIRCUIT

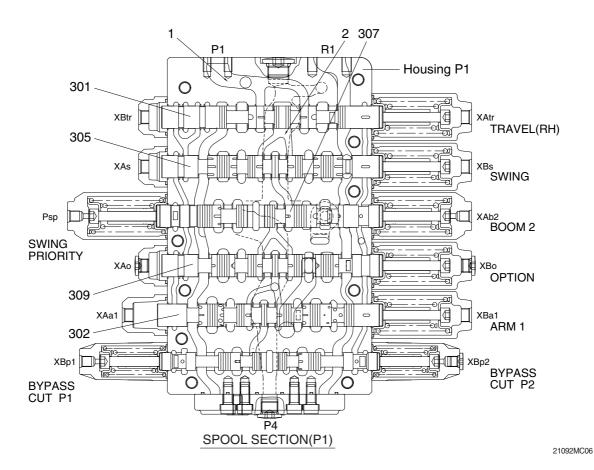


220L2MC04

3. FUNCTION

1) CONTROL IN NEUTRAL POSITION





When all spools are in the neutral positions, the pressurized oil discharged from the hydraulic pump (A1) passes through Port P1, the main path (1), the bypass circuit (2) passing the spools for travel right (301), swing (305), boom confluence (boom 2; 307), option (309) and arm 1 (302), and the arm 1 side posi-nega conversion valve (611), and returns to the hydraulic oil tank through the tank port (R1).

The positive control signal pressure (Pi1) of the arm 1 side posi-nega conversion valve (611) is led from Port Pc1 to the regulator (Pi1) on the hydraulic pump (A1) side, and controls the pump discharge flow rate to its minimum value.

The oil discharged from the hydraulic pump (A2) passes through Port P2, the main path (3), the bypass circuit (2) passing the spools for travel left (301), boom 1 (303), bucket (304) and arm 2 (306), and the boom1 side posi-nega conversion valve (611), and returns to the hydraulic oil tank through the tank port (R1).

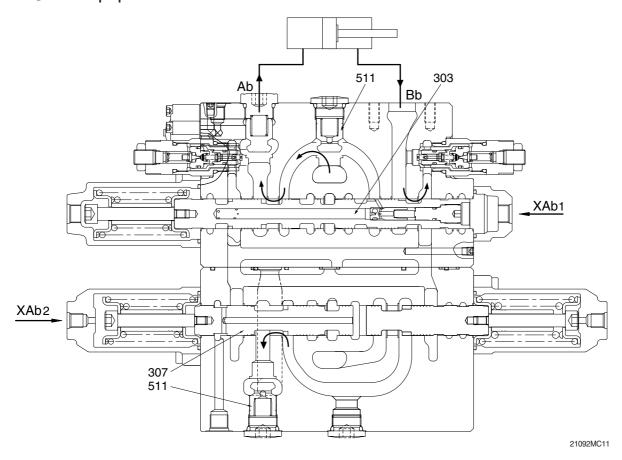
The positive control signal pressure (Pi2) of the boom 1 side posi-nega conversion valve (611) is led from Port Pc2 to the regulator (Pi2) on the hydraulic pump (A2) side, and controls the pump discharge flow rate to its minimum value.

When any of nine main spools is changed over, the bypass circuit (2) is cut off and the hydraulic oil at Port N1 or N2 in the negative control circuit is shut off.

2) EACH SPOOL OPERATION

(1) Boom control

① Boom up operation



Pilot circuit

Since the boom 1 spool (303) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

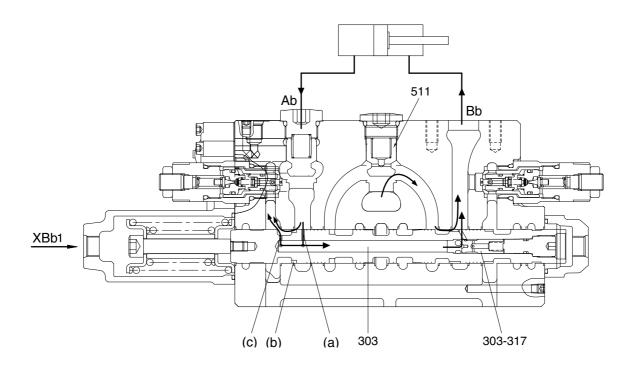
Main circuit

During the boom up operation, the pilot pressure enters through Port XAb1 and moves the boom 1 spool (303) in the left direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the boom 1 spool (303). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the boom 1 spool (303). Then, it flows around the periphery of the boom 1 spool (303) to Port Ab, and is supplied to the boom cylinder head side.

At the same time, the pilot pressure enters also through Port XAb2 to transfer the boom 2 spool (307) in the right direction. Though the pressurized oil enters into Port P1, the bypass circuit (2) is shut off due to transfer of the boom 2 spool (307). Therefore, the hydraulic oil flows in the parallel circuit and flows through the U-shaped path to the boom 2 spool (307). Then, the hydraulic oil passes through the periphery of the boom 2 spool (307), pushes open the check valve (511), joins into Port Ab in the inside path, and is supplied to the boom cylinder head side. (Boom confluent flow)

On the other hand, the return oil from the boom cylinder rod side enters through Port Bb and returns to the hydraulic oil tank through the tank port (R1).

② Boom down operation



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Pilot circuit

Since the boom 1 spool (303) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port PbL and the release signal is sent to the lock valve (252).

Main circuit

During the boom down operation, the pilot pressure enters through Port XBb1 and transfers the boom 1 spool (303) in the right direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the boom 1 spool (303). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the boom 1 spool (303). Then, it flows around the periphery of the boom 1 spool (303) to Port Bb and is supplied to the boom cylinder rod side.

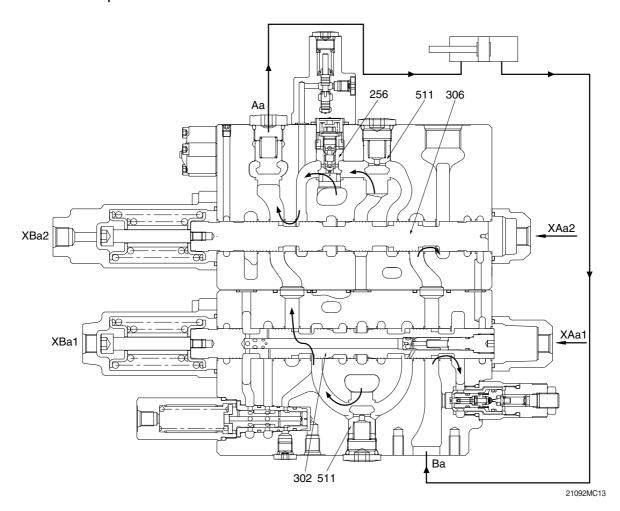
On the other hand, the return oil from the boom cylinder head side passes to the holes (a) and the notches (b) of the boom 1 spool (303).

Since this return oil has a sufficient pressure caused by the weight of the boom, it passes through the path inside the spool, pushes the poppet (303-317) in the spool in the right direction, flows around the outside of the spool. Then, it is supplied again to the boom cylinder rod side as hydraulic oil to lower the boom. (Boom regeneration)

Besides, a part of the return oil from the boom cylinder flows from the hole (c) into the tank.

(2) Arm control

① Arm out operation



Pilot circuit

Since the arm 2 spool (306) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the arm out operation, the pilot pressure enters through Ports XAa1 and XAa2. When the pressure enters through Port XAa1 and XAa2, the spools transfer in the left direction. The hydraulic oil entering through Port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool (302).

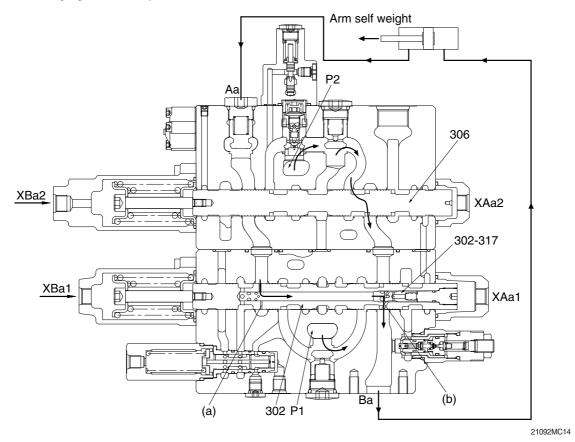
Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 1 spool (302). Then, it flows around the periphery of the arm 1 spool (302) and the arm 2 spool (306) to Port Aa, and is supplied to the arm cylinder rod side.

On the other hand, the hydraulic oil entering through Port P2 passes in the main path (3), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (306). The hydraulic oil from the parallel circuit pushes open the logic poppet (256) and the hydraulic oil from the bypass circuit (2) pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (306). Then, it flows around the periphery of the arm 2 spool (306) in the inside path and joins into Port Aa.

Besides, the return oil from the arm cylinder head side passes through Port Ba, flows into tank line in arm 1 side and in arm 2 side, and returns to the hydraulic oil tank through the tank port (R1).

② Arm in operation

· During light load only



Pilot circuit

Since the arm 2 spool (306) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port PaL and the release signal is sent to the lock valve (252).

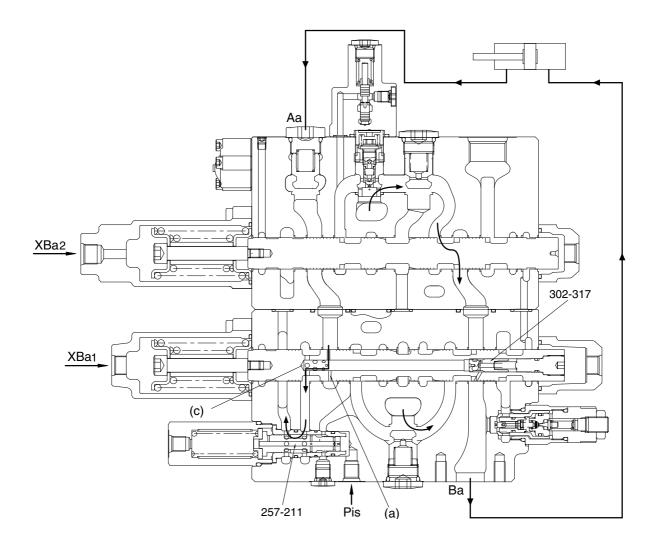
Main circuit

During the arm in operation, the pilot pressure enters through Ports XBa1 and XBa2. When the pressure enters through Port XBa1 and Port XBa2, the spools transfer in the right direction Fig. MC14. The hydraulic oil entering through Port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool (302). Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 1 spool (302). Then, it flows around the periphery of the arm 1 spool (302) to Port Ba, and is supplied to the arm cylinder head side.

On the other hand, the hydraulic oil entering through Port P2 passes in the main path (3), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (306). The hydraulic oil from the parallel circuit pushes open the logic poppet (256) and the hydraulic oil from the bypass circuit (2) pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (306). Then, it flows around the periphery of the arm 2 spool (306) and the arm 1 spool (302) in the inside path and joins into Port Ba.

Besides, the return oil from the arm cylinder rod side is pressurized by self-weight of the arms and so on, and returns to Port Aa. The pressurized oil returning to Port Aa enters into the spool through the periphery hole (a) of the arm 1 spool (302). During a light load only, it pushes open the check valve (302-317) and joins into Port Ba from the spool hole (b). The rest of oil returns to the hydraulic oil tank through the tank port (R1). This is called the arm regeneration function.

· The pressure in the arm cylinder head side increases

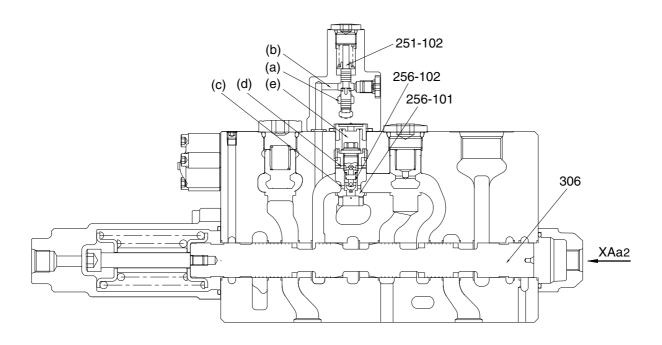


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When the pressure in the arm cylinder head side and the U-shaped path increases, the arm regeneration cut spool (257-211) is transferred in the left direction, and at the same time the check valve (302-317) is closed by its backpressure. This shuts off the arm regeneration function, and the return oil from the arm cylinder rod side enters from Port Aa through the periphery hole (a) of the arm 1 spool (302) into the spool, flows to the arm regeneration cut valve (257) through the periphery hole (c) of the arm 1 spool (302), and returns through the tank port (R1) to the hydraulic oil tank.

When the Pilot Port Pis of the arm regeneration cut spool (257-211) is pressurized, a part of the return oil from the arm cylinder rod side flows to the arm regeneration cut valve (257) and returns through the tank port (R1) to the hydraulic oil tank. (Variable arm regeneration)

3 Arm 2 logic control valve operation



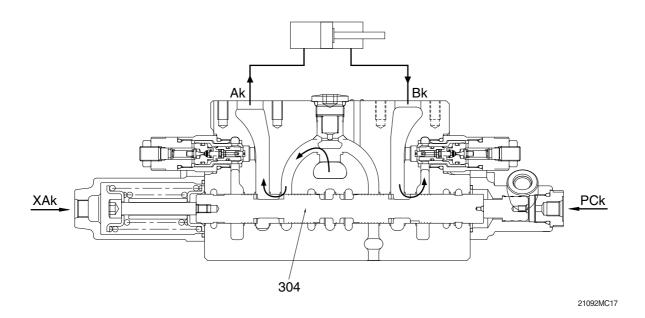
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During both the arm in operation and the boom up operation, the pilot pressure enters through Ports XBa1, XBa2, XAb1, XAb2, PaL and PnA2. The pressure PnA2 transfers the spool (251-102) in the arm 2 logic control valve to the top direction, and the path from (a) to (b) is closed. Hereby, the pressurized oil pushes open the poppet (256-102), passes in the path (c) and (d), enters into the chamber (e), and the poppet (256-101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through Port P2 flows to the boom 1 spool (303) than the arm 2 spool (306) to make the boom hoisting operation most preferential.

On the other hand, in the independent arm in operation, the pilot pressure does not enter through Ports PnA2, and the path from (a) to (b) is not closed, and the hydraulic oil of the chamber (e) flows to the path (a) and (b). The pressurized oil entering through Port P2 pushes open the poppet (256-101) and flows to the arm 2 spool (306).

(3) Bucket control

① Bucket in operation



Pilot circuit

Since the bucket spool (304) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port XBp1.

Main circuit

During the bucket in operation, the pilot pressure enters through Port XAk and transfers the bucket spool (304) in the right direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bucket spool (304). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to Port Ak and is supplied to the bucket cylinder head side.

On the other hand, the return oil from the bucket cylinder rod side enters through Port Bk, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (R1).

During both the boom up operation and bucket in operation, the pilot pressure enters through Port PCk and the bucket spool transfers in the half stroke not full stroke. Therefore, the most of pressurized oil entering through Port P2 flows to the boom 1 spool (303) than the bucket spool (304) to make the boom up operation most preferential.

② Bucket out operation

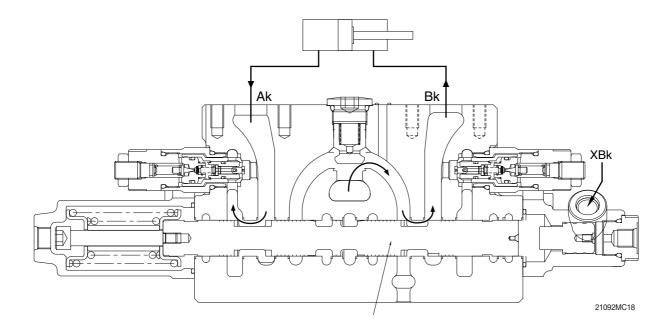
Pilot circuit

Since the bucket spool (304) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the bucket out operation, the pilot pressure enters through Port XBk and transfers the bucket spool (304) in the left direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bucket spool (304). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to Port Bk and is supplied to the bucket cylinder rod side.

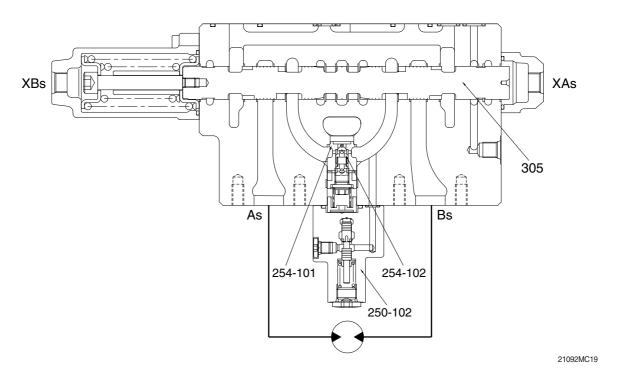
On the other hand, the return oil from the bucket cylinder head side enters through Port Ak, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (R1).



3 Bucket in confluence

During the bucket in operation, the pilot pressure enters also through Port XBp1 and transfers the bypass-cut spool (313). The pressurized oil entering through Port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bypass-cut spool (313). Therefore, the pressurized oil pushes open the check valve CCk (514), and flows through inside path and the U-shaped path to the bucket spool (304).

(4) Swing control



Swing operation

Pilot circuit

Since the swing spool (305) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the swing operation, the pilot pressure enters through Port XAs (or XBs) and transfers the swing spool (305). The pressurized oil entering through Port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the swing spool (305). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the swing spool (305). Then, it flows through the periphery of the spool to Port As (or Bs) and is supplied to the swing motor.

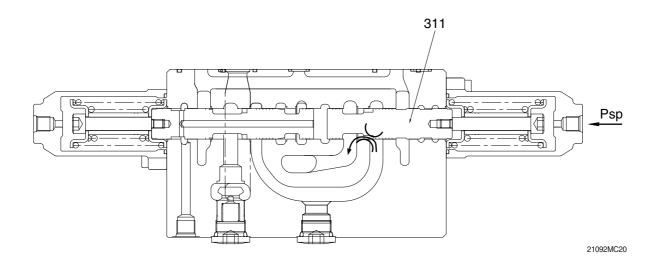
On the other hand, the return oil from the swing motor enters Port Bs (or As) and returns to the hydraulic oil tank through the tank port (R1).

2 Swing logic control valve operation

During both the swing operation and the boom up operation, the pilot pressure enters through Ports XBs (or XAs), XAb1, XAb2 and Pns. The pressure Pns transfers the spool (250-102) in swing logic control valve. Hereby, the pressurized oil pushes open the poppet (254-102), and the poppet (254-101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through Port P1 flows to the boom 2 spool (307) than the swing spool (305) to make the boom up operation most preferential.

On the other hand, in the independent swing operation, the pilot pressure does not enter through Ports Pns. The pressurized oil entering through Port P1 pushes open the poppet (254-101) and flows to the swing spool (305).

3 Swing operation preference function



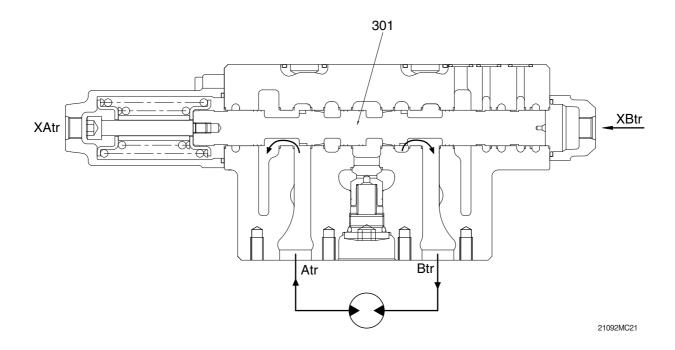
Pilot circuit

The pilot pressure enters through Port Psp to transfer the swing priority spool (311).

Main circuit

Due to transfer of the swing priority spool (311), the open area of the swing priority spool decreases, and the most of the pressurized oil entering through Port P1 flows to the swing side to make the swing operation most preferential.

(5) Travel control



Pilot circuit

Since any of the travel spools (301) on the left or right transfers and shuts off the side-bypass path, the pressure at Port Py increases.

Main circuit

When Pilot Port XBtr of the travel right spool (301) is pressurized, the bypass circuit (2) in the arm 1 side is shut off and the working fluid discharged from the hydraulic pump (A1) through Port Btr and flows to the travel right motor.

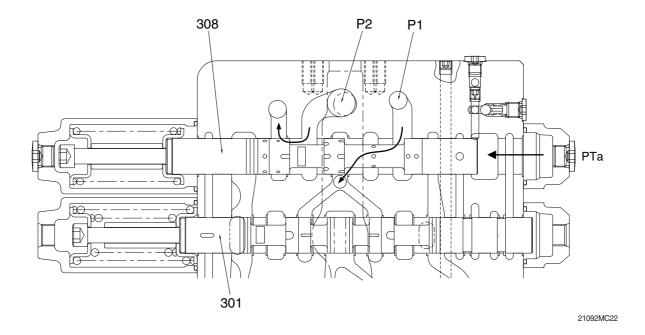
When Pilot Port XBtL of the travel left spool (301) is pressurized, the bypass circuit (2) in the boom 1 side is shut off and the working fluid discharged from the hydraulic pump (A2), similarly to that from the hydraulic pump (A1), through Port BtL and flows to the travel left motor.

On the other hand, the return oil from the right and left travel motor passes flows from Port Atr (AtL) to the travel right (left) spools (301) and returns to the hydraulic oil tank through the tank port (R1). In the case of the opposite operation (when the pilot pressure is applied to Ports XAtr and XAtL of the control valve), the operation is similar.

(6) Travel straight operation

Simultaneous operating of both travel spools (301) and other spool.

A case where both travel spools (301) and swing spool (305) are changed over will be considered. (The pilot Ports XAtL, XAtr and XAs are pressurized.)



Pilot circuit

Since the side bypass sections of both travel spools (301) close and the side bypass section of the downstream-side swing closes, the pilot pressure from the port PG enters through the port PTa to transfer the travel straight spool (308).

Main circuit

After changeover of the travel straight spool (308), the port P1 and both travel spools (301) are connected preferentially and the port P2 and the parallel paths of swing, boom 2, option and arm 1 / boom 1, bucket and arm 2 are connected preferentially. Therefore, the pressurized oil entering through Port P1 passes through mainly ports AtL and Atr, and flows to both travel motors separately.

On the other hand, the pressurized oil entering through Port P2 flows to Port As and is supplied to the swing motor.

When the pressure of Port P1 is lower than the pressure of Port P2, the part of oil entering through Port P2 flows into Port P1 side. Therefore, it prevents the rapid slowdown of the travel.

3) FUNCTION OF LOCK VALVE

The lock valve (252) is fitted between the arm cylinder rod side and the arm 2 spool (306). It decreases the leakage by the pressure of the cylinder.

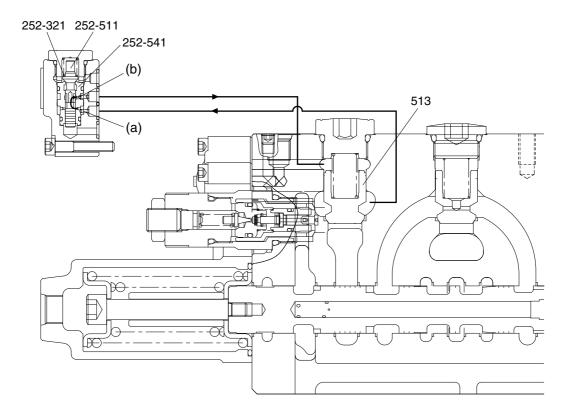
Another lock valve (252) is similarly fitted between the boom cylinder head side and the boom 1 spool (303). It decreases the leakage by the pressure of the cylinder.

(1) Neutral positions of spools

The following is the case of the boom 1 spool (303). (The case of the arm 2 spool (306) is in the same way.)

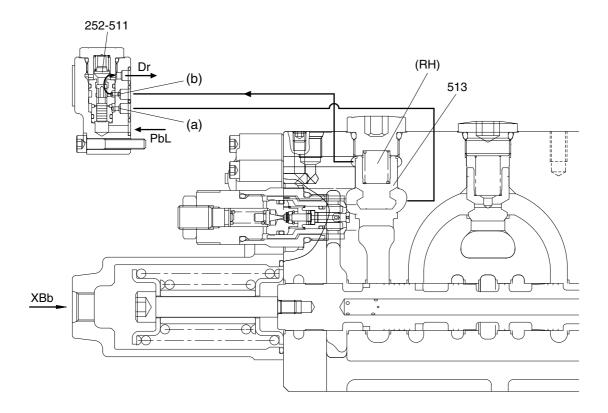
During the boom 1 spool (303) is in the neutral position, the lock valve (252) is kept in the position shown in figure. The spool (252-511) in the lock valve is pushed to the seat of the sleeve (252-541) by the force of the spring (252-321).

In this position, the pressurized oil from the boom cylinder head side enters through the hole (a), the periphery of the spool (252-511) in the lock valve and the hole (b), and it pushes the poppet (513) to the casing seat, and the leakage is decreased.



(2) Boom down operation

During the boom down operation, the pilot pressure enters through Port PbL and XBb1. The pilot pressure transfers the spool (252-511) in the lock valve assy in the top direction. By the transfer of the spool (252-511), firstly the hole (a) is blocked and the pressurized oil from the boom cylinder head side does not enter to the spring chamber (RH). Secondly, the oil in the spring chamber (RH) enters through the hole (b) and flows to drain circuit. Therefore, the poppet (513) is lifted by the pressure of the boom cylinder head side and the function of the lock valve (252) is released.



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(3) Boom up operation

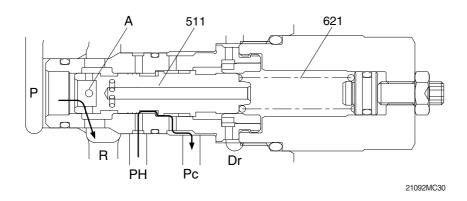
During the boom up operation, the pilot pressure enters through Port XAb1. The oil flowing from the boom 1 spool pushes open the poppet (513) and flows to Port Ab.

4) Posi-Nega Conversion Valve

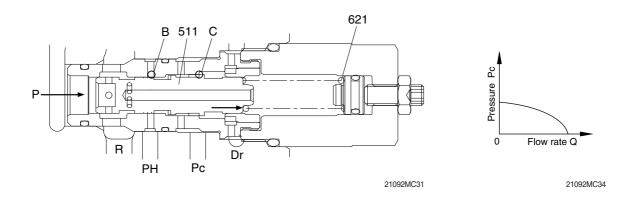
The posi-nega conversion valve is installed between the downstream of the center bypass path and the low-pressure path, and functions as follows:

(1) The delivery oil (flow rate Q) from the pump is led to the path P after passing the center by-pass path (2).

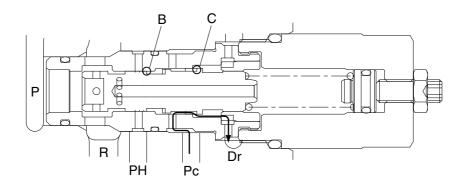
Then, it flows to the path R passing through the orifice A. On the other hand, the primary pressure oil from the port PH flows to the port Pc1 (or Pc2) through the periphery of the spool (511). On that occasion, the spool (511) remains to be pressed by the spring (621) if the pressure at the path P and the pressure at the port Pc1 (or Pc2) are below the preset pressure.



(2) When the flow rate Q increases and the pressure at the path P increases, the spool (511) begins to move to the right, and so adjusts the Pc1 (or Pc2) pressure at the notches of the path B and C that the pressure at the path P and the Pc1 (or Pc2) pressure are balanced with the spring (621) at the set pressure. When the pressure at the path P rises, the Pc1 (or Pc2) pressure is lowered. The relationship between the flow rate Q of the hydraulic oil flowing from the path P to the path R and the pressure at the port Pc1 (or Pc2) is as shown in graph.

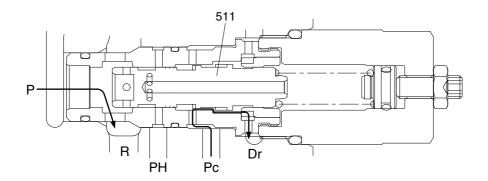


(3) The pressure at Pc1 (or Pc2) is used for the control of pump discharge flow rate, and the pump discharge flow rate can be reduced by lowering the Pc1 (or Pc2) port pressure.



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(4) If the flow rate Q increases more than required, the spool strokes to largely open the P-R line, generating the relieving condition.

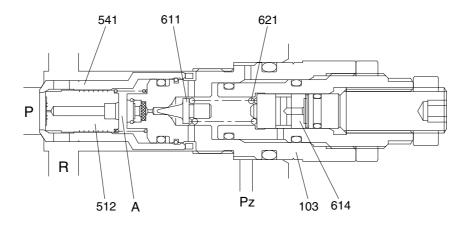


5) CIRCUIT PRESSURE PROTECTION

The control valve has two kinds of relief valve to limit the pressure in a circuit.

(1) Main relief valve

The main relief valve is fitted in the P2 housing and functions as follows.



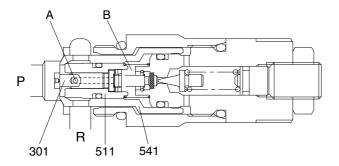
- ① The hydraulic oil is filled up in the inside space chamber (A) from the path (P) through a hole of the seat (541) and a restriction of the plunger (512), and seats the plunger (512) against the seat (541) securely.
- ② When the pressure in the path (R) becomes equal to the set load of the spring (621), the poppet (611) opens to make the hydraulic oil flow through a hole of the plug (103), around the poppet (611) and into the low pressure path (R).
- ③ Opening of the poppet (611) causes the pressure in the chamber (A) to fall and the plunger (512) to open. As the result the pressurized oil in the path (R) runs into the low pressure path (R) directly.
- When the pressurized oil higher than pressure 40 kgf/cm² enters through the port Pz, it pushes the piston (614) to change the relief set pressure of the spring (621) to the high pressure.

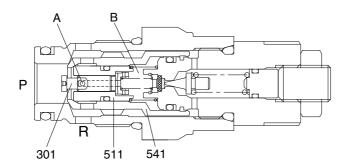
(2) Port relief valve

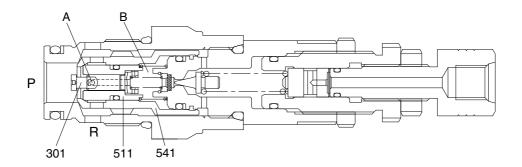
The port relief valve is fitted between the cylinder port and low-pressure path. In addition to the relief valve, this serves also as an anti-cavitation check valve, and functions as follows:

① Function as relief valve

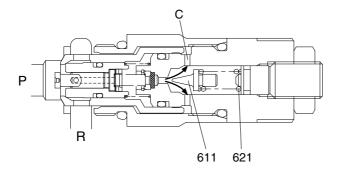
a. The pressurized oil passes through Hole A of the piston (301), is filled up in Chamber B of the inside space, and seat the plunger (511) against the seat (541) securely.

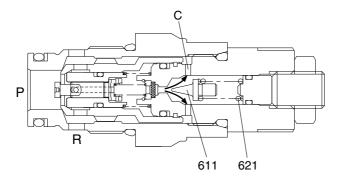


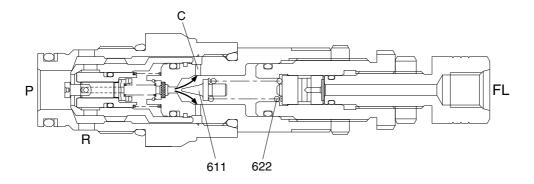




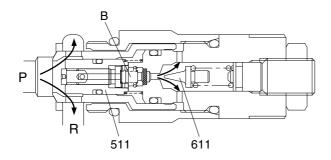
b. When the pressure in the path (P) becomes equal to the set pressure of the spring (621 or 622), the pressurized oil pushes open the poppet (611), flows around it, and flows to the low pressure path (R) through hole C.

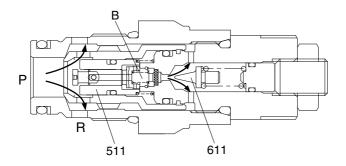


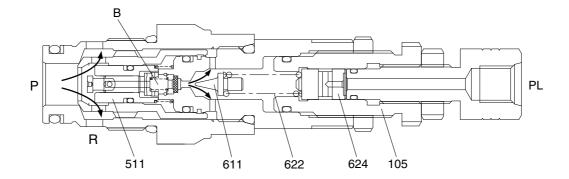




c. Opening of the poppet (611) causes the pressure in Chamber B to fall and the plunger (511) to open. As the result the pressurized oil in the path (P) runs into the low pressure path (R) directly.





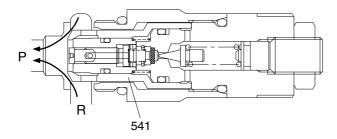


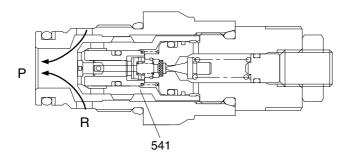
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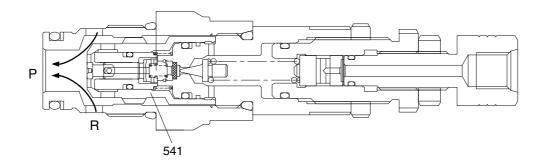
d. When the pressurized oil higher than pressure 25 kgf/cm² enters through the port PL, it pushes the piston (624) to change the relief set pressure of the spring (622) to the high pressure.

2 Function as Anti-Cavitation Check Valve

When any negative pressure exists in the path (P), the oil is supplied through the path (R). When the pressure at (R) becomes higher than that in the path (P), the seat (541) moves in the right direction. Then, sufficient oil passes around the seat (541) from the path (R) to the path (P) and prevents cavitation.





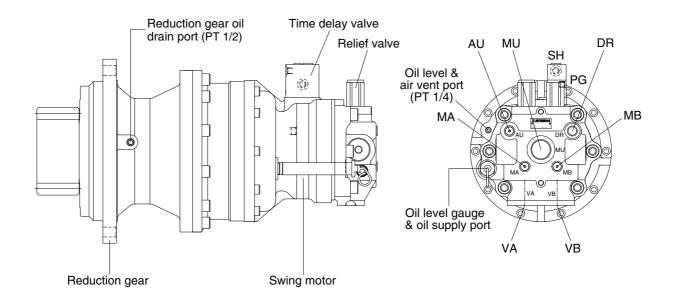


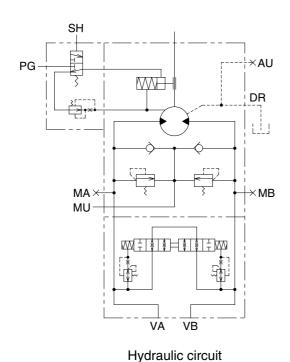
GROUP 3 SWING DEVICE (TYPE 1, 2)

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

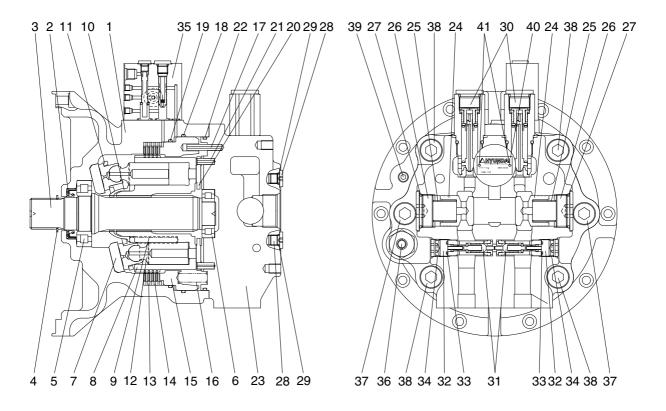
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.





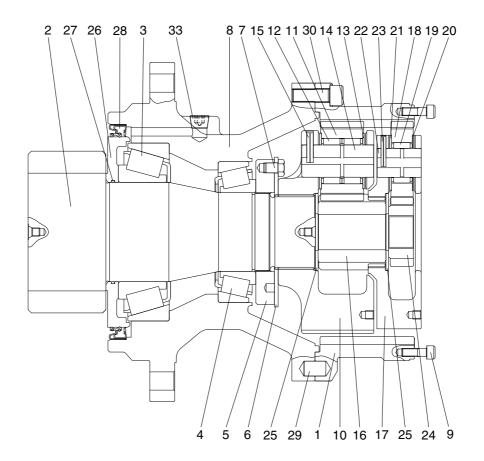
Port	Port name	Port size
VA	Main port	ø 20
VB	Main port	ø 20
DR	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
PG	Brake releasestand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
MA, MB	Gauge port	PF 1/4
AU	Air vent port	PF 1/4

1) SWING MOTOR



4	Cooing	15	Darking pieten	20	O ring
ı	Casing	15	Parking piston	29	O-ring
2	Oil seal	16	Brake spring	30	Relief valve assy
3	Shaft	17	Spring pin	31	Reactionless valve assy
4	Snap ring	18	O-ring	32	Plug
5	Roller bearing	19	O-ring	33	O-ring
6	Needle bearing	20	Valve plate	34	O-ring
7	Swash plate	21	Spring pin	35	Time delay valve assy
8	Cylinder block	22	O-ring	36	Level gauge
9	Spring	23	Valve casing	37	Socket bolt
10	Ball guide	24	Check valve	38	Socket bolt
11	Retainer plate	25	Spring	39	Plug
12	Piston assy	26	Plug	40	Name plate
13	Friction plate	27	O-ring	41	Rivet
14	Separate plate	28	Plug		

2) REDUCTION GEAR



1	Ring gear	11	Planetary gear 2	21	Thrust washer 1
2	Drive shaft	12	Needle bearing 2	22	Carrier pin 1
3	Taper bearing	13	Thrust washer 2	23	Spring pin 1
4	Taper bearing	14	Carrier pin 2	24	Sun gear 1
5	Ring nut	15	Spring pin 2	25	Thrust plate
6	Lock plate	16	Sun gear 2	26	Sleeve
7	Hexagon bolt	17	Carrier 1	27	O-ring
8	Casing	18	Planetary gear 1	29	Parallel pin
9	Socket bolt	19	Needle bearing 1	30	Socket bolt
10	Carrier 2	20	Thrust washer 1	33	Plug

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder block (8) through valve casing of motor (23), and valve plate (20).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (12).

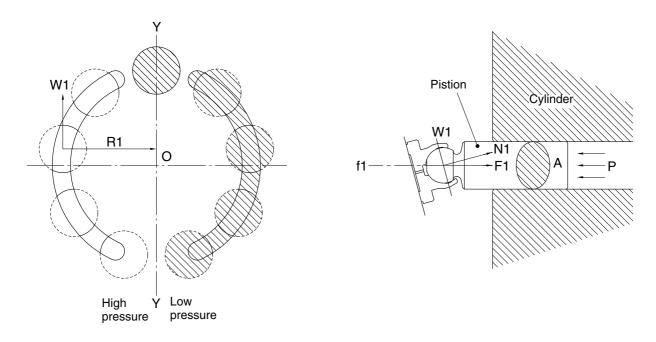
The high hydraulic can generate the force, $F1=P\times A$ (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle, α .

W1 generates torque, $T=W1 \times R1$, for Y-Y line connected by the upper and lower sides of the piston as following pictures.

The sum of torque (Σ W1×R1), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (8) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



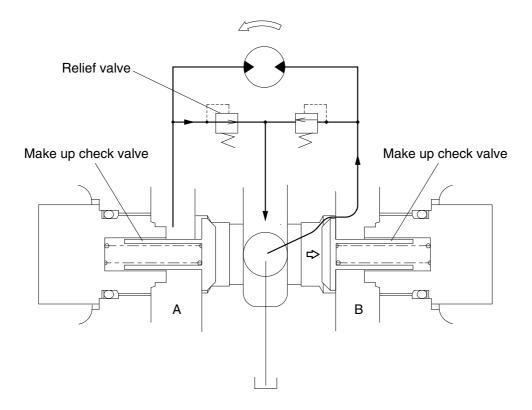
2) MAKE UP VALVE

In the system using this type of motor, there is no counter balance functioning valve and there happens the case of revolution exceeding hydraulic supply of motor. To prevent the cavitation caused by insufficient oil flow there is a make up valve to fill up the oil insufficiency.

A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

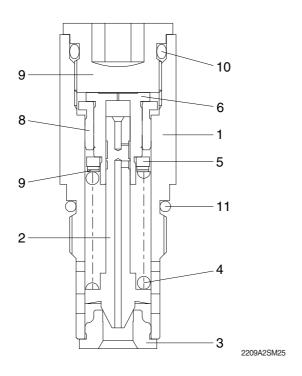
Pressurized oil into the port B, the motor rotate counterclockwise.

If the plunger of MCV moves neutral position, the oil in the motor is drain via left relief valve, the drain oil run into motor via right make up valve, which prevent the cavitation of motor.



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3) RELIEF VALVE



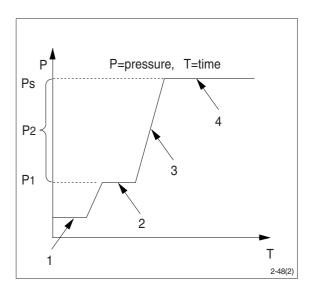
- 1 Sleeve
- 2 Poppet
- 3 Poppet seat
- 4 Spring
- 5 Spring seat
- 6 Shim
- 7 Piston
- 8 Stopper
- 9 Plug
- 10 O-ring
- 11 O-ring

(1) Construction of relief valve

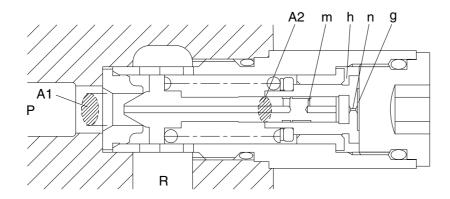
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

Figure illustrates how the pressure acting on the relief valve is related to its rising process. Here is given the function, referring to the figure following page.



① Ports (P,R) at tank pressure.

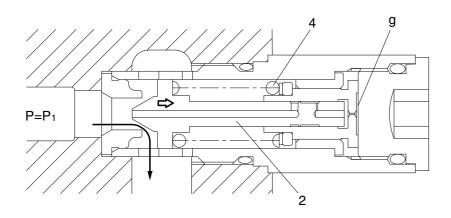


2209A2SM26

 $\@$ When hydraulic oil pressure (P \times A1) reaches the preset force (FSP) of spring (4), the plunger (2) moves to the right as shown.

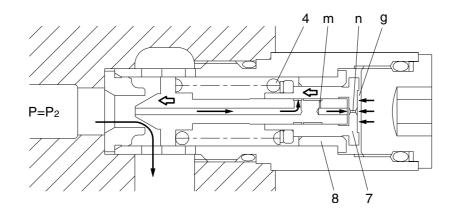
 $P1 \times A1=Fsp+Pg \times A2$

$$P1 = \frac{Fsp + Pg \times A2}{A1}$$



2209A2SM27

③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (FSP) of spring (4), the piston (7) moves left and stop the piston (7) hits the bottom of bushing (8).

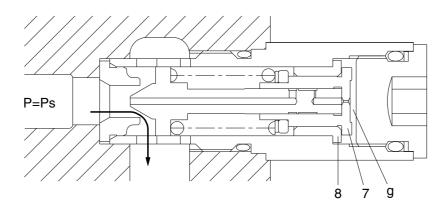


2209A2SM28

④ When piston (7) hits the bottom of bushing (8), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (Ps).

$$Ps \times A1=Fsp+Ps \times A2$$

$$Ps = \frac{Fsp}{A_1 - A_2}$$



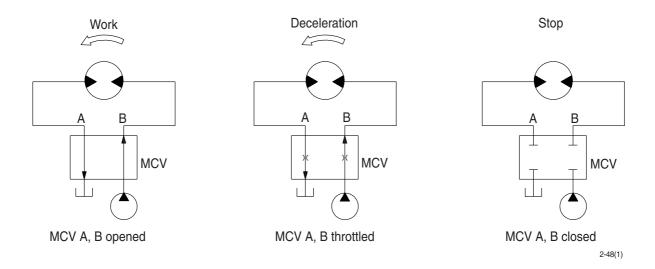
2209A2SM29

4) BRAKE SYSTEM

(1) Control valve swing brake system

This is the brake system to stop the swing motion of the excavator during operation. In this system, the hydraulic circuit is throttled by the swing control valve, and the resistance

created by this throttling works as a brake force to slow down the swing motion.



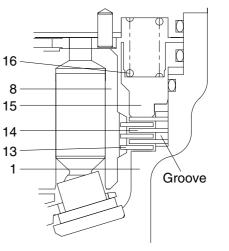
(2) Mechanical swing parking brake system

This is function as a parking brake only when all of the RCV lever (except swing, arm in) are not operated.

① Brake assembly

Circumferential rotation of separate plate (14) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (16) through friction plate (13), separate plate (14) and parking piston (15), friction force occurs there.

Cylinder block (8) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



2209A2SM35

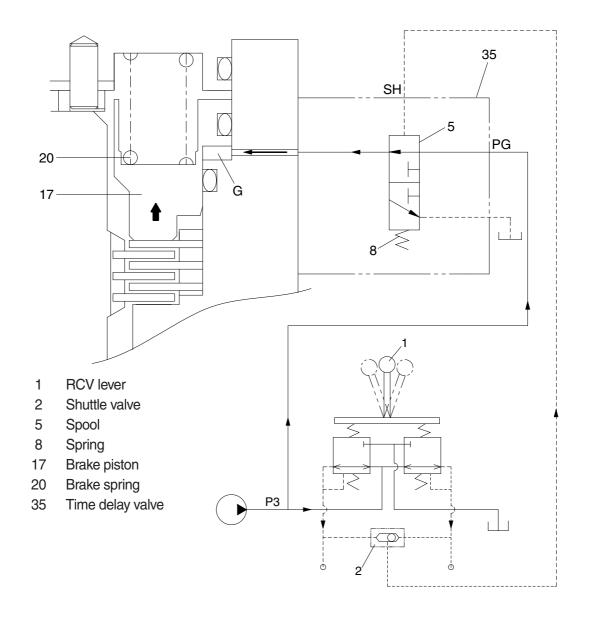
Casing
 Separate plate
 Cylinder block
 Parking piston
 Friction plate
 Brake spring

② Operating principle

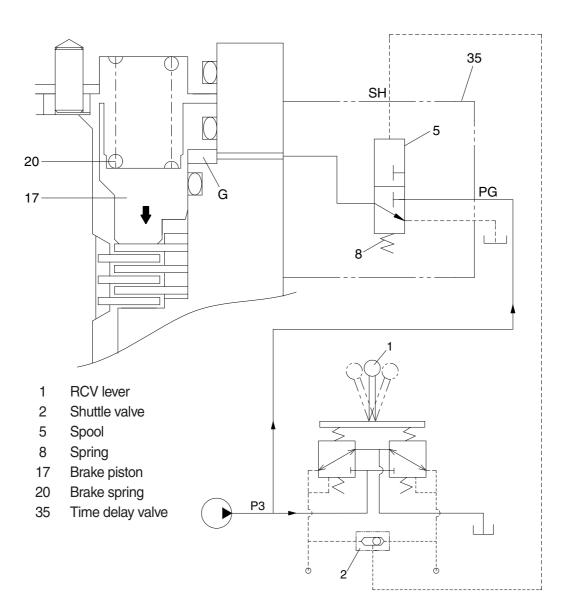
a. When the RCV lever (1) is set to the swing or arm in operating position, the pilot oil go to SH of the time delay valve (35).

This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged oil (P3) goes to the chamber G through port PG.

This pressure is applied to move the parking piston (15) to the upward against the force of the brake spring (16). Thus, it releases the brake force.



b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to the top.Then, the parking piston (15) is moved lower by spring force and the return oil from the chamber G flows back to tank port.At this time, the brake works.

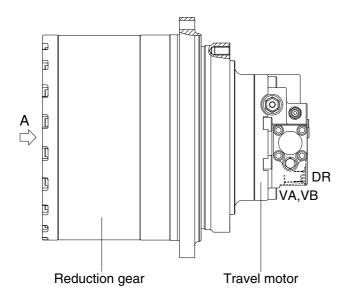


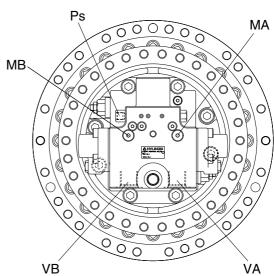
GROUP 4 TRAVEL DEVICE (TYPE 1, 2)

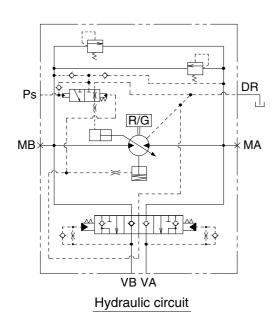
1. CONSTRUCTION

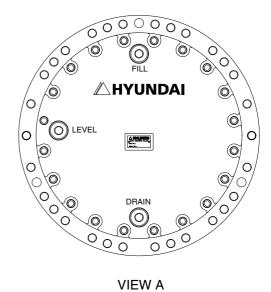
Travel device consists travel motor and gear box.

Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.







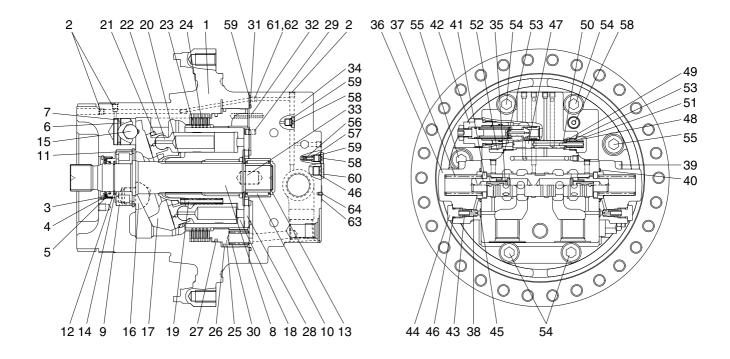


220L2TM01

Port	Port name	Port size
VA, VB	Valve port	PF 1
Ps	Pilot port	PF 1/4
DR	Drain port	PF 1/2
MA, MB	Gauge port	PF 1/4

2. SPECIFICATION

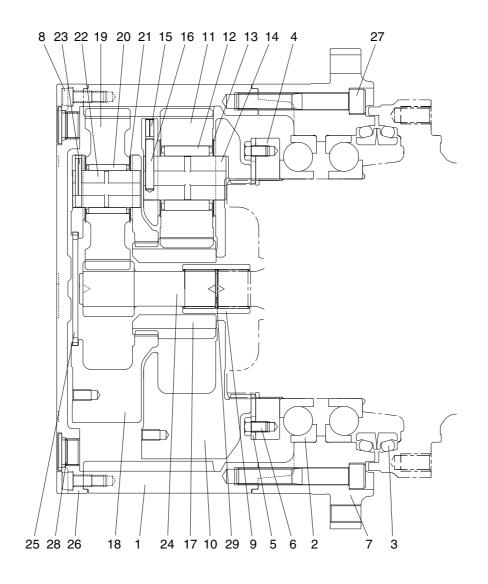
1) TRAVEL MOTOR



220L2TM02

1	Casing	23	Friction plate	44	Plug
2	Plug	24	Separated plate	45	O-ring
3	Oil seal	25	Parking piston	46	O-ring
4	Thrust plate	26	D-ring	47	Spool
5	Snap ring	27	D-ring	48	Plug
6	Swash piston	28	Valve plate	49	Spring seat
7	Piston seal	29	Parallel pin	50	Parallel pin
8	Shaft	30	Brake spring	51	Spring
9	Cylinder roller bearing	31	O-ring	52	Connector
10	Needle bearing	32	Spring pin	53	O-ring
11	Snap ring	33	Parallel pin	54	Hexagon socket head bolt
12	Snap ring	34	Rear cover	55	Hexagon socket head bolt
13	Snap ring	35	Main spool assy	56	Check valve
14	Thrust plate	36	Spool cover	57	Spring
15	Steel ball	37	Spring	58	Plug
16	Pivot	38	Restrictor	59	O-ring
17	Swash plate	39	Hexagon socket head bolt	60	Plug
18	Cylinder block	40	O-ring	61	Restrictor
19	Spring	41	Spring seat	62	Restrictor
20	Ball guide	42	Relief valve assy	63	Name plate
21	Retainer plate	43	Spring	64	Rivet
22	Piston assy				

2) TRAVEL REDUCTION GEAR



2209A2TM22

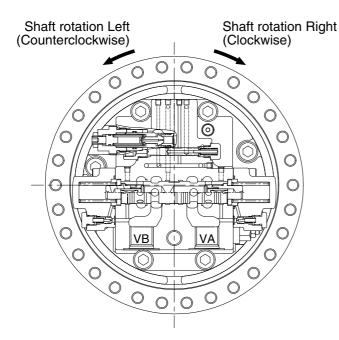
1	Ring gear	12	Needle bearing 2	22	Carrier pin 1
2	Ball bearing	13	Thrust washer 2	23	Spring pin 1
3	Floating seal assy	14	Carrier pin 2	24	Sun gear 1
4	Nut ring	15	Spring pin 2	25	Thrust plate
5	Lock plate	16	Solid pin 2	26	Cover
6	Hexagon bolt	17	Sun gear 2	27	Hexagon socket head bolt
7	Housing	18	Carrier 1	28	Plug
8	Hexagon socket head bolt	19	Planetary gear 1	29	Snap ring
9	Coupling	20	Needle bearing 1	30	Name plate
10	Carrier 2	21	Thrust washer 1	31	Rivet
11	Planetary gear 2				

3. OPERATION

1) MOTOR

High pressure oil delivered form hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (34) and valve plate (28), led to cylinder block (18).

The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclock wise)

25092TM23

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

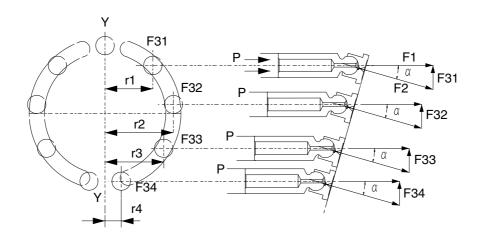
 $F1 = P \times A$ (P : pressure, A : area of piston section)

The swash plate (17) with inclined angle of $^{\alpha}$ divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$$

This drive torque is transmitted via cylinder block (18) to driving shaft (8).



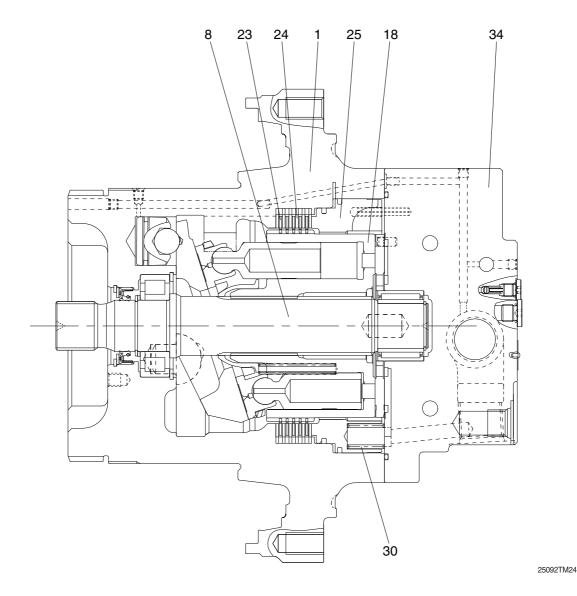
2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (34), is applied to the parking piston (25).

Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separated plates (24), inserted into the casing (1), and friction plates (23), coupled to cylinder block (18) by the outer splines.

When no pressure is activated on the parking piston (25), it is pushed by the brake springs (30) and it pushes friction plates (23) and separated plates (24) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (18) and hence the shaft (8).



3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure P_A that overcome the spring (51), the spring (51) is compressed and spool (47) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (56) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (6). As a result, swash plate (17) turns around the line L which connect the two pivots (16) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (17) keeps the position.

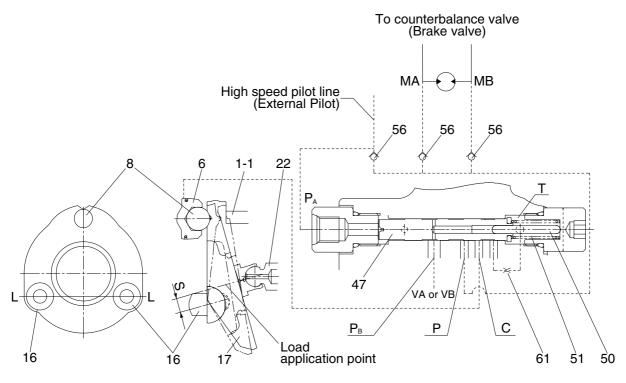
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

When no pressure is in the high speed pilot line P_A , spool (35) is pushed back by the spring (51) and pressure that pressed the shifter piston (6) is released to the hydraulic tank through restrictor (61).

Here, nine pistons are there and they equally spaced on the swash plate (17). The force that summed up those of pistons comes to almost the center of the swash plate (17) as shown. Since the pivots (16) are off-set by S from the center, the rotating force of product S and the force moves swash plate (17) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port $P_{\rm B}$ and this pressure activate on pin (50). When the pressure at $P_{\rm B}$ exceeds predetermined value, spool (47) returns to the left by the counter-pressure against pin (50) and the pressure on the shifter piston (6) through port C is released to the tank and the motor comes to low speed.

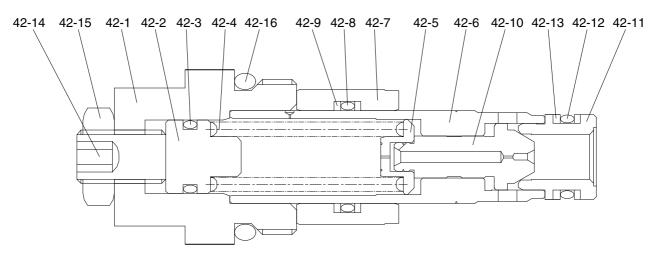
When P_B goes down, the spool (47) moves to the right and the speed become high.



4) OVERLOAD RELIEF VALVE

(1) Structure

This valve is screwed in the motor rear cover (34) and consists of : plug (42-1) that is screwed and fixed in the rear cover (34), poppet (42-10) and supports the poppet seat (42-11), spring (42-4) that is operating relief valve setting pressure and supports the spring seat (42-5), that is inserted in the sleeve (42-6), screw (42-14) that is adjust the spring force, nut (42-15) that fix screw (42-14), piston (42-7) that reduce the shock.



42-1 Plug	42-7 Piston	42-12 O-ring
42-2 Guide	42-8 O-ring	42-13 Back-up ring
42-3 O-ring	42-9 Back-up ring	42-14 Socket screw
42-4 Spring	42-10 Poppet	42-15 Hexagon nut
42-5 Spring seat	42-11 Poppet seat	42-16 O-ring
42-6 Sleeve		

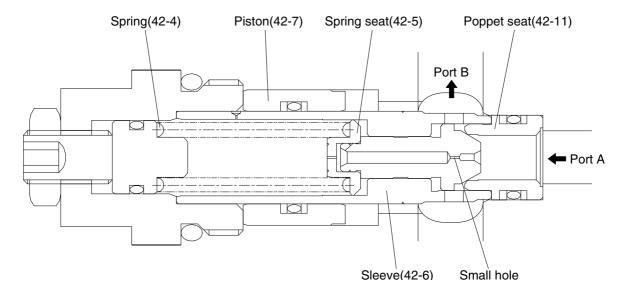
(2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions:

- ① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
- ② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
- ③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of poppet (42-10) which seats on the poppet seat (42-11) and, at the same time, is delivered, via small hole, to the spring seat (42-5) located inside the sleeve (42-6) and the seat bore pressure increases up to "A" port pressure. The poppet (42-10) opposes to spring (42-4) by the force of the pressure exerted on the area difference between poppet seat's effective diameter and spring seat bore and keep the predetermined pressure.

When hydraulically braking, the piston (42-7) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (42-7) through the small hole in the poppet (42-10) and piston (42-7) moves rightward until it touches the stopper in rear cover. In this while, the poppet (42-10) maintains "A" port pressure at comparatively low against the spring (42-4) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



5) BRAKE VALVE

(1) Structure

The brake valve portion mainly consists of the following parts:

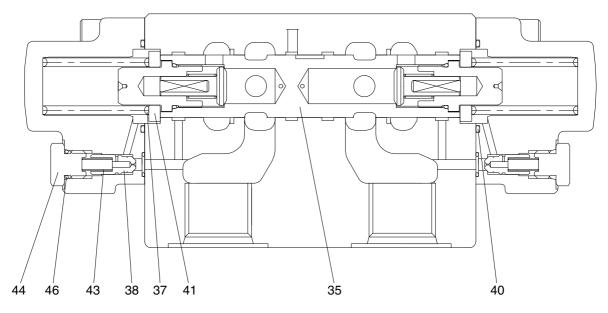
① Spool

By shifting the spool (35), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-74, (2) Operation)

② Check valve (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



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35 Main spool

37 Spring

38 Restrictor

40 O-ring

41 Spring seat

43 Restrictor spring

44 Plug

46 O-ring

(2) Operation

① Holding operation

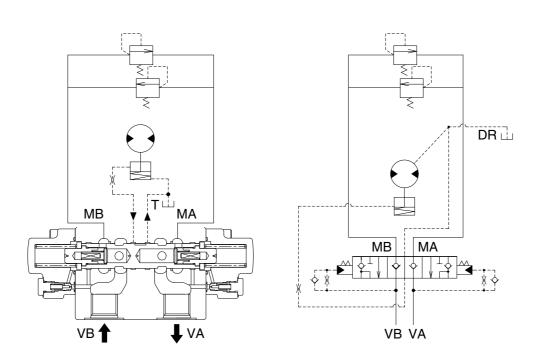
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (37) located on both spool ends holds the spool (35) at central position.

Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.

If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (35), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.

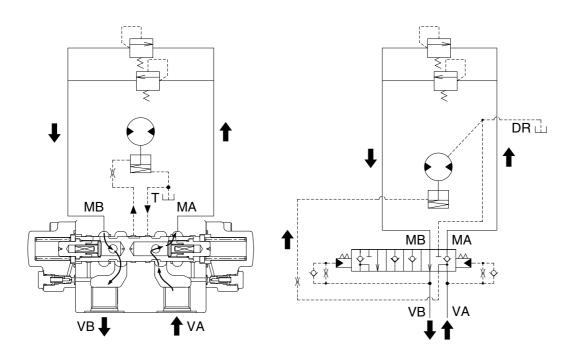


② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (35), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (35) leftwards, overcoming the spring (37) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed. As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.

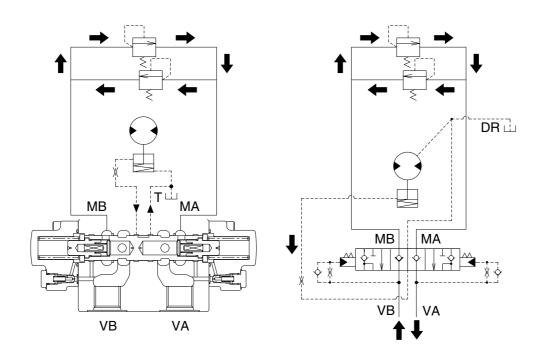


3 Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (35) returns to the neutral position by spring (37) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



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④ Counterbalance operation

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.

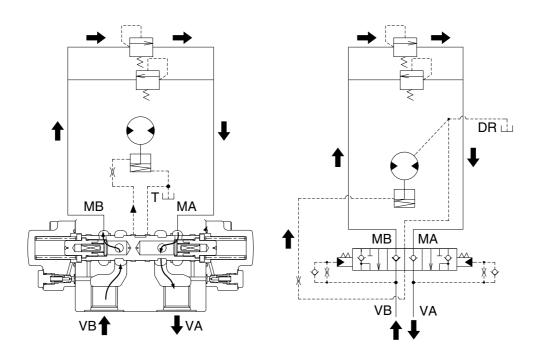
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (37) force moves the spool (35) leftwards towards neutral position.

Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (35) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.

In order to give stable counterbalance operation, the restrictors (38) are set in the pilot chamber to damp the spool (35) movement.

The parking brake is released during pressure adjusting action of the spool (35).



25092TM32

6) REDUCTION GEAR

Reduction unit slows down the rotating speed of motor and converts motor torque to strong rotating force.

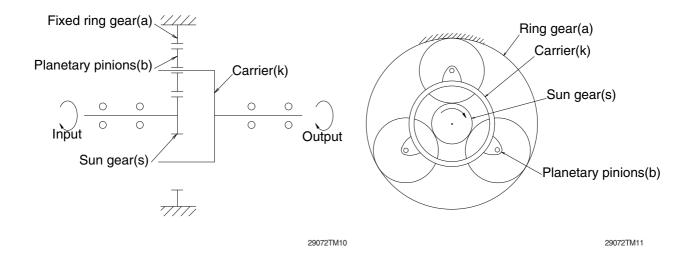
This reduction unit utilizes two stages, planetary reduction system.

Planetary reduction system consists of sun gear, planetary gears, (planetary) carriers, and ring gear.

When the sun gear (s) is driven through input shaft, planetary pinions (b), rotating on their center, also move, meshing with fixed ring gear (a), around sun gear (s).

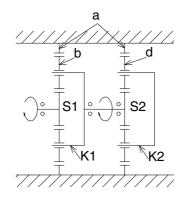
This movement is transferred to carrier (k) and deliver the torque.

This mechanism is called planetary gear mechanism.



When the sun gear S1 is driven by input shaft, planetary action occurs among gears S1, a and b and revolution of gear b transfers the rotation of carrier K1 to second sun gear S2, and also evokes planetary action between gear S2, a and d.

This time, because carrier **K2** is fixed to frame, gear **d** drives ring gear **a** and then ring gear **a** rotates to drive sprocket.



29072TM12

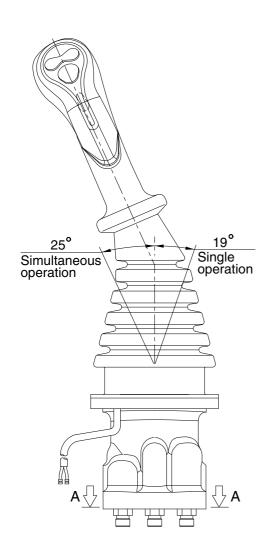
GROUP 5 RCV LEVER

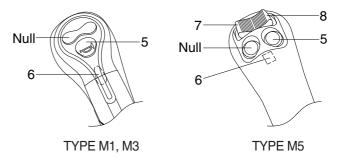
1. STRUCTURE

The casing has the oil inlet port P (primary pressure) and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.

* Refer to the parts manual for the types of the RCV lever.

1) TYPE M1, M3, M5

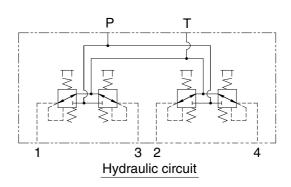


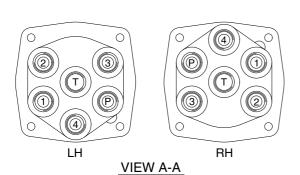


Switches

Туре	No.	LH	RH	
M1, M3	5	One touch decel	Horn	
IVII, IVIO	6	Power boost	Breaker	
	5	One touch decel	Horn	
M5	6	Power boost	Null	
CIVI	7	CCW rotation	Close	
	8	CW rotation	Open	

* Number 7 and 8 : Option attachment



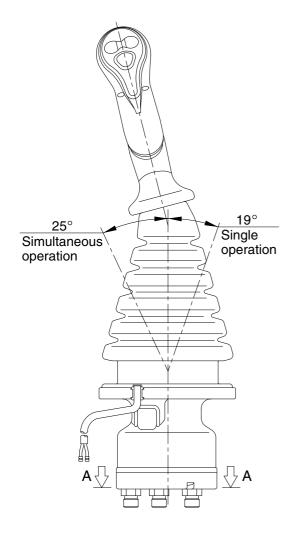


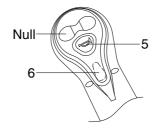
Pilot ports

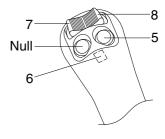
Port	LH	RH	Port size	
Р	Pilot oil inlet port	Pilot oil inlet port		
Т	Pilot oil return port	Pilot oil return port		
1	Left swing port	Bucket out port	PF 3/8	
2	Arm out port	Boom up port	FF 3/0	
3	Right swing port	Bucket in port		
4	Arm in port	Boom down port		

300L2RL01

2) TYPE M2, M4, M6







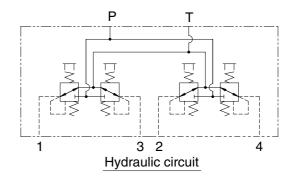
TYPE M2, M4

TYPE M6

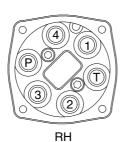
Switches

Туре	No.	LH	RH	
MO MA	5	One touch decel	Horn	
M2, M4	6	Power boost	Breaker	
	5	One touch decel	Horn	
Me	6	Power boost	Null	
M6	7	CCW rotation	Close	
	8	CW rotation	Open	

* Number 7 and 8 : Option attachment







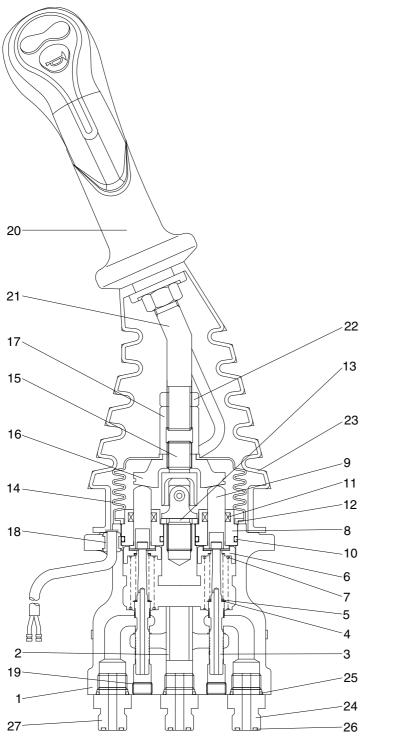
VIEW A-A

Pilot ports

Port	LH	RH	Port size
Р	Pilot oil inlet port	Pilot oil inlet port	
Т	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	PF 3/8
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

300L2RL05

3) CROSS SECTION



- 1 Case
- 2 Bushing
- 3 Spool
- 4 Shim
- 5 Spring
- 6 Spring seat
- 7 Spring
- 8 Plug
- 9 Push rod
- 10 O-ring
- 11 Rod seal
- 12 Plate
- 13 Spacer
- 14 Boot
- 15 Joint assembly
- 16 Swash plate
- 17 Adjusting nut
- 18 Bushing
- 19 Plug
- 20 Handle assembly
- 21 Handle bar
- 22 Nut
- 23 Boot
- 24 Last guard filter
- 25 O-ring
- 26 O-ring
- 27 Connector

300L2RL06

Item numbers are based on the type M1.

The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (3), spring (5) for setting secondary pressure, return spring (7), spring seat (6) and shim (4). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm² (depending on the type). The spool is pushed against the push rod (9) by the return spring.

When the push rod is pushed down by tilting the handle, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output ports (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port or tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

Item numbers are based on the type M1.

The functions of the spool (3) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output port pressure oil to tank port T.

The spring (5) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (9) is inserted and can slide in the plug (8).

For the purpose of changing the displacement of the push rod through the swash plate (16) and adjusting nut (17) are provided the handle assy (20) that can be tilted in any direction around the fulcrum of the universal joint (15) center.

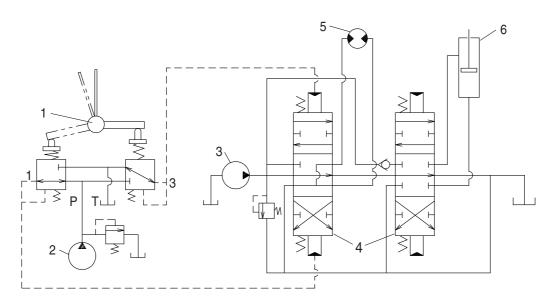
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

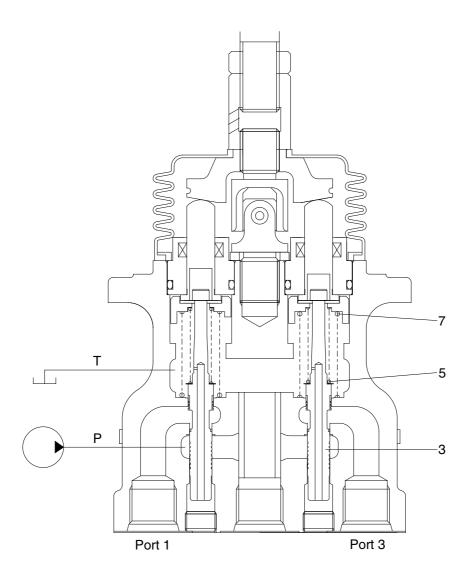
The diagram shown below is the typical application example of the pilot valve.



2-70

- 1 Pilot valve
- 2 Pilot pump
- 3 Main pump
- 4 Main control valve
- 5 Hydraulic motor
- 6 Hydraulic cylinder

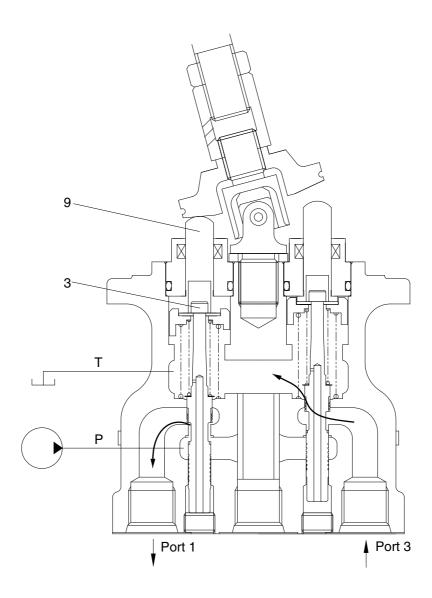
(1) Case where handle is in neutral position



300L2RL03

The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (3). Therefore, the spool is pushed up by the spring (7) to the position of port (1, 3) in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where handle is tilted



300L2RL04

When the push rod (9) is stroked, the spool (3) moves downwards.

Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.

When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.

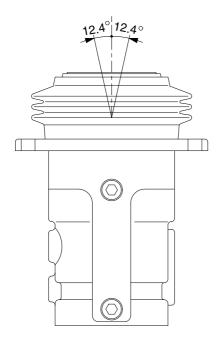
In this manner the secondary pressure is kept at the constant value.

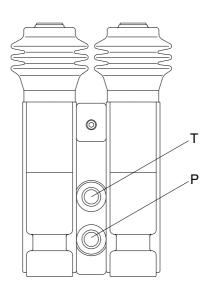
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

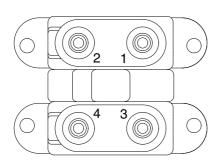
GROUP 6 RCV PEDAL

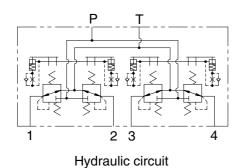
1. STRUCTURE

The casing (spacer) has the oil inlet port P (primary pressure), and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1,2,3 and 4 provided at the bottom face.









Port size Port Port Ρ Pilot oil inlet port Τ Pilot oil return port Travel (LH, Forward) 1 PF 1/4 2 Travel (LH, Backward) Travel (RH, Forward) 3 4 Travel (RH, Backward)

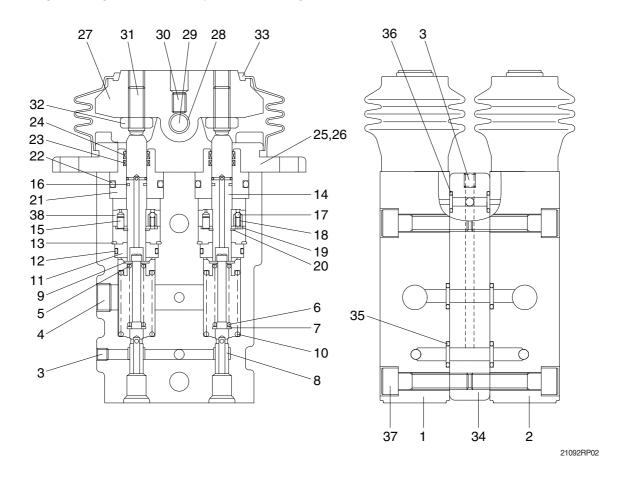
21092RP01

CROSS SECTION

The construction of the RCV pedal is shown in the below drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (8), spring (6) for setting secondary pressure, return spring (10), stopper (9), and spring seat (7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm² (depending on the type). The spool is pushed against the push rod (14) by the return spring.

When the push rod is pushed down by tilting pedal, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.



1	Body(1)	14	Push rod	27	Cam
2	Body(2)	15	Spring pin	28	Bushing
3	Plug	16	Seal	29	Cam shaft
4	Plug	17	Steel ball	30	Set screw
5	Spring seat	18	Spring	31	Set screw
6	Spring	19	Plate	32	Nut
7	Spring seat	20	Snap ring	33	Bellows
8	Spool	21	Plug	34	Space
9	Stopper	22	O-ring	35	O-ring
10	Spring	23	Rod seal	36	O-ring
11	Rod guide	24	Dust seal	37	Socket bolt
12	O-ring	25	Cover	38	Piston
13	Snap ring	26	Socket bolt		

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output port (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (8) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output spool to determine the output pressure.

The spring (6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (14) is inserted and can slide in the plug (21). For the purpose of changing th displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

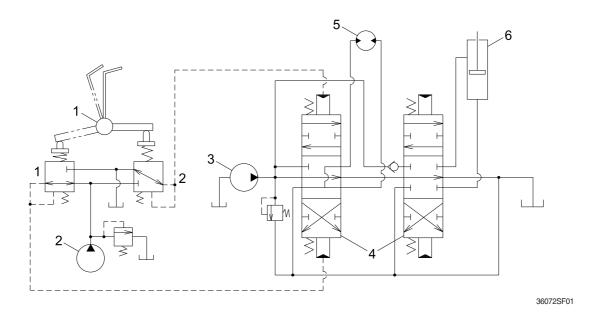
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

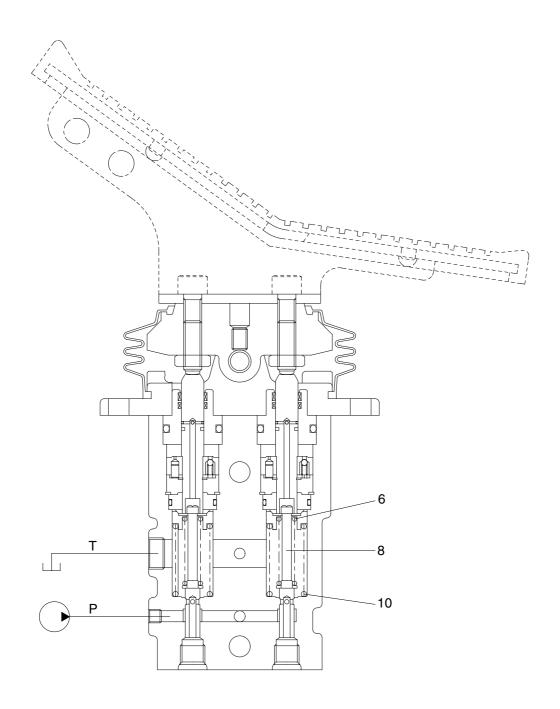
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below ant the attached operation explanation drawing.

The diagram shown below is the typical application example of the pilot valve.



- 1 Pilot valve
- 2 Pilot pump
- 3 Main pump
- 4 Main control valve
- 5 Hydraulic motor
- 6 Hydraulic cylinder

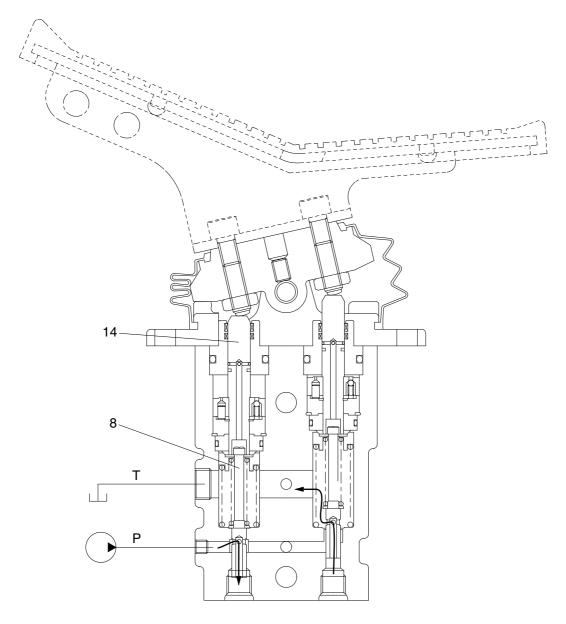
(1) Case where pedal is in neutral position



21092RP03

The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (8). Therefore, the spool is pushed up by the spring (10) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted



21092RP04

When the push rod (14) is stroked, the spool (8) moves downwards.

Then port P is connected with port 1, and the oil supplied from the pilot pump flows through port 1 to generate the pressure.

When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.

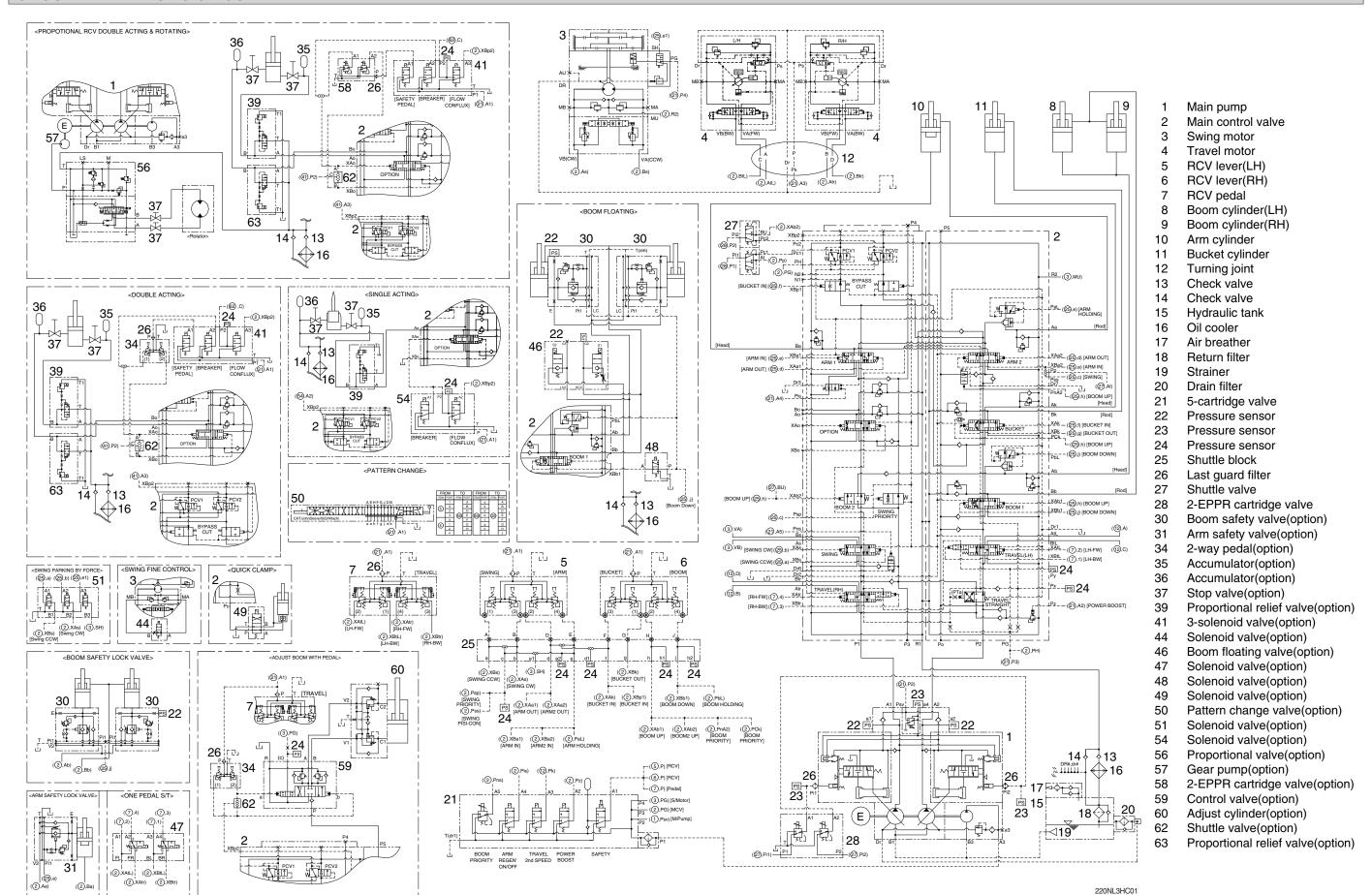
In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.

SECTION 3 HYDRAULIC SYSTEM

Group	1 Hydraulic Circuit 3	3-1
Group	2 Main Circuit ·····	3-2
Group	3 Pilot Circuit ······	3-5
Group	4 Single Operation	3-15
Group	5 Combined Operation	3-25

GROUP 1 HYDRAULIC CIRCUIT



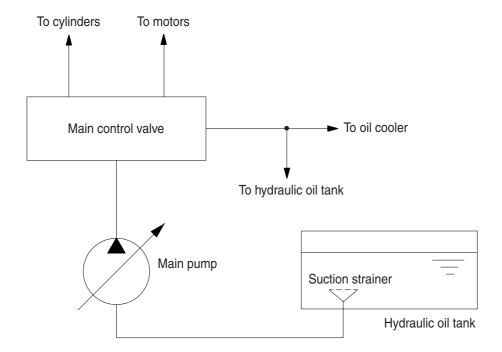
GROUP 2 MAIN CIRCUIT

The main hydraulic circuit consists of suction circuit, delivery circuit, return circuit and drain circuit.

The hydraulic system consists of one main pump, one control valve, one swing motor, four cylinders and two travel motors.

The swash plate type variable displacement axial piston pump is used as the main pump and is driven by the engine at ratio 1.0 of engine speed.

1. SUCTION AND DELIVERY CIRCUIT



(210-7) 3-03

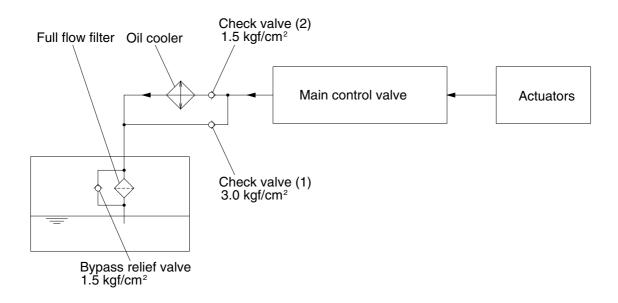
The pumps receive oil from the hydraulic tank through a suction strainer. The discharged oil from the pump flows into the control valve and goes out the tank ports.

The oil discharged from the main pump flows to the actuators through the main control valve.

The main control valve controls the hydraulic functions.

The return oil from the actuators flows to the hydraulic tank through the main control valve and the oil cooler.

2. RETURN CIRCUIT



220NL3CI01

All oil returned from each actuator returns to the hydraulic tank through the main control valve.

The bypass check valves are provided in the return circuit.

The setting pressure of bypass check valves are 1.5 kgf/cm² (21 psi) and 3.0 kgf/cm² (43 psi). Usually, oil returns to the hydraulic tank from the left side of control valve through oil cooler.

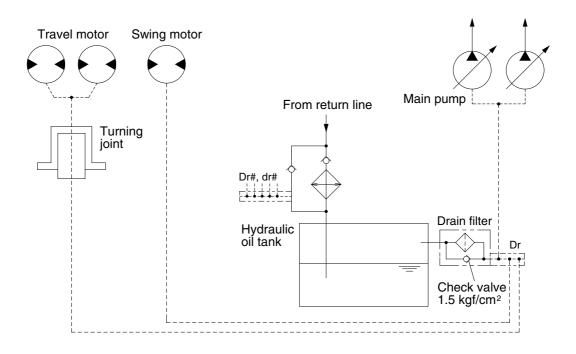
When oil temperature is low, viscosity becomes higher and flow resistance increases when passing through the oil cooler. When the oil pressure exceeds 3.0 kgf/cm² (43 psi), the oil returns directly to the hydraulic tank, resulting in the oil temperature being raised quickly at an appropriate level.

When the oil cooler is clogged, the oil returns directly to the hydraulic tank through bypass check valve (1). The full-flow filter and bypass relief valve are provided in the hydraulic tank.

The oil returned from right and left side of control valve is combined and filtered by the full-flow filter. A bypass relief valve is provided in the full-flow filter.

When the filter element is clogged, the bypass relief valve opens at 1.5 kgf/cm² (21 psi) differential pressure.

3. DRAIN CIRCUIT



220NL3CI02

Besides internal leaks from the motors and main pump, the oil for lubrication circulates. These oil have to be fed to the hydraulic tank passing through drain filter.

When the drain oil pressure exceed 1.5 kgf/cm² (21 psi), the oil returns to the hydraulic tank directly.

1) TRAVEL MOTOR DRAIN CIRCUIT

Oil leaked from the right and left travel motors comes out of the drain ports provided in the respective motor casing and join with each other. These oils pass through the turning joint and return to the hydraulic tank after being filtered by drain filter.

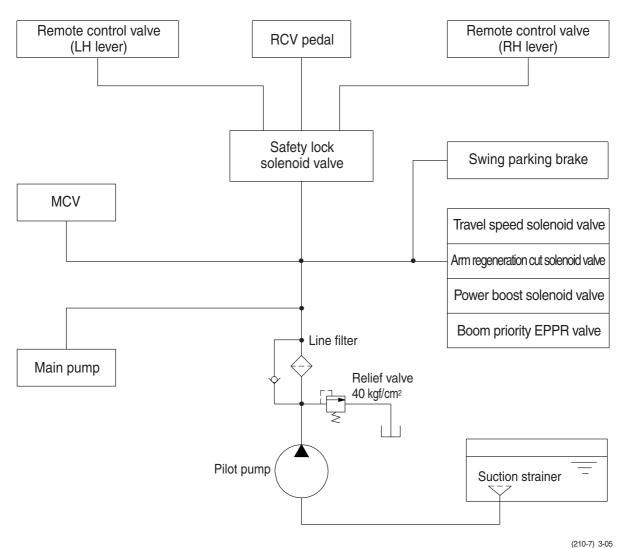
2) SWING MOTOR DRAIN CIRCUIT

Oil leaked from the swing motor returns to the hydraulic tank passing through a drain filter.

3) MAIN PUMP DRAIN CIRCUIT

Oil leaked from main pump returns to the hydraulic tank passing through drain filter.

GROUP 3 PILOT CIRCUIT



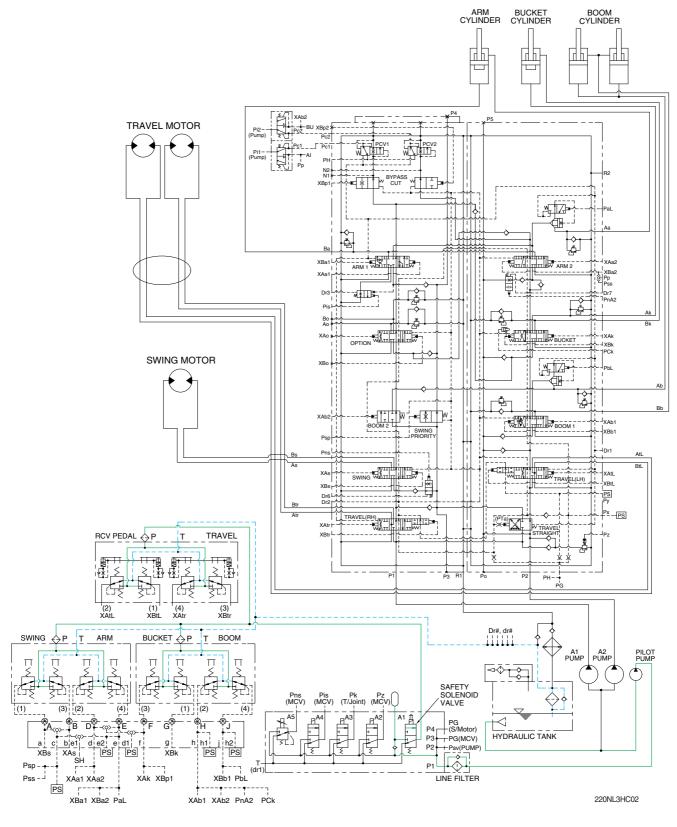
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The pilot circuit consists of suction circuit, delivery circuit and return circuit.

The pilot pump is provided with relief valve, receives the oil from the hydraulic tank through the suction strainer.

The discharged oil from the pilot pump flows to the remote control valve through line filter, EPPR valve, solenoid valve assemblies, swing parking brake, main control valve and safety lock solenoid valve.

1. SUCTION, DELIVERY AND RETURN CIRCUIT

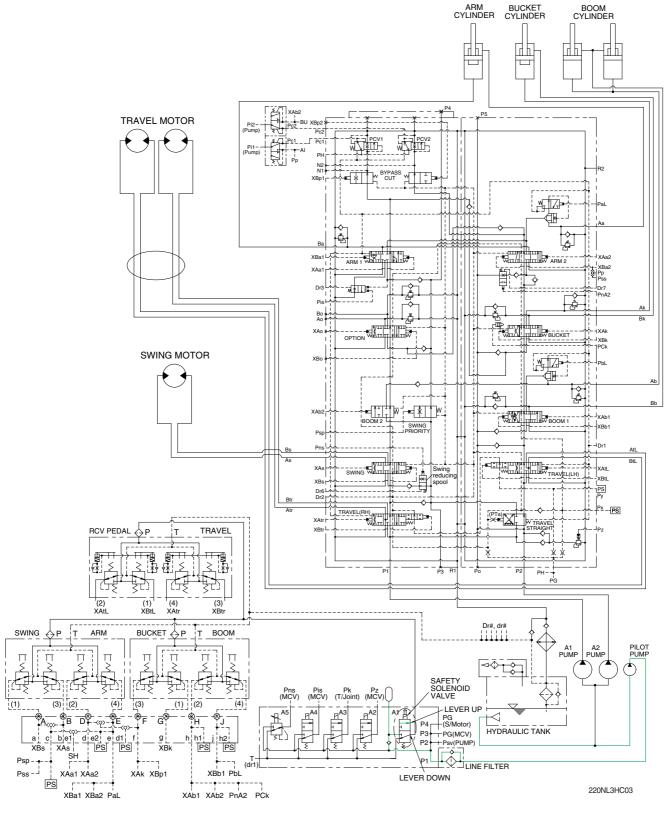


The pilot pump receive oil from the hydraulic tank. The discharged oil from the pilot pump flows to the safety solenoid valve through the line filter. The oil is filtered by the line filter. The pilot relief valve is provided in the pilot pump for limiting the pilot circuit pressure.

The oil filtered by line filter flows remote control valve through safety solenoid valve.

The return oil flow into the hydraulic tank.

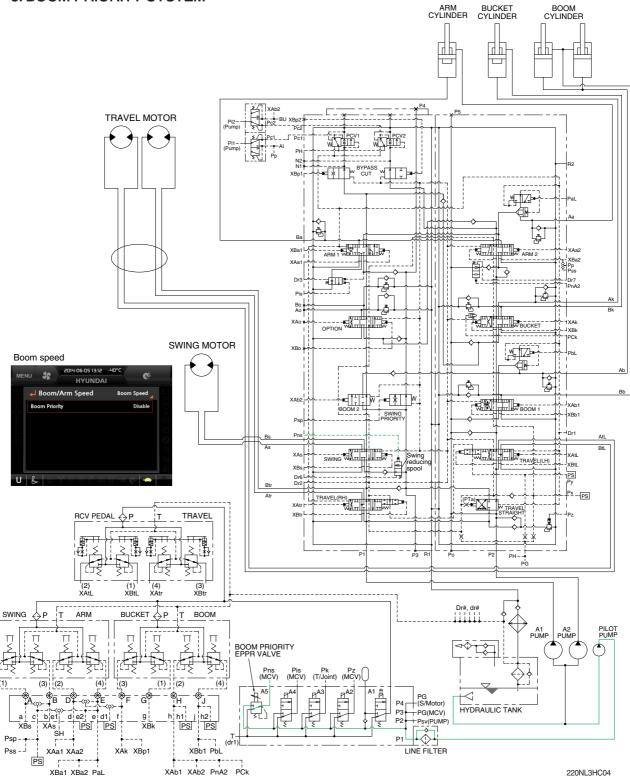
2. **SAFETY VALVE** (SAFETY LEVER)



When the lever of the safety solenoid valve is moved upward, oil flows into the remote control valve through solenoid valve and line filter.

When the lever of the safety solenoid valve is moved upward, oil does not flow into the remote control valve, because of the blocked port.

3. BOOM PRIORITY SYSTEM



When carrying out the combined operation of swing and boom up, the boom up operating speed is lowered then normal operation.

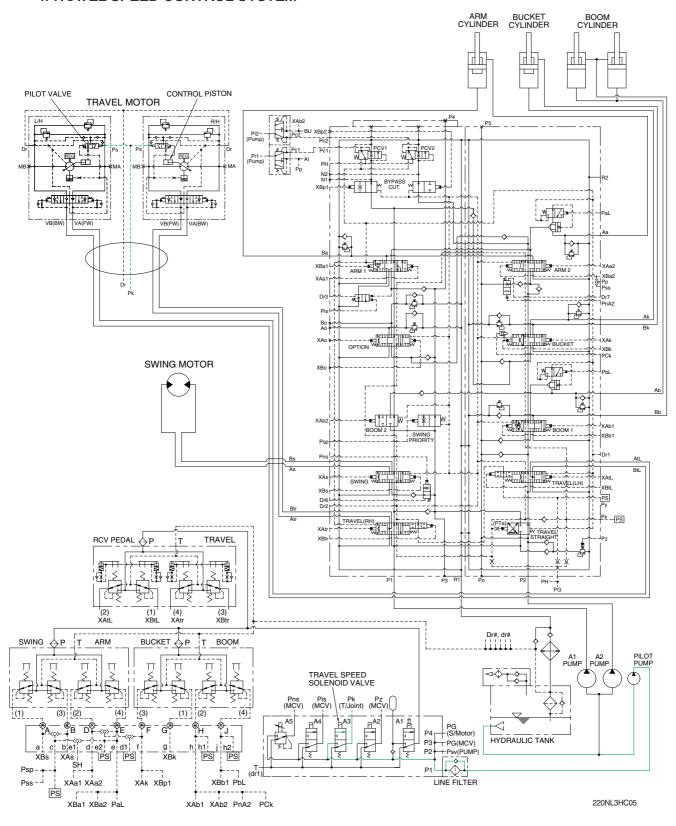
To increase working efficiency, swing speed reducing system is used.

The pilot oil from pilot pump flow into **Pns** port in main control valve through boom priority EPPR valve. **Pns** oil pressure moves swing reducing spool to lower position and oil flow rate to the swing motor decreased.

Then, the boom up speed is increased. This is called the boom priority system.

The boom up speed can be adjusted by the cluster. Refer to page 3-20 of the operator's manual.

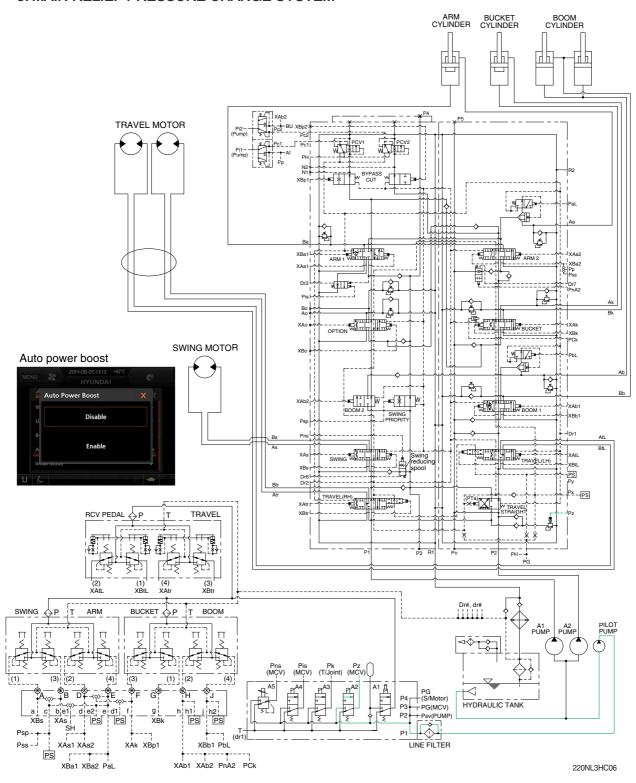
4. TRAVEL SPEED CONTROL SYSTEM



When the travel speed solenoid valve was placed in the Hi position, the pressure oil from pilot pump through line filter flows to port **Ps** of travel speed change over valve, and the control piston is pushed left (LH) and right (RH), thus minimizing the displacement.

When the travel speed solenoid valve was placed in the Lo position, the oil of **Ps** port return to the tank and the control piston is returned, thus maximizing the displacement.

5. MAIN RELIEF PRESSURE CHANGE SYSTEM

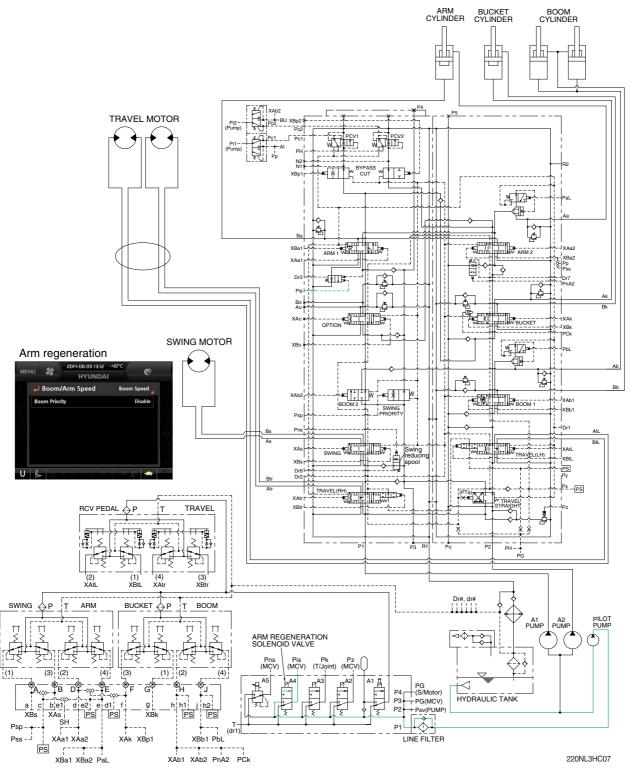


When the power boost switch on the left control lever is pushed ON, the power boost solenoid valve is actuated, the discharged oil from the pilot pump flows into **Pz** port of the main relief valve of main control valve; then the setting pressure of the main relief valve is raised from 350 kgf/cm² to 380 kgf/cm² for increasing the digging power.

And even when pressed continuously, it is canceled after 8 seconds.

When the auto power boost function is selected to enable on the cluster, the pressure of the main relief pressure is automatically increased to 380 kgf/cm² as working condition by the MCU. It is operated max 8 seconds.

6. ARM REGENERATION CUT SYSTEM



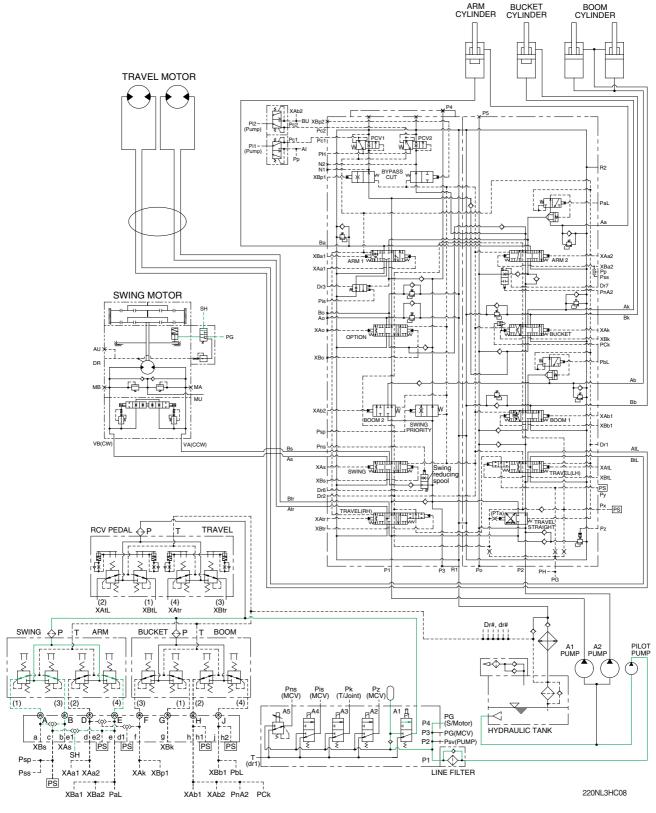
When the arm regeneration is selected to disable on the cluster, the arm regeneration solenoid valve is activated. The pilot oil from pilot pump flow into **Pis** port in main control valve through solenoid valve and the arm regeneration spool is shifted to left.

Then, the oil from arm regeneration passage returns to tank and the arm regeneration function is deactivated.

When the arm regeneration is selected to enable on the cluster, the arm regeneration function is activated and arm in operation speed is increased.

Refer to page 2-30 for the arm regeneration function.

7. SWING PARKING BRAKE RELEASE

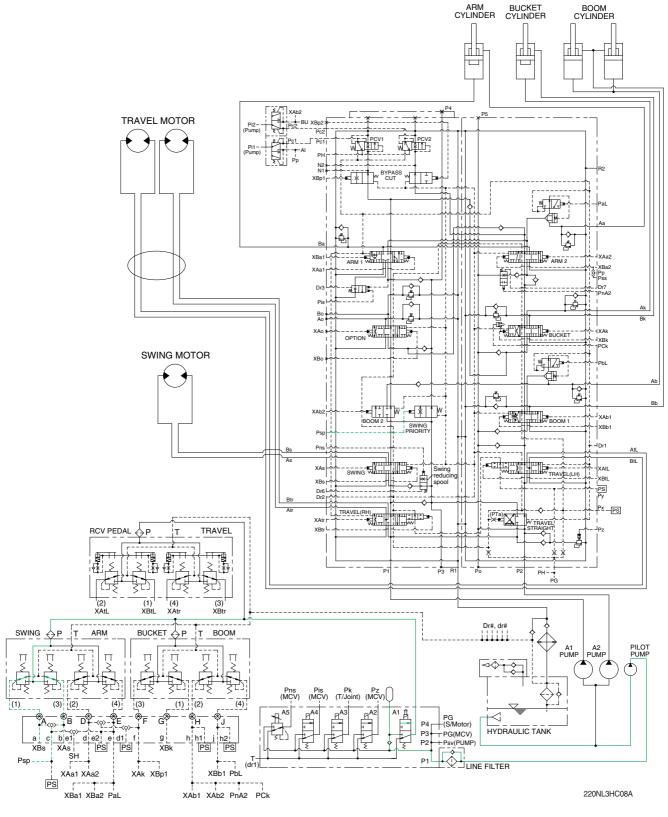


When the swing control lever or arm in control lever is tilted, the pilot oil flows into SH port through main control valve.

This pressure moves spool of the swing brake valve so, discharged oil from pilot valve flows to swing motor PG port. This pressure is applied to swing motor disc, thus the brake is released.

When the swing control lever and arm in control lever are set in the neutral position, oil in the swing motor disc cylinder is drained, thus the brake is applied.

8. SWING PRIORITY SYSTEM

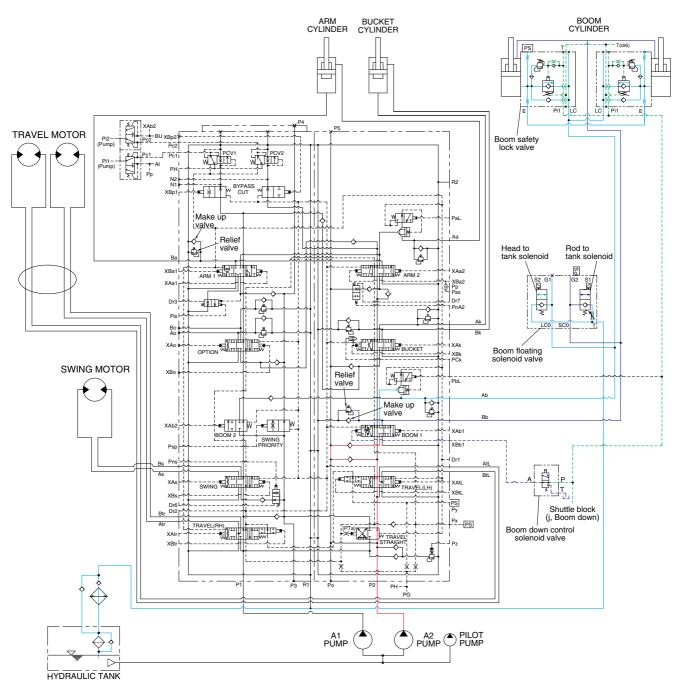


When carrying out the combined operation of swing and arm of the left control valve, the swing speed can be lowered than operating speed of arm.

Psp pressure from the swing shuttle block change the swing priority spool and decreases the oil flow rate to the next section to make the swing operation most preferential.

This is called the swing priority system. For details, refer to page 2-41.

9. BOOM FLOATING SYSTEM



220NL3HC30

Smooth and convenient boom movement is accomplished by only arm control lever operation.

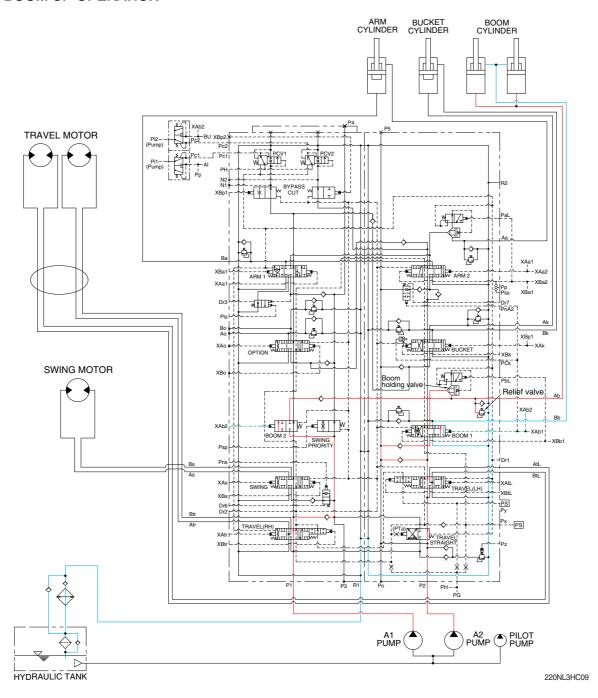
The boom floating solenoid valves are equipped in the rod and head of boom cylinder that are controlled to act as floating mode.

"Rod to tank solenoid" and "Head to tank solenoid" are active. So the hydraulic oil of rod and head goes to tank, and floating is accomplished. In the mode, boom down control solenoid is active so that boom down pilot pressure is cut.

For more details, refer to page 5-13.

GROUP 4 SINGLE OPERATION

1. BOOM UP OPERATION



When the right control lever is pulled back, the boom spools in the main control valve are moved to the up position by the pilot oil pressure from the remote control valve.

The oil from the A1 and A2 pump flows into the main control valve and then goes to the large chamber of boom cylinders.

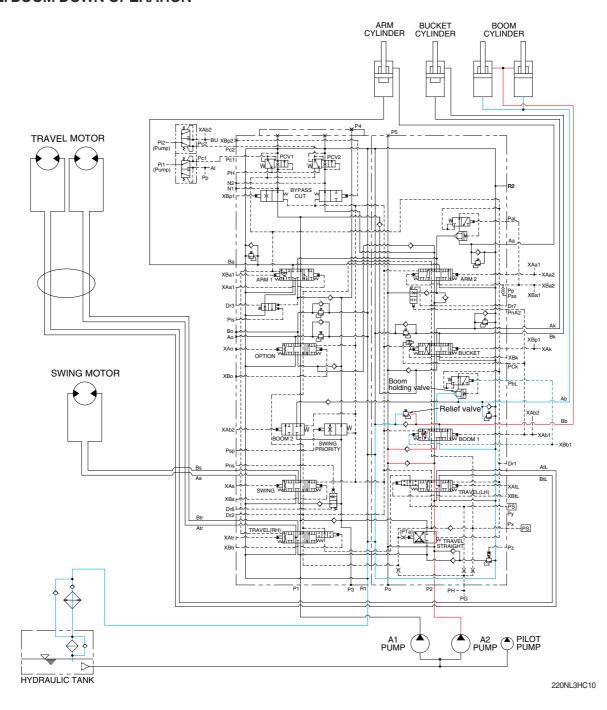
At the same time, the oil from the small chamber of boom cylinders returns to the hydraulic oil tank through the boom 1 spool in the main control valve. When this happens, the boom goes up.

The excessive pressure in the boom cylinder head side is prevented by relief valve.

When the boom is up and the control lever is returned to neutral position, the circuit for the holding pressure at the bottom end of the boom cylinder is closed by the boom holding valve.

This prevents the hydraulic drift of boom cylinder.

2. BOOM DOWN OPERATION



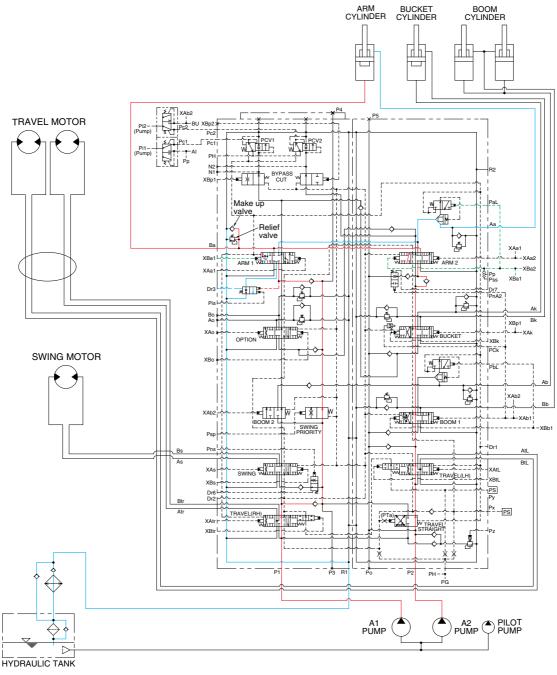
When the right control lever is pushed forward, the boom 1 spool in the main control valve is moved to the down position by the pilot oil pressure from the remote control valve.

The oil from the A2 pump flows into the main control valve and then goes to the small chamber of boom cylinders. At the same time, the oil from the large chamber of boom cylinders returns to the hydraulic tank through the boom spool in the main control valve.

When the down speed of boom is faster, the oil returned from the large chamber of boom cylinder combines with the oil from the A2 pump, and flows into the small chamber of the cylinder.

This prevents cylinder cavitation by the negative pressure when the A2 pump flow can not match the boom down speed. And the excessive pressure in the boom cylinder rod side is prevented by the relief valve.

3. ARM IN OPERATION



220NL3HC11

When the left control lever is pulled back, the arm spools in the main control valve are moved to the roll in position by the pilot oil pressure from the remote control valve.

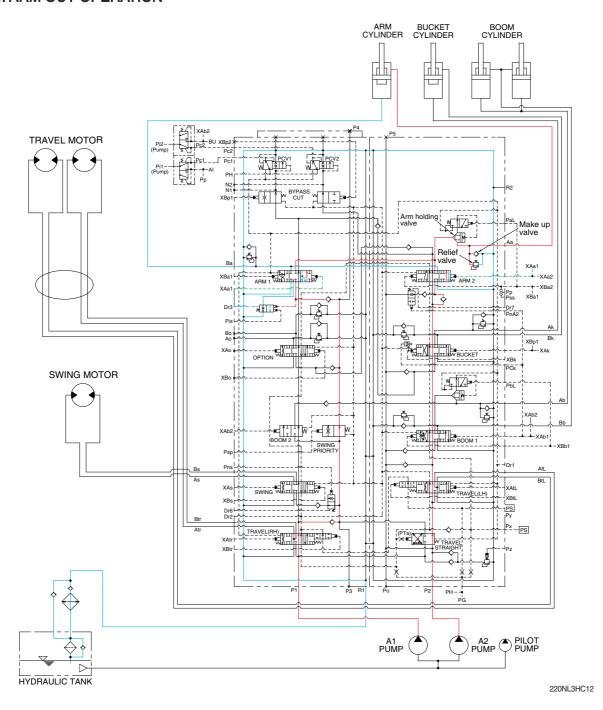
The oil from the A1 and A2 pump flows into the main control valve and then goes to the large chamber of arm cylinder.

At the same time, the oil from small chamber of arm cylinder returns to the hydraulic oil tank through the arm 1 spool in the main control valve. When this happens, the arm rolls in.

The excessive pressure in the arm cylinder head side is prevented by relief valve.

The cavitation which will happen to the head side of the arm cylinder is also prevented by the makeup valve in the main control valve.

4. ARM OUT OPERATION



When the left control lever is pushed forward, the arm spools in the main control valve are moved to the roll out position by the pilot oil pressure from the remote control valve.

The oil from the A1 and A2 pump flows into the main control valve and then goes to the small chamber of arm cylinder.

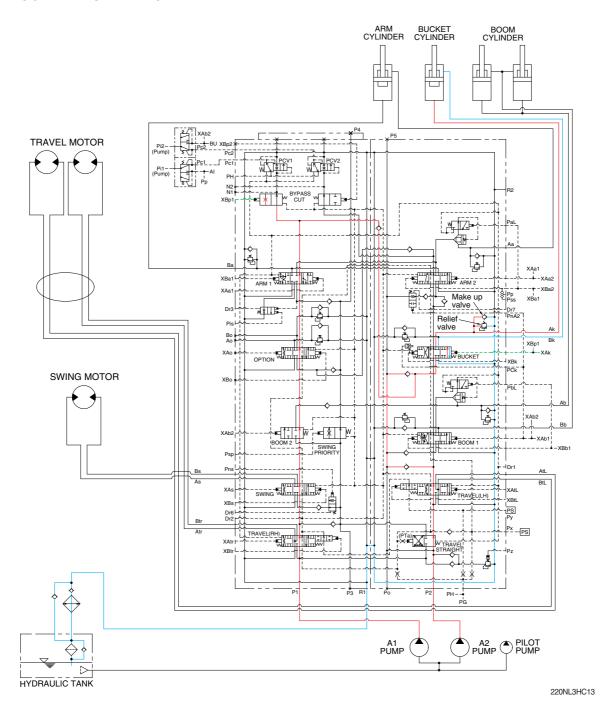
At the same time, the oil from the large chamber of arm cylinder returns to the hydraulic oil tank through the arm spools in the main control valve. When this happens, the arm rolls out.

The excessive pressure in the arm cylinder rod side is prevented by relief valve.

When the arm is roll out and the control lever is returned to neutral position, the circuit for the holding pressure at the rod side of the arm cylinder is closed by the arm holding valve.

The cavitation which will happen to the rod side of the arm cylinder is also prevented by the makeup valve in the main control valve.

5. BUCKET IN OPERATION



When the right control lever is pulled left, the bucket spool in the main control valve is moved to the roll in position by the pilot oil pressure from the remote control valve.

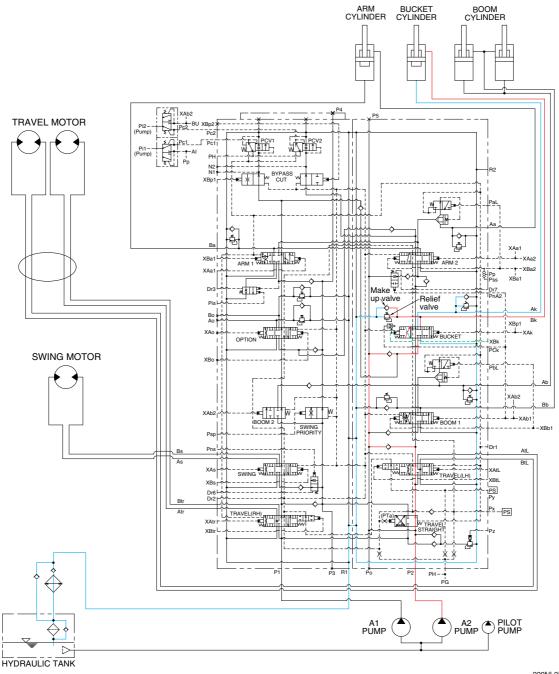
The oil from the A2 pump flows into the main control valve and then goes to the large chamber of bucket cylinder. The oil form the A1 pump flows into the large chamber of bucket cylinder through confluence oil passage in the main control valve by bypass cut pilot pressure (XBp1).

At the same time, the oil from the small chamber of bucket cylinder returns to the hydraulic oil tank through the bucket spool in the main control valve. When this happens, the bucket rolls in.

The excessive pressure in the bucket cylinder head side is prevented by relief valve.

The cavitation which will happen to the head side of the bucket cylinder is also prevented by the make-up valve in the main control valve.

6. BUCKET OUT OPERATION



220NL3HC14

When the right control lever is pushed right, the bucket spool in the main control valve is moved to the roll out position by the pilot oil pressure from the remote control valve.

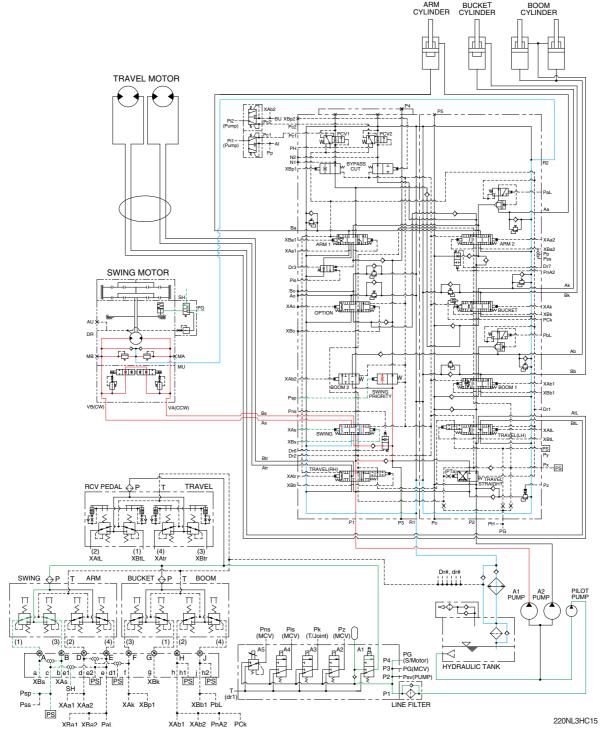
The oil from the A2 pump flows into the main control valve and then goes to the small chamber of bucket cylinder.

At the same time, the oil from the large chamber of bucket cylinder returns to the hydraulic oil tank through the bucket spool in the main control valve. When this happens, the bucket rolls out.

The excessive pressure in the bucket cylinder rod side is prevented by relief valve.

The cavitation which will happen to the rod side of the bucket cylinder is also prevented by the makeup valve in the main control valve.

7. SWING OPERATION



When the left control lever is pushed left or right, the swing spool in the main control valve is moved to the left or right swing position by the pilot oil pressure from the remote control valve.

Also the swing operation preference function is operated by the pilot pressure Psp (refer to page 3-13).

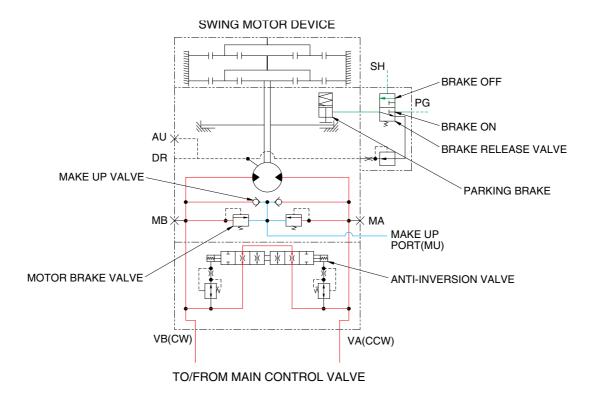
The oil from the A1 pump flows into the main control valve and then goes to the swing motor.

At the same time, the return oil from the swing motor returns to the hydraulic oil tank through the swing spool in the main control valve.

When this happens, the upper structure swings to the left or right.

The swing parking brake, make up valve and the motor brake valve are provided in the swing motor. The cavitation which will happen to the swing motor is also prevented by the make up valve in the swing motor itself.

SWING CIRCUIT OPERATION



220NL3HC15A

1) MOTOR BRAKE VALVE

Motor brake valve for the swing motor limits to cushion the starting and stopping pressure of swing operation and controls the swing motor operating pressure.

2) MAKE UP VALVE

The make up valves prevent cavitation by supplying return oil to the vacuum side of the motor.

3) PARKING BRAKE

This is function as a parking brake only when the swing control lever and arm in control lever are not operated.

PARKING BRAKE "OFF" OPERATION

The parking brake is released by the pilot pressure oil from the pilot pump.

When the swing control lever or arm in control lever placed in the operating position, the pilot oil flows into SH port through the MCV. This pressure transferred to the brake release valve and the brake release valve is change over. Then the pilot oil pressure PG lift the brake piston and release the parking brake.

PARKING BRAKE "ON" OPERATION

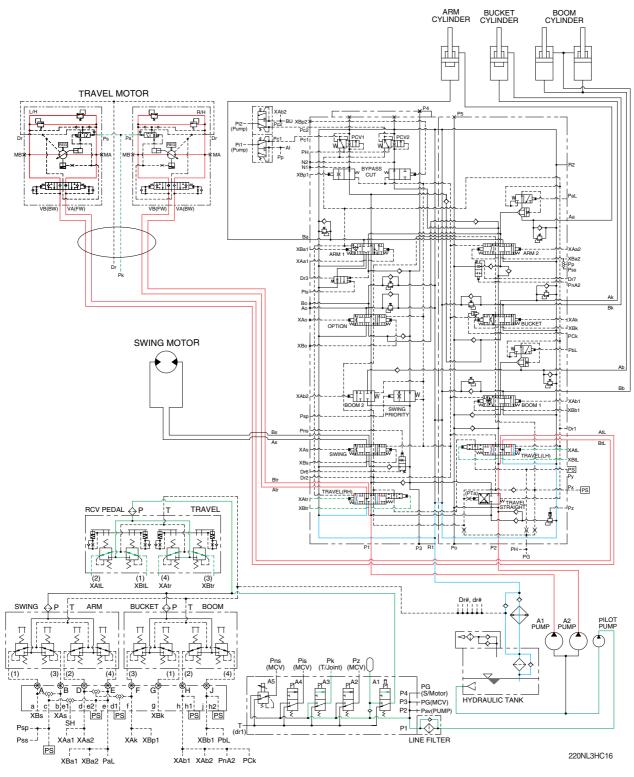
When the swing control lever and arm in control lever placed in the neutral position, the pressure of the pilot oil passage down.

Then the brake release valve returned to the neutral position and the oil is returned from the brake piston to the hydraulic oil tank. And the brake is set to "ON".

4) ANTI-INVERSION VALVE

This anti-inversion valve absorbs shocks produced as swing motion stops and reduced oscillation cause by swing motion.

8. TRAVEL FORWARD AND REVERSE OPERATION



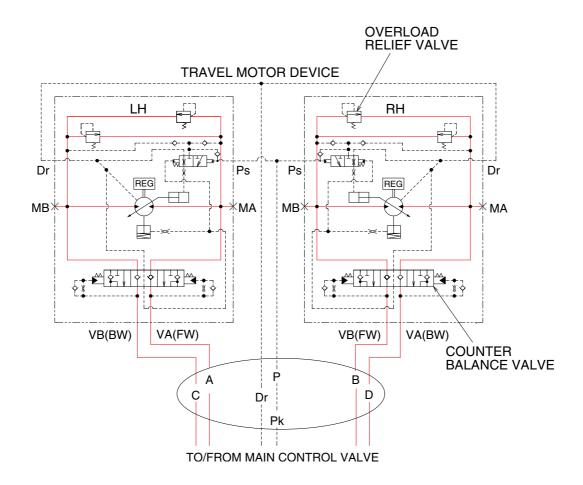
When the travel levers are pushed forward or reverse position, the travel spools in the main control valve are moved to the forward or reverse travel position by the pilot oil pressure from the remote control valve.

The oil from the each pump flows into the main control valve and then goes to the each travel motor through the turning joint.

The return oil from both travel motors returns to the hydraulic oil tank through the turning joint and the travel spools in the main control valve.

When this happens, the machine moves to the forward or reverse.

TRAVEL CIRCUIT OPERATION



260L3HC16A

Valves are provided on travel motors to offer the following functions.

1) COUNTER BALANCE VALVE

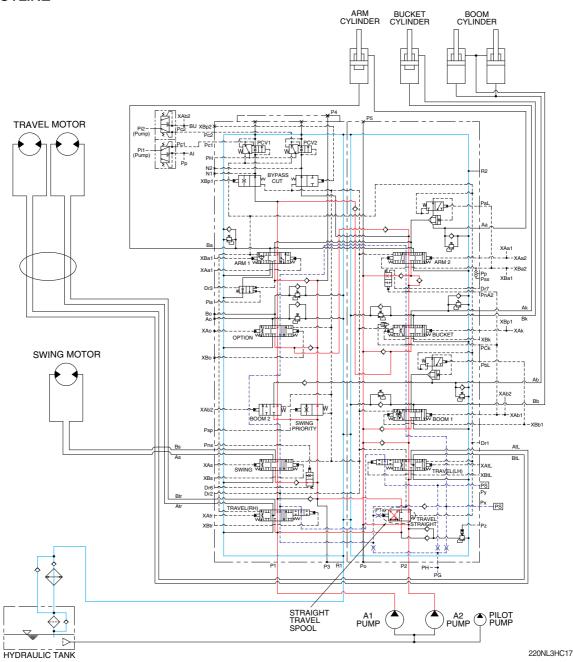
When stopping the motor of slope descending, this valve to prevent the motor over run.

2) OVERLOAD RELIEF VALVE

Relief valve limit the circuit pressure below 350 kgf/cm² to prevent high pressure generated at a time of stopping the machine. Stopping the motor, this valve sucks the oil from lower pressure passage for preventing the negative pressure and the cavitation of the motor.

GROUP 5 COMBINED OPERATION

1. OUTLINE



The oil from the A1 and A2 pump flows through the neutral oil passage, bypass oil passage and confluence oil passage in the main control valve. Then the oil goes to each actuator and operates them. Check valves and orifices are located on these oil passage in the main control valve. These control the oil from the main pumps so as to correspond to the operation of each actuator and smooth the combined operation.

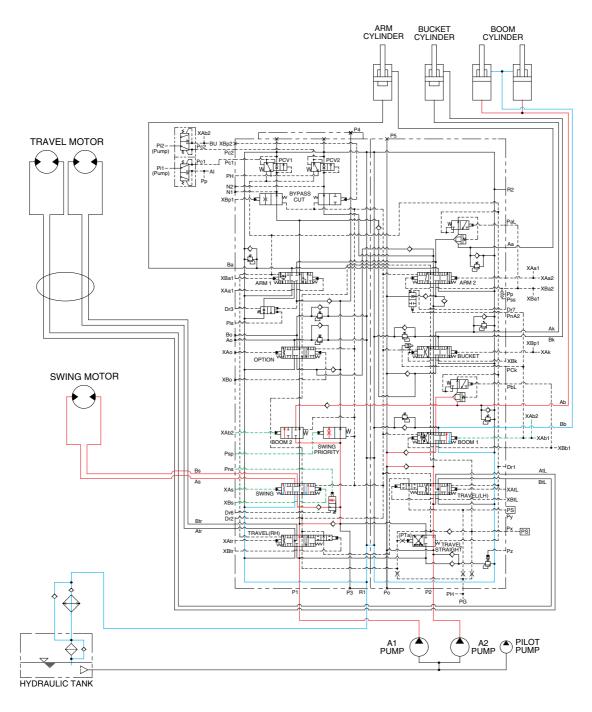
STRAIGHT TRAVEL SPOOL

This straight travel spool for straight travel is provided in the main control valve.

If any actuator is operated when traveling, the straight travel spool is pushed to the right by the pilot oil pressure.

Consequently, the left and right travel oil supply passage are connected, and equivalent amount of oil flows into the left and right travel motors. This keeps the straight travel.

2. COMBINED SWING AND BOOM UP OPERATION



220NL3HC18

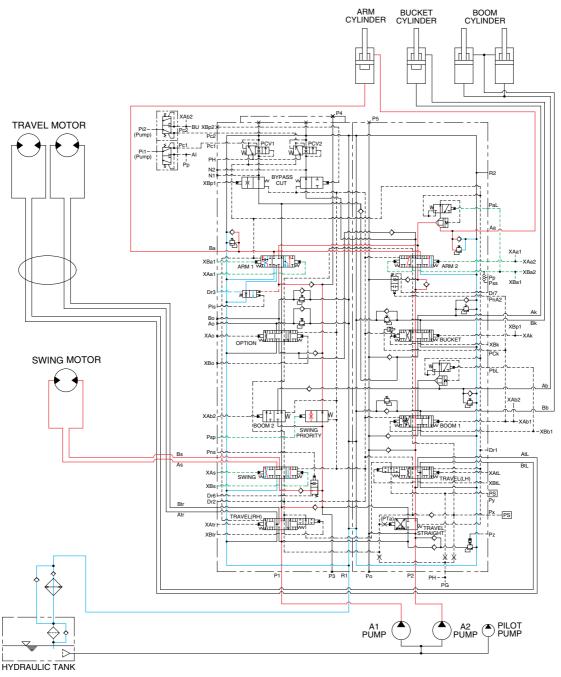
When the swing and boom up functions are operated simultaneously, the swing spool and boom spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the A1 pump flows into the swing motor through swing spool and the boom cylinder through boom 2 spool.

The oil from the A2 pump flows into the boom cylinders through the boom 1 spool in the right control valve. The upper structure swings and the boom is operated.

Refer to page 3-8 for the boom priority system.

3. COMBINED SWING AND ARM OPERATION



220NL3HC19

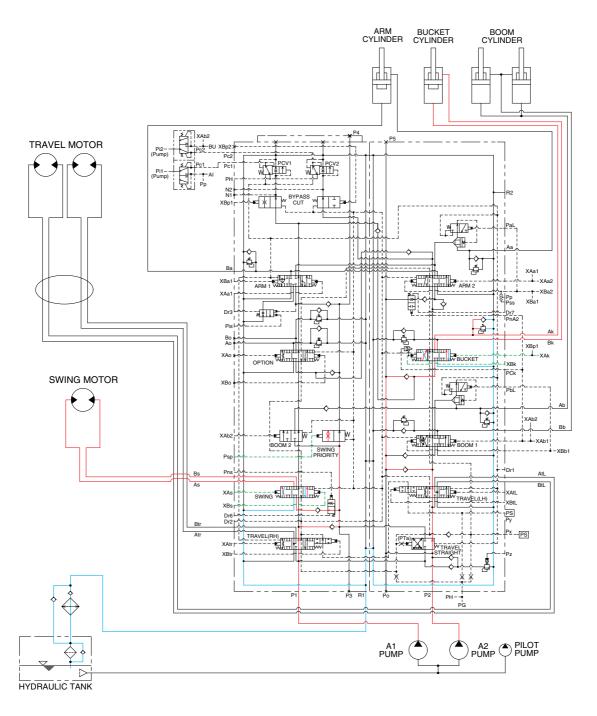
When the swing and arm functions are operated simultaneously, the swing spool and arm spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the A1 pump flows into the swing motor through swing spool and the arm cylinder through arm 1 spool.

The oil from the A2 pump flows into the arm cylinder through the arm 2 spool of the right control valve. The upper structure swings and the arm is operated.

Refer to page 3-13 for the swing operation preference function.

4. COMBINED SWING AND BUCKET OPERATION



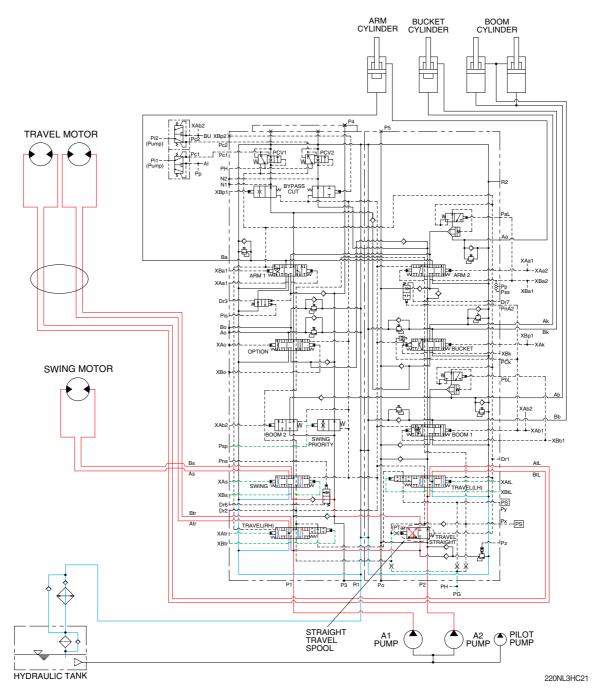
220NL3HC20

When the swing and bucket functions are operated simultaneously, the swing spool and bucket spool in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the A1 pump flows into the swing motor through the swing spool in the left control valve. The oil from the A2 pump flows into the bucket cylinder through the bucket spool in the right control valve.

The upper structure swings and the bucket is operated.

5. COMBINED SWING AND TRAVEL OPERATION



When the swing and travel functions are operated simultaneously, the swing spool and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve and straight travel spool is pushed to the right by the pilot oil pressure from the pilot pump.

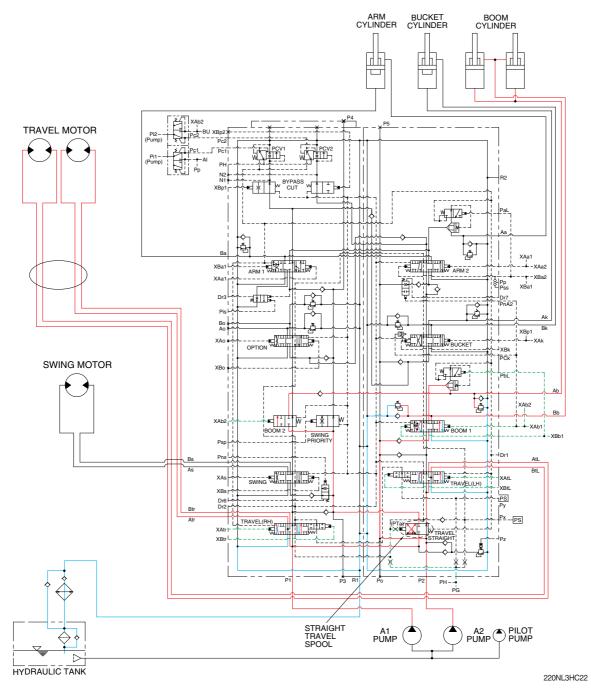
The oil from the A1 pump flows into the travel motors through the RH travel spool of the left control valve and the LH travel spool of the right control valve via the straight travel spool.

The oil from the A2 pump flows into the swing motor through the straight travel spool.

When the pressure of the travel motors is lower than the pressure of the swing motor, some oil from the A2 pump flows into the travel motors through the check valve and orifice in the straight travel spool. This prevents the rapid slowdown of the travel.

The upper structure swings and the machine travels straight.

6. COMBINED BOOM AND TRAVEL OPERATION



When the boom and travel functions are operated simultaneously, the boom spools and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve and the straight travel spool is pushed to the right by the oil pressure from pilot pump.

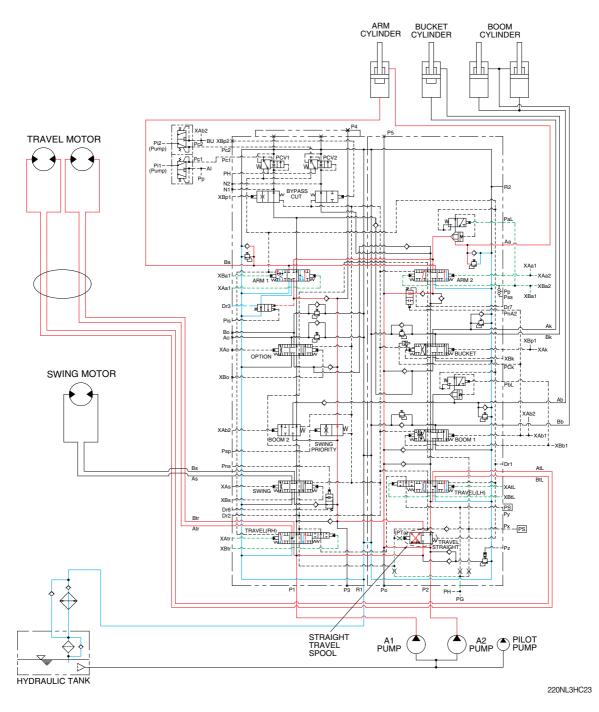
The oil from the A1 pump flows into the travel motors through the RH travel spool of the left control valve and the LH travel spool of the right control valve via the straight travel spool.

The oil from the A2 pump flows into the boom cylinders through the boom 2 spool and boom 1 spool via the parallel and confluence oil passage in case boom up operation.

When the pressure of the travel motors is lower than the pressure of the boom cylinders, some oil from the A2 pump flows into the travel motors through the check valve and orifice in the straight travel spool. This prevents the rapid slowdown of the travel.

The boom is operated and the machine travels straight.

7. COMBINED ARM AND TRAVEL OPERATION



When the arm and travel functions are operated simultaneously, the arm spools and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve and the straight travel spool is pushed to the right by the oil pressure from pilot pump.

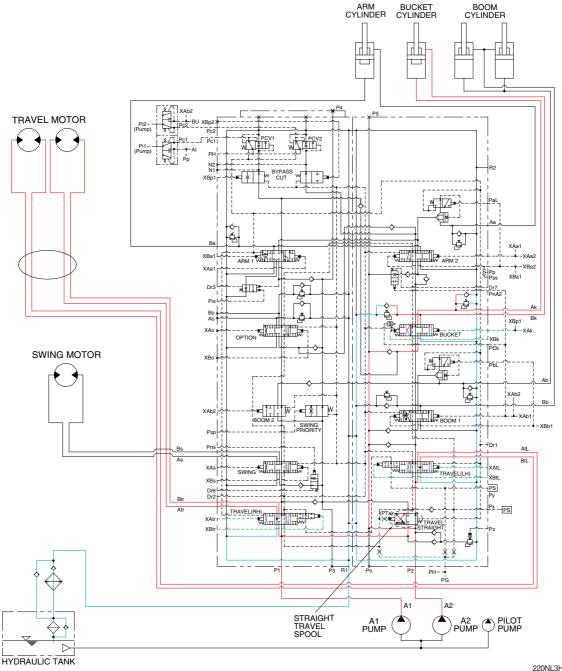
The oil from the A1 pump flows into the travel motors through the RH travel spool of the left control valve and the LH travel spool of the right control valve via the straight travel spool.

The oil from the A2 pump flows into the arm cylinders through the arm 1 spool and arm 2 spool via the parallel and confluence oil passage.

When the pressure of the travel motors is lower than the pressure of the arm cylinder, some oil from the A2 pump flows into the travel motors through the check valve and orifice in the straight travel spool. This prevents the rapid slowdown of the travel.

The arm is operated and the machine travels straight.

8. COMBINED BUCKET AND TRAVEL OPERATION



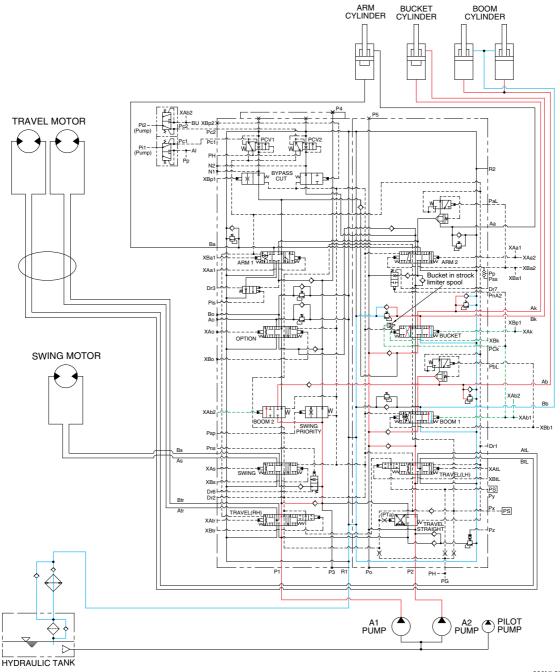
When the bucket and travel functions are operated simultaneously, the bucket spool and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve, and the straight travel spool is pushed to the right by the oil pressure from pilot pump. The oil from the A1 pump flows into the travel motors through the RH travel spool of the left control valve and the LH travel spool of the right control valve via the straight travel spool of the control valve.

The oil from the A2 pump flows into the bucket cylinder through the bucket spool via the confluence oil passage.

When the pressure of the travel motors is lower than the pressure of the bucket cylinder, some oil from the A2 pump flows into the travel motors through the check valve and orifice in the straight travel spool. This prevents the rapid slowdown of the travel.

The bucket is operated and the machine travels straight.

9. COMBINED BOOM UP AND BUCKET OPERATION



220NL3HC25

When the boom up and bucket functions are operated simultaneously, each spool in the main control valve is moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the A1 pump flows into the boom cylinders through the boom 2 spool in the left control valve. The oil from the A2 pump flows into the boom cylinders and bucket cylinder through the boom 1 spool, bucket spool and the parallel and confluence oil passage in the right control valve.

Also, when the boom up and bucket in functions are operated simultaneously, the boom up operation preference function is operated by the pilot pressure PCk and then the bucket spool transfers in the half stroke not full stroke (refer to page 2-33). Therefore, the most of pressurized oil flows into boom 1 spool than the bucket spool to make the boom up operation more preferential. The boom and bucket are operated.

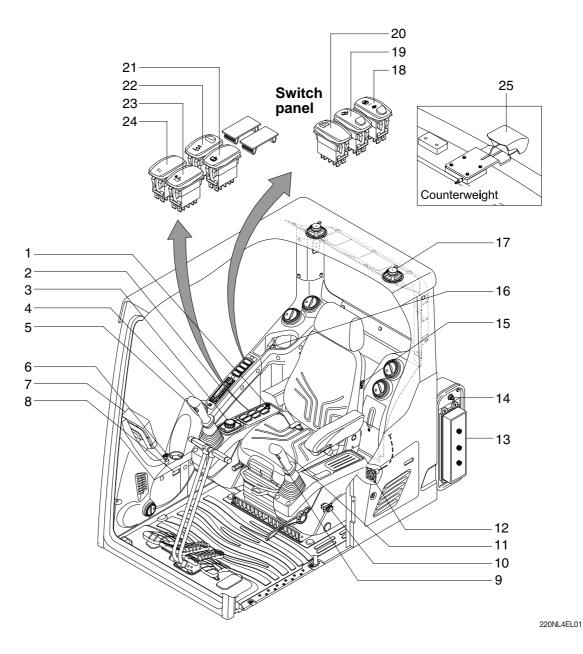
SECTION 4 ELECTRICAL SYSTEM

Group	1	Component Location	4-1
Group	2	Electrical Circuit	4-3
Group	3	Electrical Component Specification	4-23
Group	4	Connectors	4-34

SECTION 4 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION

1. LOCATION 1

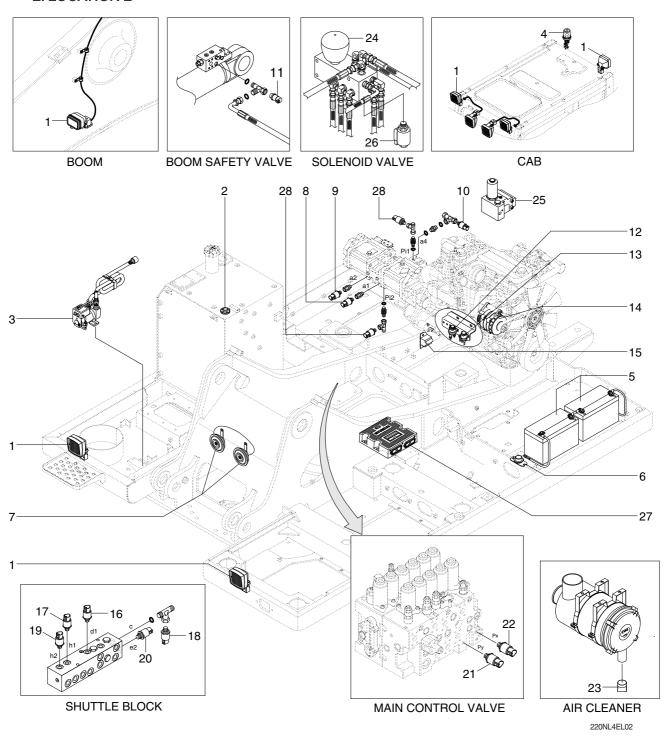


- 1 Cigar lighter
- 2 Radio & USB player
- 3 Haptic controller
- 4 Horn switch
- 5 Breaker operation switch
- 6 Starting switch
- 7 Cluster
- 8 Service meter
- 9 Power max switch

- 10 Emergency engine stop switch
- 11 One touch decel switch
- 12 RS232 & J1939 service socket
- 13 Fuse & relay box
- 14 Master switch
- 15 Seat heater switch
- 16 Power socket
- 17 Speaker
- 18 SCR system cleaning switch

- 19 Quick clamp switch
- 20 Air compressor switch
- 21 Lower wiper & washer switch
- 22 Boom floating switch
- 23 Swing lock/fine switch
- 24 Travel straight switch
- 25 Rear view camera

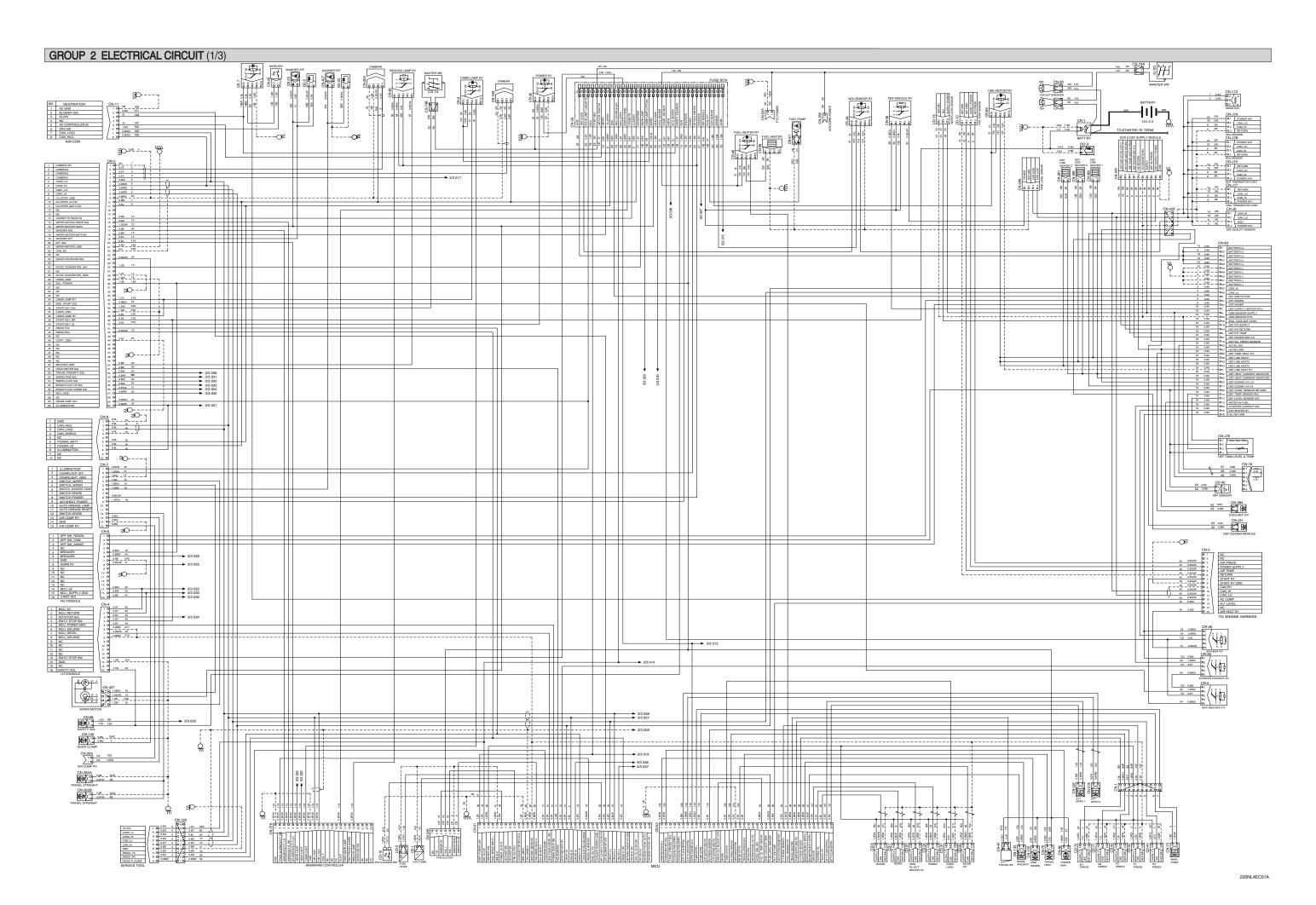
2. LOCATION 2



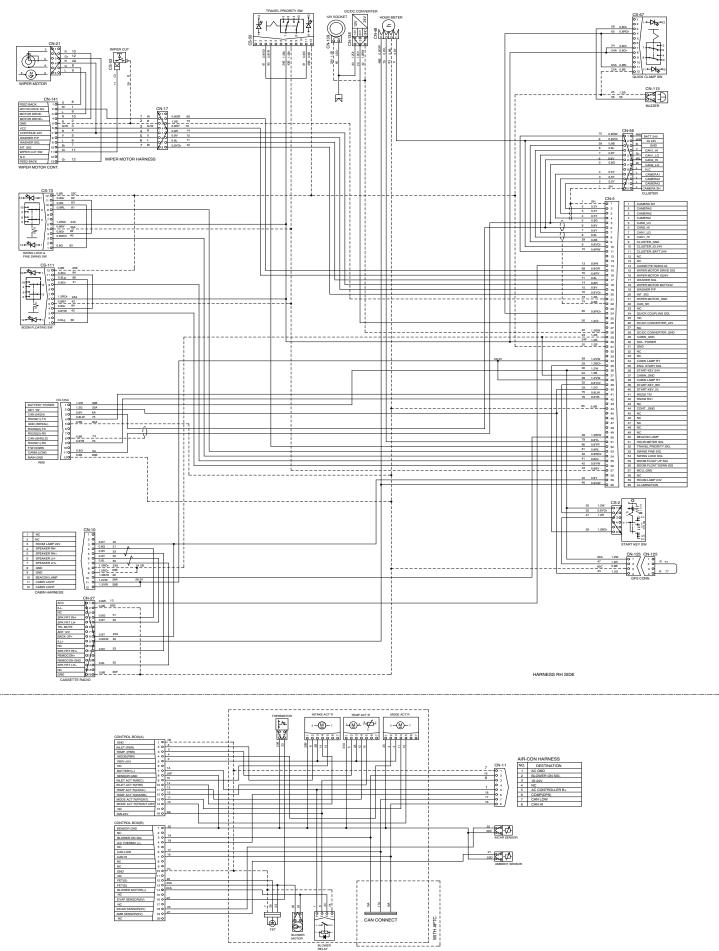
- 1 Lamp
- 2 Fuel sender
- 3 Fuel filler pump
- 4 Beacon lamp
- 5 Battery
- 6 Battery relay
- 7 Horn
- 8 P1 pressure sensor
- 9 P2 pressure sensor
- 10 EPPR pressure sensor

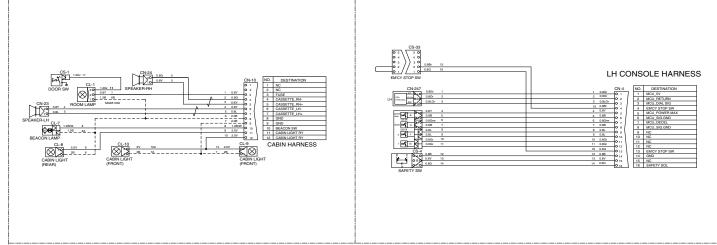
- 11 Overload pressure sensor
- 12 Start relay
- 13 Heater relay
- 14 Alternator
- 15 Travel alarm buzzer
- 16 Arm/Bucket in pressure sensor
- 17 Boom up pressure sensor
- 18 Swing pressure sensor
- 19 Boom down pressure sensor
- 20 Arm in pressure sensor

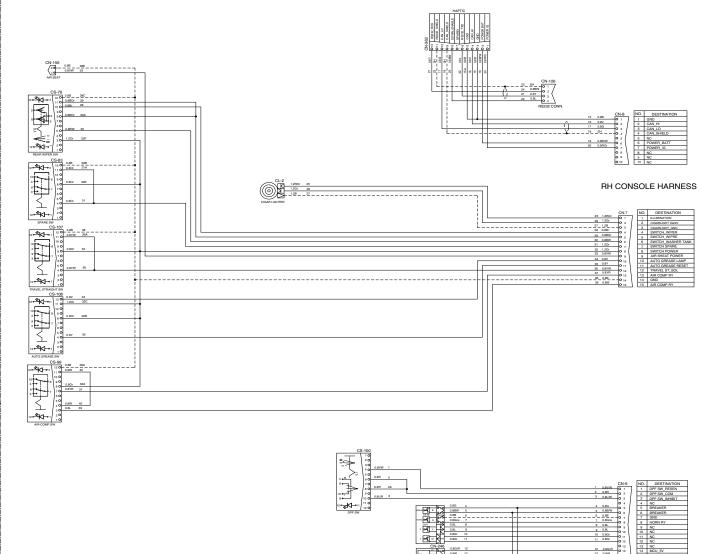
- 21 Attach pressure sensor
- 22 Travel pressure sensor
- 23 Air cleaner sensor
- 24 5 cartridge valve
- 25 Pump EPPR valve
- 26 Boom priority EPPR valve
- 27 MCU
- 28 Nega-control pressure sensor



· ELECTRICAL CIRCUIT (2/3)



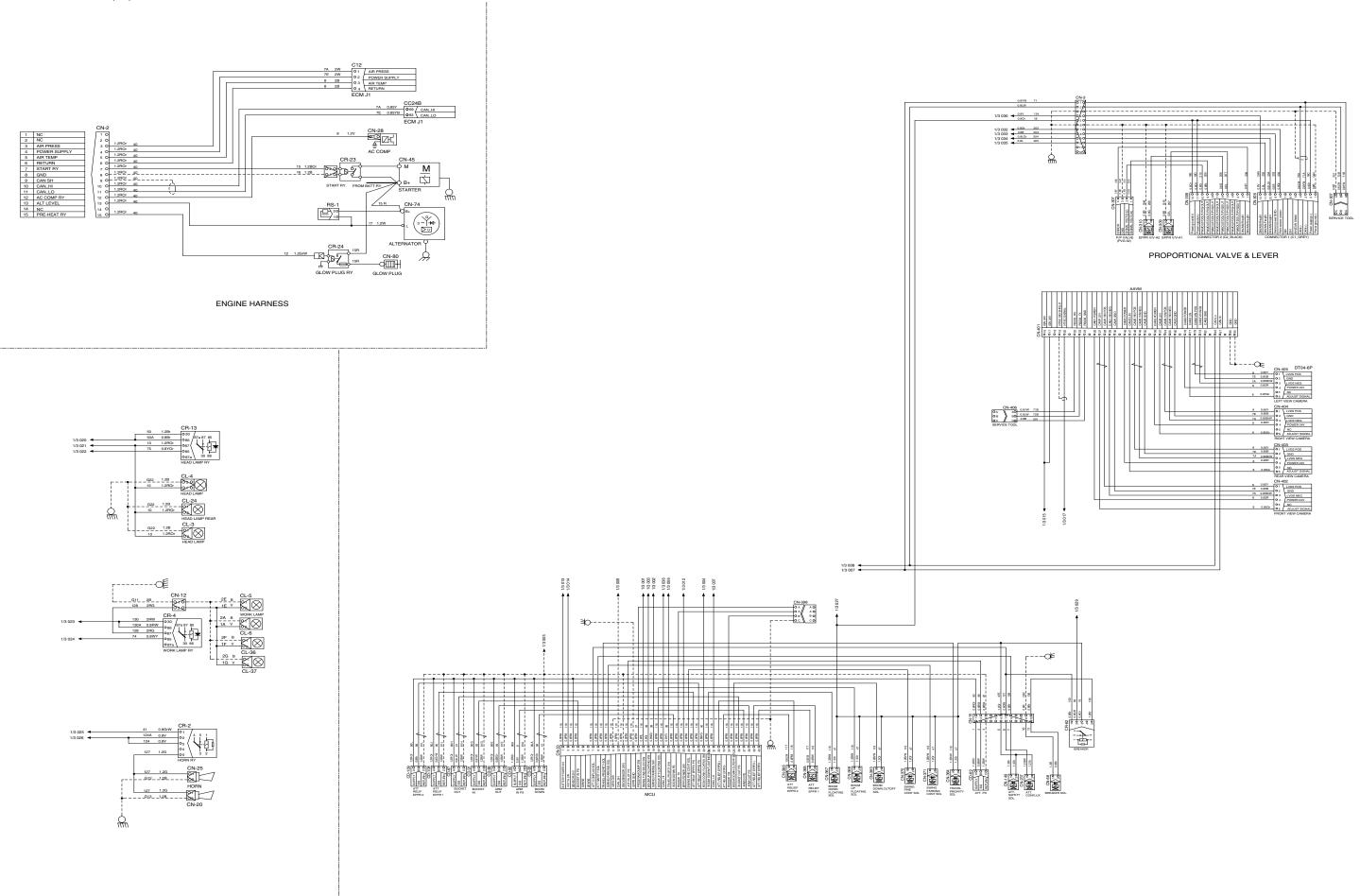




CS-26A 0.88W 5A 0.8G 4A

220NL4EC02A

· ELECTRICAL CIRCUIT (3/3)



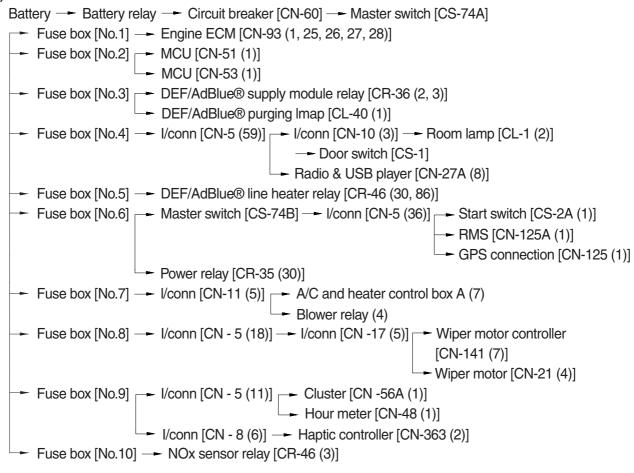
MEMORANDUM

1. POWER CIRCUIT

The negative terminal of battery is grounded to the machine chassis.

When the start switch is in the OFF position, the current flows from the positive battery terminal as shown below.

1) OPERATING FLOW



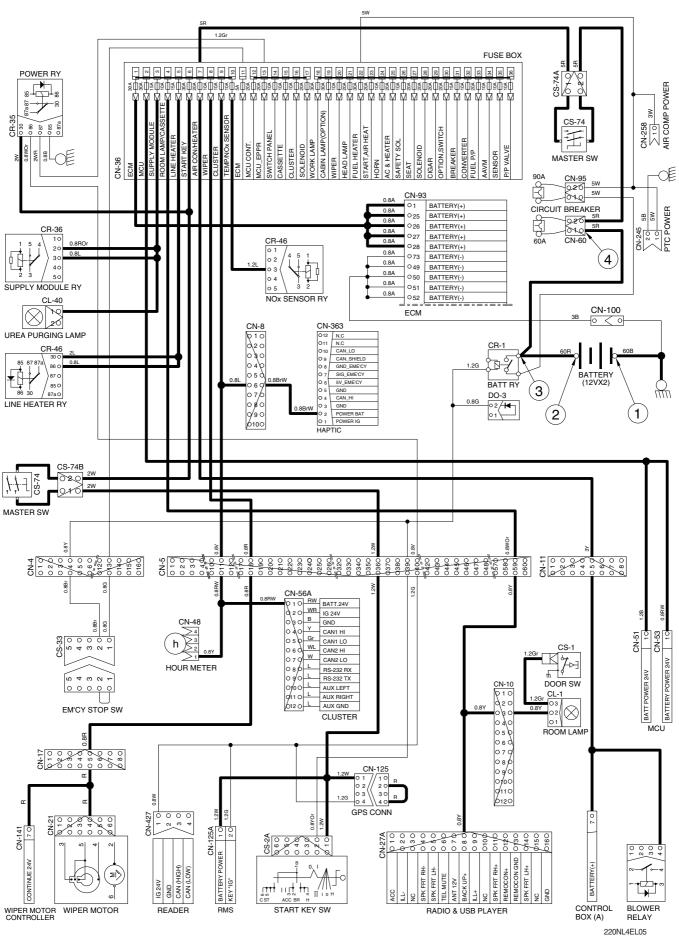
I/conn : Intermediate connector

2) CHECK POINT

Engine	Start switch	Check point	Voltage
	OFF	① - GND (battery 1EA)	10~12.5V
OFF		② - GND (battery 2EA)	20~25V
OFF	OFF	③ - GND (battery relay 2EA)	20~25V
		④ - GND (circuit breaker)	20~25V

***** GND : Ground

POWER CIRCUIT



2. STARTING CIRCUIT

1) OPERATING FLOW

```
Battery(+) terminal — Battery relay [CR-1] — Circuit breaker [CN-60] — Master switch [CS-74A] — Fuse box [No.6] — Master switch [CS-74B] — I/conn [CN-5(36)] — Start switch [CS-2A (1)] — Power relay [CR-35 (30)]
```

(1) When start key switch is in ON position

```
Start switch ON [CS-2 (2)] — I/conn [CN-5 (39)]

Battery relay [CR-1] — Battery relay operating (all power is supplied with the electric component)

I/conn [CN-4 (4)] — Emergency engine stop sw [CS-33 (2)—(1)] — I/conn [CN-4 (13)]

— Fuse box [No. 11] — Engine ECM [CN-93 (5)]

Start switch ON [CS-2 (3)] — GPS conn [CN-125 (2)—(4)]

— I/conn [CN-5 (40)] — Power relay [CR-35 (86)—(87)]

— Fuse box [No.12] — MCU [CN-51 (21)]

— Reader [CN-427 (1)]

— RMS [CN-125 (2)]
```

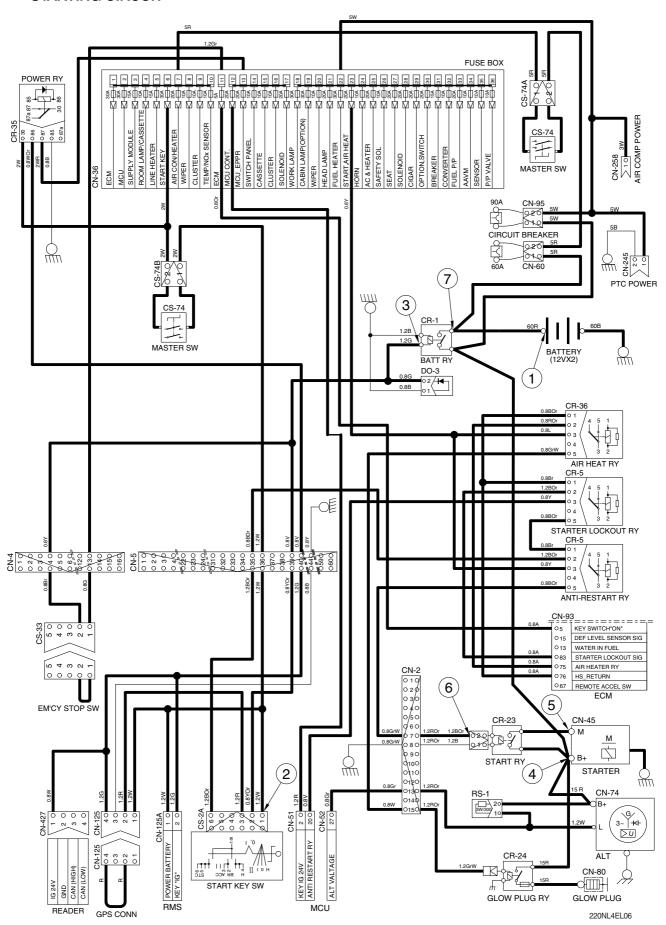
(2) When start key switch is in START position

```
Start switch START [CS-2 (6)] \longrightarrow I/conn [CN-5 (35)] \longrightarrow Anti-restart relay [CR-5 (2) \longrightarrow (5)] \longrightarrow I/conn [CN-2 (7)] \longrightarrow Start relay [CR-23 (2)] \longrightarrow Starter motor operating
```

2) CHECK POINT

Engine	Start switch	Check point	Voltage
		① - GND (battery)	
		② - GND (start key)	
		③ - GND (battery relay M4)	
OPERATING	START	④ - GND (starter B ⁺)	20~25V
		⑤ - GND (starter M)	
		⑥ - GND (start relay)	
		⑦ - GND (battery relay M8)	

STARTING CIRCUIT



3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator releases the key switch to the ON position.

Charging current generated by operating alternator flows into the battery through the battery relay [CR-1].

The current also flows from alternator to each electrical component and controller through the fuse box.

1) OPERATING FLOW

(1) Warning flow

Alternator "L" terminal → I/conn [CN-2 (13)] → MCU alternator level [CN-52 (27)] → Cluster charging warning lamp (Via CAN interface)

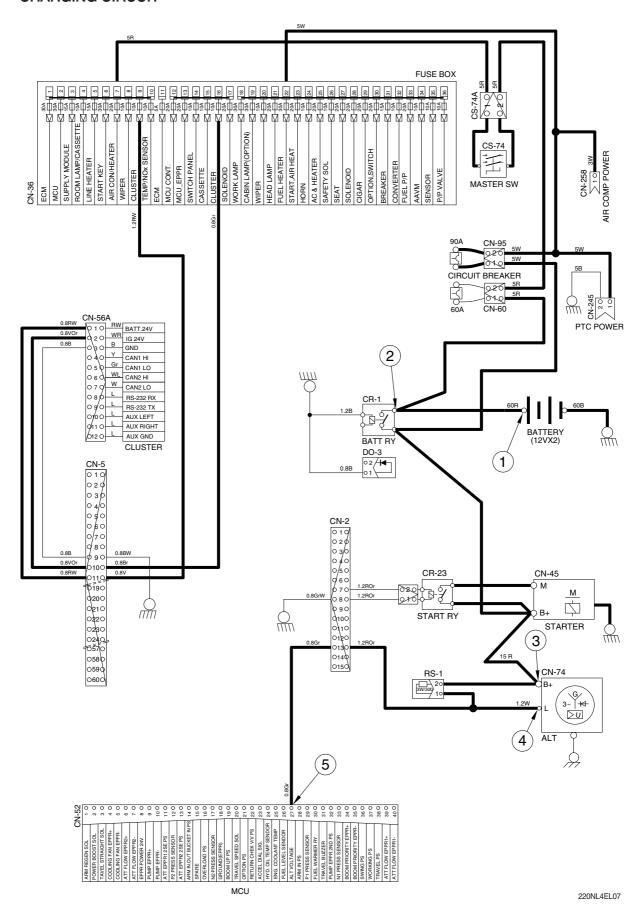
(2) Charging flow

2) CHECK POINT

Engine	Start switch	Check point	Voltage
		① - GND (battery voltage)	
		② - GND (battery relay)	
Run	ON	③ - GND (alternator B ⁺ terminal)	20~25V
		④ - GND (alternator L terminal)	
		⑤ - GND (MCU)	

***** GND : Ground

CHARGING CIRCUIT



4. HEAD AND WORK LIGHT CIRCUIT

1) OPERATING FLOW

Fuse box (No.21) — Head light relay [CR-13 (30, 86)] Fuse box (No.18) — Work light relay [CR-4 (30, 86)]

(1) Head light switch ON

Head light switch ON [CN-376 (13)] — Head light relay [CR-13 (85) \rightarrow (87)] — Head light ON [CL-3 (2), CL-4 (1), CL-24 (2)] — I/conn [CN-7 (1)] — Cigar light [CL-2] — I/conn [CN-5 (60)] — Radio & USB player illumination ON [CN-27A (9)]

(2) Work light switch ON

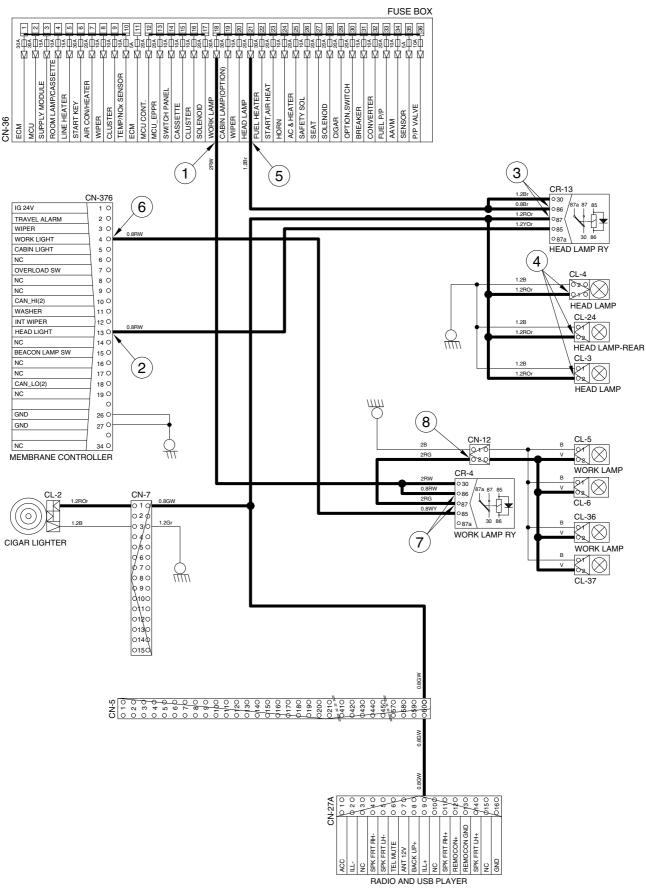
Work light switch ON [CN-376 (4)] → Work light relay [CR-4 (85) → (87)] → I/conn [CN-12 (2)] → Work light ON [CL-5 (2), CL-6 (2), CL-36 (2), CL-37 (2)]

2) CHECK POINT

Engine	Start switch	Check point	Voltage
		① - GND (fuse box)	
	ON	② - GND (head light switch power output)	20~25V
		③ - GND (head light relay)	
CTOD		④ - GND (head light)	
STOP		⑤ - GND (fuse box)	
		⑥ - GND (work light switch power output)	
		⑦ - GND (work light relay)	
		8 - GND (work light)	

***** GND : Ground

HEAD AND WORK LIGHT CIRCUIT



5. BEACON LAMP AND CAB LIGHT CIRCUIT

1) OPERATING FLOW

```
Fuse box (No.30) — Beacon lamp relay [CR-36 (2, 3)] Fuse box (No.19) — Cab light relay [CR-9 (30, 86)]
```

(1) Beacon lamp switch ON

(2) Cab light switch ON

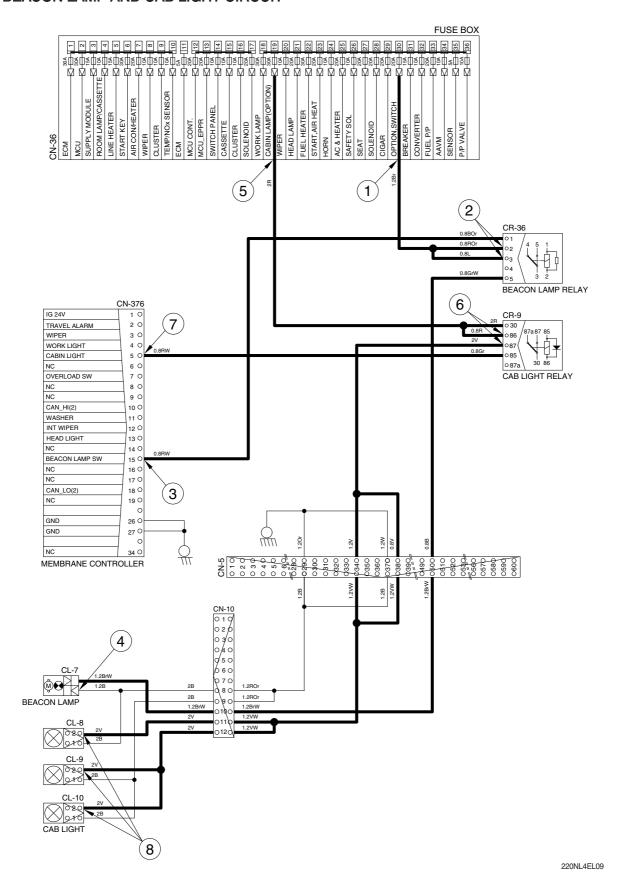
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Cab light switch ON [CN-376 (5)] — Cab lamp relay [CR-9 (85) \rightarrow (87)] — I/conn [CN-5 (34, 38)] — I/conn [CN-10 (11)] — Cab light ON [CL-8 (2)] — I/conn [CN-10 (12)] — Cab light ON [CL-9 (2), CL-10 (2)]
```

2) CHECK POINT

Engine	Start switch	Check point	Voltage
		① - GND (fuse box)	
		② - GND (beacon lamp relay)	
		③ - GND (beacon lamp switch power output)	00.057
STOP	ON	④ - GND (beacon lamp)	
5106	ON	⑤ - GND (fuse box)	20~25V
		⑥ - GND (cabin light relay)	
		⑦ - GND (cab light switch power output)	
		8 - GND (cab light)	

***** GND : Ground

BEACON LAMP AND CAB LIGHT CIRCUIT



6. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

(1) Key switch ON

Fuse box (No.14) → Membrance controller [CN-376 (1)]

Fuse box (No.8) — I/conn [CN-5 (18)] — I/conn [CN-17 (5)] — Wiper motor controller [CN-141 (7)] — Wiper motor [CN-21 (4)]

Fuse box (No.20)

I/conn [CN-5 (16)]

Low wiper motor [CN-17 (4)]

Wiper motor controller [CN-141 (6)]

Washer pump [CN-22 (2)]

(2) Wiper switch ON (Intermittent)

Wiper switch ON [CN-376 (12)] → I/conn [CN-5 (20)] → I/conn [CN-17 (8)]

Wiper motor controller [CN-141 (10)→(3)] → Wiper motor [CN-21 (6)] → Intermittently operating

(3) Wiper switch ON (continual)

Wiper switch ON [CN-376 (3)] → I/conn[CN-5 (15)] → I/conn[CN-17 (2)]

→ Wiper motor controller [CN-141 (2) → (4)] → Wiper motor [CN-21 (2)] → Continual operating

(4) Washer switch ON

Washer switch ON [CN-376 (11)] → I/conn [CN-5 (17)] → I/conn [CN-17 (7)]

- → Wiper motor controller [CN-141 (9) → (8)] → I/conn [CN-17 (6)] → I/conn [CN-5 (19)]
- → Washer pump [CN-22 (1)] → Washer operating

Wiper switch ON [CN-376 (3)] → I/conn[CN-5 (15)] → I/conn[CN-17 (2)]

— Wiper motor controller [CN-141 (2) → (4)] — Wiper motor [CN-21 (2)] — Continual operating

(5) Auto parking (when switch OFF)

Switch OFF [CN-376 (3)] — Wiper motor parking position by wiper motor controller

2) OPERATING FLOW (LOW WIPER)

(1) Kev switch ON

Fuse box (No. 30) → I/conn [CN-7 (8)] → Low wiper switch [CS-79 (1, 5)]

(2) Wiper switch ON (1st)

Wiper switch ON [CS-79 (1 \rightarrow 2)] \longrightarrow I/conn [CN-7 (5)] \longrightarrow Wiper motor [CN-407 (4)] \longrightarrow Wiper operating

(3) Wiper switch ON (2nd)

Wiper switch ON [CS-79 (5 \rightarrow 4)] — I/conn [CN-7 (6)] — I/conn [CN-262 (2)] — Washer pump [CN-407 (2)] — Washer operating

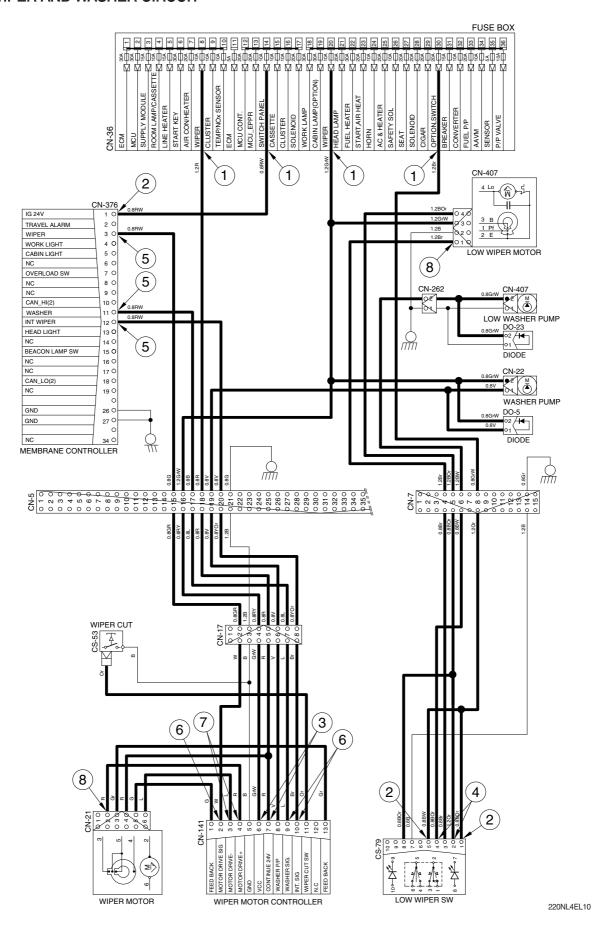
Wiper switch ON [CS-79 (1 \rightarrow 2)] \longrightarrow I/conn [CN-7 (5)] \longrightarrow Wiper motor [CN-407 (4)] \longrightarrow Wiper operating

3) CHECK POINT

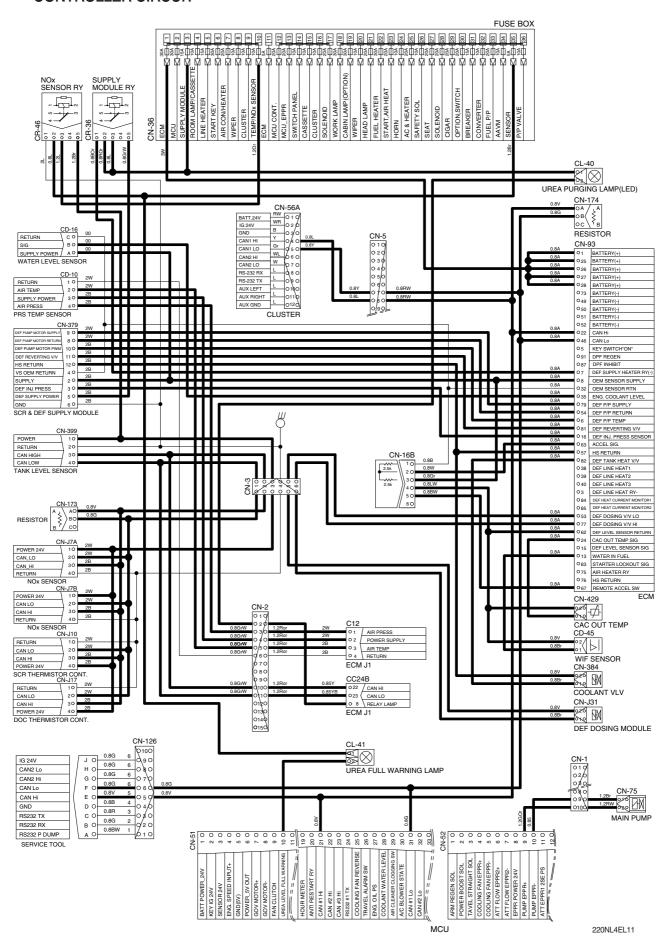
Engine	Start switch	Check point	Voltage
		① - GND (fuse box)	
		② - GND (switch power input)	20~25V
		③ - GND (wiper power input)	
STOP	ON	④ - GND (switch power input)	
3106	ON	⑤ - GND (switch power output)	0 ~ 5V
		⑥ - GND (wiper power input)	24V
		⑦ - GND (wiper power output)	
		8 - GND (wiper motor)	0 or 24V

*** GND: Ground**

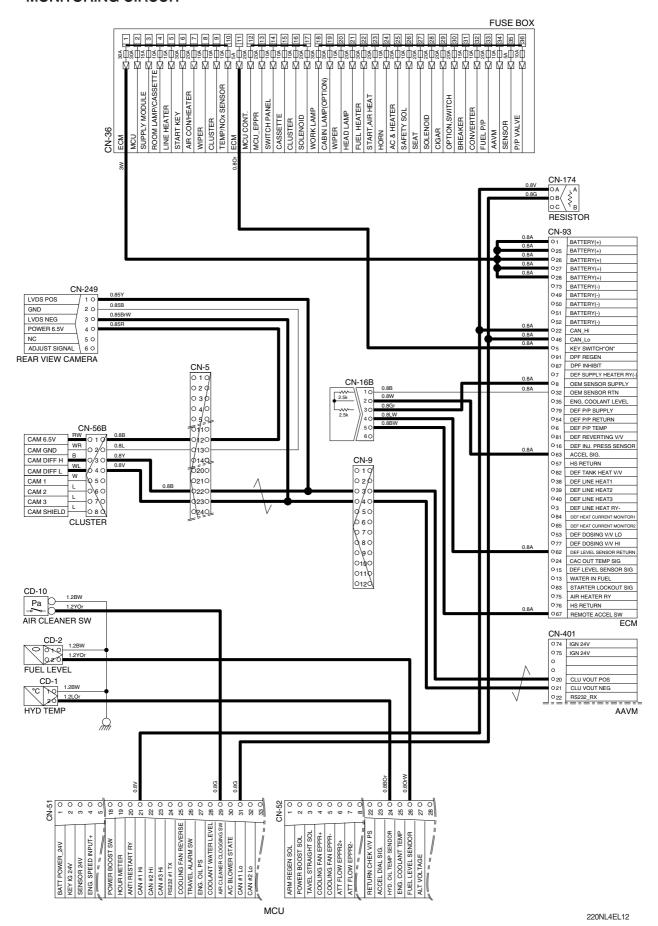
WIPER AND WASHER CIRCUIT



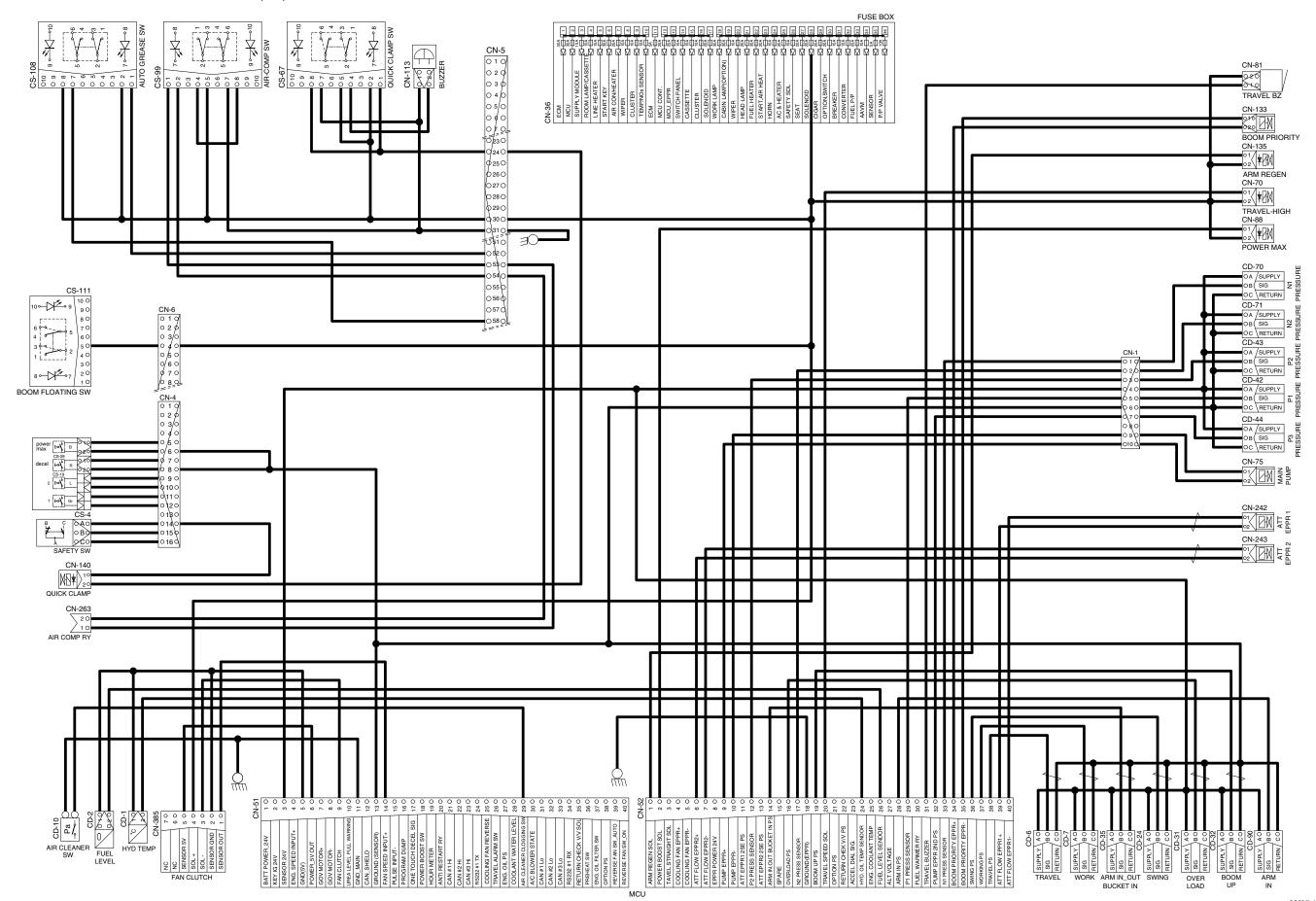
CONTROLLER CIRCUIT



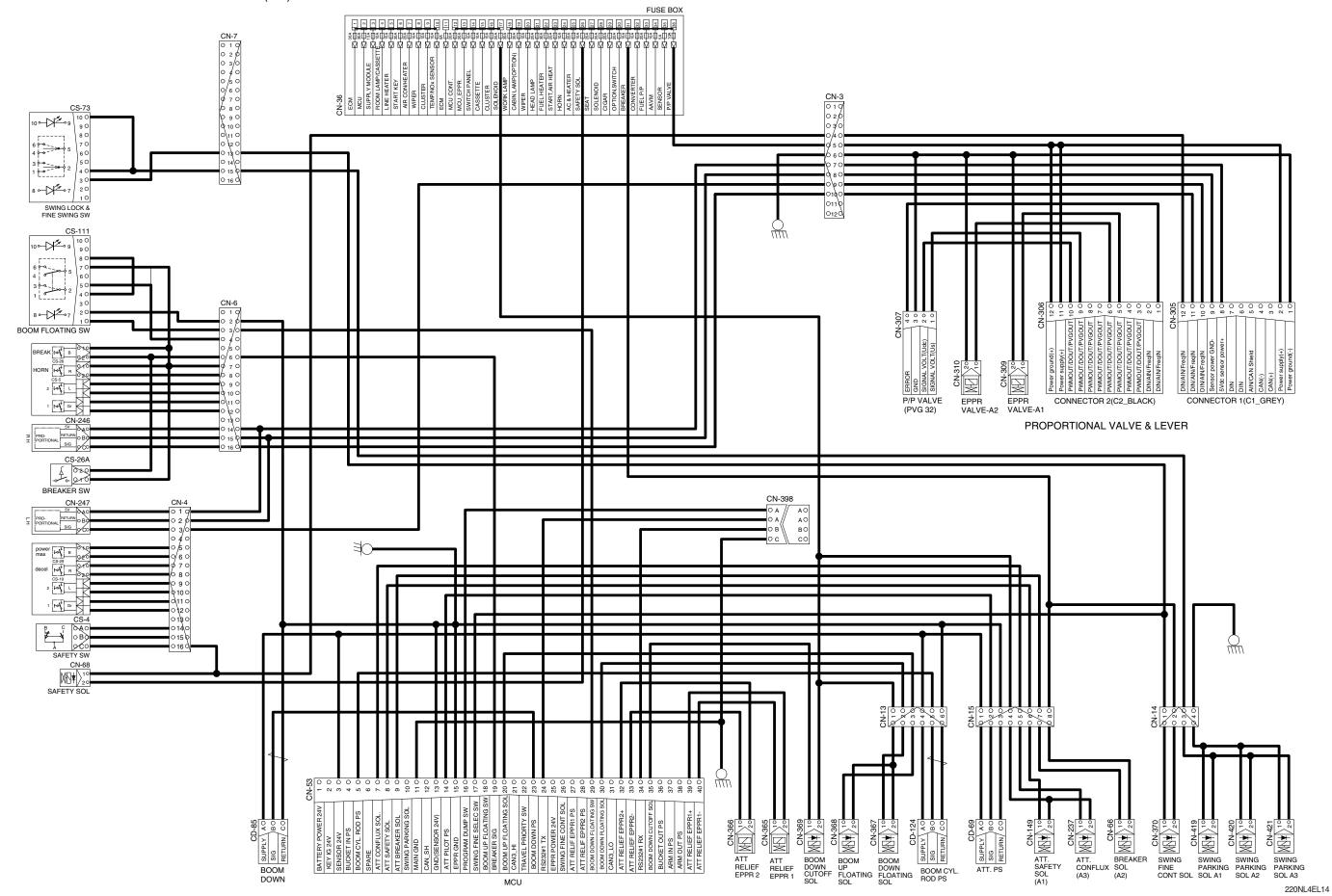
MONITORING CIRCUIT



ELECTRIC CIRCUIT FOR HYDRAULIC (1/2)



ELECTRIC CIRCUIT FOR HYDRAULIC (2/2)



GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

Part name	Symbol	Specifications	Check
Battery		12V × 100Ah (2EA)	 * Check specific gravity 1.280 over : Over charged 1.280 ~ 1.250 : Normal 1.250 below : Recharging
Battery relay	CR-1	Rated load : 24V 100A (continuity) 1000A (30seconds) ** Check coil resistance(Normal : About 50 Ω ** Check contact Normal : ∞ Ω	
Glow plug relay	CR-24	24V 200A	* Check contact Normal : 0.942 Ω (For terminal 1-GND)
Start key	CS-2A	B-BR : 24V 1A B-ACC: 24V 10A B-ST : 24V 40A	* Check contact OFF: $\infty \Omega$ (for each terminal) ON: 0Ω (for terminal 1-3 and 1-2) START: 0Ω (for terminal 1-6)
Pressure sensor	O A SUPPLY O B SIG O C RETURN CD-6 CD-7 CD-16 CD-24 CD-31 CD-32 CD-35 CD-42 CD-43 CD-44 CD-69 CD-70 CD-71 CD-85 CD-90 CD-124	8~30V	* Check contact Normal : 0.1 Ω
Resistor	O A A A A A A A A A A A A A A A A A A A	4W	* Check resistance A-B : 120 Ω

Part name	Symbol	Specifications	Check
Glow plug	CN-80	24V 200A	* Check resistance 0.25~0.12 Ω
Temperature sensor (hydraulic)	°C 20	-	* Check resistance 50°C : 804 Ω 80°C : 310 Ω 100°C : 180 Ω
Air cleaner pressure switch	Pa CD-10	N.O TYPE	* Check contact High level : $∞$ $Ω$ Low level : 0 $Ω$
Fuel level sender	CD-2	-	* Check resistance Full: 50 Ω 6/12: 350 Ω 11/12: 100 Ω 5/12: 400 Ω 10/12: 150 Ω 4/12: 450 Ω 9/12: 200 Ω 3/12: 500 Ω 8/12: 250 Ω 2/12: 550 Ω 7/12: 300 Ω 1/12: 600 Ω Empty warning: 700 Ω
Relay (air con blower)	3 4 4 0 3 0 2 0 1 2 10	24V 20A	% Check resistance Normal : About 200 Ω (for terminal 1-3) $\infty \Omega$ (for terminal 2-4)
Relay	CR-2 CR-5 CR-36 CR-39 CR-45 CR-46 CR-50 CR-51	24V 16A	* Check resistance Normal : About 160 Ω (for terminal 1-2) 0Ω (for terminal 3-4) $\infty\Omega$ (for terminal 3-5)

Part name	Symbol	Specifications	Check
Relay	CR-4 CR-7 CR-9 CR-13 CR-35 CR-46 CR-52	24V 16A	* Check resistance Normal : About 160 Ω (for terminal 85-86) 0Ω (for terminal 30-87a) $\infty\Omega$ (for terminal 30-87)
Solenoid valve	CN-66 CN-68 CN-70 CN-88 CN-135 CN-140 CN-149 CN-237 CN-262A CN-262B CN-367 CN-368 CN-369 CN-370 CN-419 CN-420 CN-421	24V 1A	* Check resistance Normal: 15~25 Ω (for terminal 1-2)
EPPR valve	CN-75 CN-133 CN-242 CN-243 CN-309 CN-310 CN-365 CN-366 CN-378 CN-384	700mA	* Check resistance Normal : 15~25 Ω (for terminal 1-2)
Speaker	O 1 O 2 CN-23(LH) CN-24(RH)	20W	* Check resistance Normal : A few Ω
Switch (locking type)	CS-52 CS-67 CS-83 CS-99 CS-107 CS-108 CS-111	24V 1.5A	* Check contact Normal ON : 0 Ω (for terminal 2-3, 5-6) Ω (for terminal 1-2, 4-5) OFF: Ω (for terminal 2-3, 5-6) Ω (for terminal 1-2, 4-5)
Room lamp	3 O 2 O 1 O CL-1	24V 10W	% Check disconnection Normal : 1.0 Ω ON : 0 Ω (For terminal 1-2) $\infty \Omega$ (For terminal 1-3) OFF : $\infty \Omega$ (For terminal 1-2) 0 Ω (For terminal 1-3)

Part name	Symbol	Specifications	Check
Head lamp, Work lamp, Cab lamp	CL-3 CL-4 CL-5 CL-6 CL-8 CL-9 CL-10 CL-24 CL-36 CL-37	24V 65W (H3 Type)	* Check disconnection Normal : 1.2 Ω
Beacon lamp	CL-7	21V 70W (H1 Type)	* Check disconnection Normal : A few Ω
Fuel filler pump	CN-61	24V 10A 35 <i>l</i> /min	* Check resistance Normal : 1.0 Ω
Hour meter	4 3 2 h 1 CN-48	16~32V	 Check operation Supply power(24V) to terminal No.2 and connect terminal No.1 and ground
Horn	CN-20 CN-25	DC22~28V 2A	Check operation Supply power(24V) to each terminal and connect ground.
Safety switch	B C A O O B O CS-4	24V 15A (N.C TYPE)	% Check contact Normal : 0Ω (for terminal A-B) Ω (for terminal A-C) Operating : Ω (for terminal A-B) Ω (for terminal A-C)

Part name	Symbol	Specifications	Check
Wiper cut switch	CS-53	24V (N.O TYPE)	% Check contact Normal : 0 Ω (one pin to ground)
Receiver dryer	Pa 2 0 1 0 CN-29	24V 2.5A	% Check contact Normal: ∞ Ω
Radio & USB player	ACC ILL Q 2 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0	24V 2A	** Check voltage 20~25V (for terminal 1-3, 3-8)
Washer pump	M 2 CN-22 CN-408	24V 3.8A	** Check contact Normal: 10.7 Ω (for terminal 1-2)
Wiper motor	3 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	24V 2A	** Check disconnection Normal : 7 Ω (for terminal 2-6)
Low wiper motor	B 3 0 3 0 0 2 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0	24V	-

Part name	Symbol	Specifications	Check
DC/DC Converter	0 3 0 12V 12V 2 0 24V GND 24V CN-138	12V 3A	Check voltage24V (for terminal 1-2)12V (for terminal 1-3)
Cigar lighter	CL-2	24V 5A 1.4W	 Check coil resistance Normal : About 1M Ω Check contact Normal : ∞ Ω Operating time : 5~15sec
Alternator	©B+ ©L (3~ +4+ ▷U	Denso 24V 95A	** Check contact Normal : 0 Ω (for terminal B+-L) Normal : 24~27.5V
Starter	M M H	24V 4.8kW	* Check contact Normal: 0.1 Ω
Travel alarm	CN-81	24V 0.5A	* Check contact Normal : 5.2 Ω
Air conditioner compressor	CN-28 =	24V 79W	** Check contact Normal: 13.4 Ω

Part name	Symbol	Specifications	Check
Start relay	CR-23	24V 300A	* Check contact Normal : 0.94 Ω (for terminal 1-2)
Blower motor	2 <u>M</u>	24V 9.5A	** Check resistance Normal : 2.5 *\Omega\$ (for terminal 1-2)
Duct sensor (switch)	20	1°C OFF 4°C ON	** Check resistance Normal : 0 Ω (for terminal 1-2), the atmosphere temp : Over 4°C
Door switch	CS-1	24V 2W	* Check resistance Normal : About 5M Ω
Switch (power max, one touch decel, horn, breaker)	CS-5 CS-19 CS-26 CS-29	24V 6A	% Check resistance Normal : ∞ Ω
Circuit breaker	CN-60 CN-95	60A (CN-60) 90A (CN-95)	Check disconnection Normal : 0 Ω (connect ring terminal and check resist between terminal 1 and 2)

Part name	Symbol	Specifications	Check
Master switch	CS-74A, CS-74B	6-36V	** Check disconnection Normal : 0.1 Ω
Breaker switch	CS-26A	-	-
Quick clamp buzzer	CN-113	24V 200mA 107±4dB	-
Socket	O1 O2 CN-139	12V 10A	-
Switch	CS-79	-	% Check contact Normal ON : 0Ω (for terminal 1-2, 4-5) Ω (for terminal 2-3, 5-6) OFF : Ω (for terminal 1-2, 4-5) Ω (for terminal 2-3, 5-6)
Switch	CS-100	24V 8A	 Check contact Normal OFF: ∞ Ω (for terminal 1-2, 2-3, 4-5, 5-6)

Part name	Symbol	Specifications	Check		
Switch	CS-73	% Check contact Normal OFF: ∞ Ω (for			
Fuel heater	CN-96	-	-		
DEF/AdBlue® line heater	O 1 O 2 O 2 O CN-381 CN-382 CN-383	-	-		
WIF sensor	©2 ©1 CD-45	-	-		
PRS temp sensor	O 1 RETURN O 2 AIR TEMP O 3 SUPPLY POWER O 4 AIR PRESS CD-10	5.0V 0.2A	% Check contact Normal 0Ω (for terminal 1-2, 47.5 Ω) Ω (for terminal 3-1, 1k Ω) Ω (for terminal 4-1, 1k Ω)		
DEF/AdBlue® sensor	O1	-	-		

Part name	Symbol	Specifications	Check
DEF/AdBlue® fill up warning lamp (LED)	CL-40	-	-
Proportional valve sensor	Proportional SIG C C CN-246 CN-247	-	-
Start button	CAN_H A O CAN_L B O GND C O CS-2B	-	-
DEF/AdBlue® full lamp	CL-41	-	-
Temperature sensor (A/C incar, A/C ambient, CAC out)	CN-429	-	-
EPPR valve	CN-384 CN-J31	24V 700mA	* Check resistance Normal : 15~25 Ω (For terminal 1-2)

Part name	Symbol	Specifications	Check
DEF/AdBlue® tank level senosr	○ 1	-	-
Proportional valve sensor	○ 1	-	-
Camera	01 LVDS POS 02 GND 03 LVDS NEG 04 POWER 24V 05 NC 06 ADJUST SIGNAL CN-402 CN-403 CN-404 CN-405	-	-

GROUP 4 CONNECTORS

1. CONNECTOR DESTINATION

Connector	Time	No. of	Destination	Connecto	r part No.
number	Туре	pin	Destination	Female	Male
CN-1	AMP	10	I/conn (Frame harness-Pump PS harness)	S816-010002	S816-110002
CN-2	AMP	15	I/conn (Frame harness-Engine harness)	2-85262-1	368301-1
CN-3	TYCO	12	I/conn (Frame harness-Pro vlv harness)	174661-2	368537-1
CN-4	AMP	16	I/conn (Console harness LH-Frame harness)	368047-1	368050-1
CN-5	DEUTSCH	60	I/conn (Side harness RH-Frame harness)	DRB16-60SAE-L018	DRB14-60PAE-L018
CN-6	AMP	16	I/conn (Console harness RH-Frame harness)	368047-1	368050-1
CN-7	AMP	15	I/conn (Console harness RH-Frame harness)	2-85262-1	368301-1
CN-8	AMP	10	I/conn (Console harness RH-Frame harness)	S816-010002	174655-2
CN-9	DEUTSCH	12	I/conn (Frame harness-AAVM harness)	DT06-12SA-P021	DT04-12PA-P021
CN-10	DEUTSCH	12	I/conn (Cab harness-Side harness RH)	DT06-12S-EP06	DT04-12PA-P021
CN-11	DEUTSCH	8	I/conn (Frame harness-Aircon harness)	DT06-8S-EP06	-
CN-12	DEUTSCH	2	l/conn (Frame harness-Boom wire harness)	DT06-2S-EP06	DT04-2P-E004
CN-13	AMP	6	I/conn (Frame harness-2 Way harness)	174262-2	174264-2
CN-13	AMP	4	Swing parking & fine control	174257-2	174259-2
CN-14	AMP	4	I/conn (Frame harness-2 Way harness)	174257-2	174259-2
CN-15	AMP	8	I/conn (Frame harness-2 Way harness)	174982-2	174984-2
CN-16	AMP	6	Emergency engine start & speed control	S816-006002	S816-106002
CN-17	AMP	8	I/conn (Side harness RH-Wiper harness)	S816-008002	S816-108002
CN-18	AMP	2	I/conn (Frame harness-Low wiper washer tank harness)	174352-2	174354-2
CN-20	MOLEX	2	Horn	36825-0211	-
CN-21	AMP	6	Wiper motor	S810-006202	-
CN-22	KET	2	Washer tank 1	MG640605	-
CN-23	KET	2	Speaker-LH	MG610070	-
CN-24	KET	2	Speaker-RH	MG610070	-
CN-25	DEUTSCH	2	Horn	DT06-2S-EP06	-
CN-27A	KUM	16	Radio & USB player	PK145-16017	-
CN-27B	AMP	8	Radio & USB player	-	174984-2
CN-28	KUM	1	Aircon compressor	NMWP01F-B	-
CN-29	KET	2	Receiver dryer	MG640795	-
CN-36	-	-	Fuse & relay box	21Q7-10910	-
CN-45	RING-TERM	-	Starter motor B+	S820-108000	-
CN-48	KET	1	Hour meter	2-520193-2	-
CN-51	DEUTSCH	40	MCU	DRC26-40SA	-
CN-52	DEUTSCH	40	MCU	DRC26-40SB	-
CN-53	DEUTSCH	40	MCU	DRC26-40SA	-

Connector	Type	No. of	Destination	Connecto	or part No.
number	Туре	pin	Destination	Female	Male
CN-56A	AMP	12	Cluster	-	174663-2
CN-56B	AMP	8	Cluster	-	174984-2
CN-60	YAZAKI	2	Circuit breaker	-	7222-4220-30
CN-61	DEUTSCH	2	Fuel filler pump	DT06-2S-EP06	-
CN-66	DEUTSCH	2	Solenoid (A2)	DT06-2S-EP06	-
CN-68	DEUTSCH	2	Safety solenoid	DT06-2S-EP06	-
CN-70	DEUTSCH	2	Travel high solenoid	DT06-2S-EP06	-
CN-74	RING-TERM	1	Alternator "B" terminal	-	S820-108000
CN-74	RING-TERM	1	Alternator "L" terminal	-	S820-105000
CN-75	AMP	2	Pump EPPR	S816-002002	-
CN-80	RING-TERM	-	Glow plug	S820-306000	-
CN-81	DEUTSCH	2	Travel buzzer solenoid	DT06-2S-EP06	-
CN-88	DEUTSCH	2	Power max solenoid	DT06-2S-EP06	-
CN-93	DELPHI	60	ECM	13964577	-
CN-95	YAZAKI	2	Circuit breaker	-	7222-4220-30
CN-100	KET	1	ECM ground	MG640944-5	-
CN-113	KET	2	Buzzer	MG651205-5	-
CN-125	Econoseal J	4	GPS connector	S816-004002	S816-104002
CN-125A	DEUTSCH	12	GPS	DT06-12S-P021	DT04-12PA-P021
CN-126	DEUTSCH	4	RS232	DT06-4S	DT04-4P
CN-126	TYCO	10	I/conn (Frame harness-Sevice tool harness)	2-1418390-1	S816-11002
CN-133	DEUTSCH	2	Boom priority solenoid	DT06-2S-EP06	-
CN-135	DEUTSCH	2	Arm regeneration solenoid	DT06-2S-EP06	-
CN-138	FASTEN	3	DC/DC converter	S810-003202	-
CN-139	FASTEN	2	12V socket	172434-2	-
CN-140	DEUTSCH	2	Quick clamp solenoid	DT06-2S-EP06	DT04-2P-E005
CN-141	AMP	13	Wiper motor controller	172498-1	-
CN-147	AMP	4	Fuel heater	2-967325-3	-
CN-149	DEUTSCH	2	Attach safety solenoid (A1)	DT06-2S-EP06	-
CN-156	DEUTSCH	2	Air seat heat	DT06-2S-EP06	DT04-2P
CN-157	AMP	1	Antena power	S822-014002	-
CN-173	DEUTSCH	3	Resistor	DT06-3S-EP06	DT04-3P-EP10
CN-174	DEUTSCH	3	Resistor	DT06-3S-EP06	DT04-3P-EP10
CN-237	DEUTSCH	2	Attach conflux solenoid (A3)	DT06-2S-EP06	-
CN-242	AMP	2	Attach EPPR 1 (A1)	174352-2	-
CN-243	AMP	2	Attach EPPR 2 (A2)	174352-2	-
CN-245	FCI	4	PTC power	180900-0	-
CN-246	DEUTSCH	3	Proportional valve-RH	DT06-3S	DT04-3P

Connector	T	No. of	Doubleshies	Connecto	or part No.
number	Type	pin	Destination	Female	Male
CN-247	DEUTSCH	3	Proportional valve-LH	DT06-3S	DT04-3P
CN-249	DEUTSCH	4	Rear view camera	DT06-4S-EP06	DT04-4P-E005
CN-258	KET	1	Air compressor power	MG640944-5	MG650943-5
CN-262	-	2	Straight travel solenoid	174352-2	174354-2
CN-262A	DEUTSCH	2	Straight travel solenoid 1	DT06-2S-EP06	-
CN-262B	DEUTSCH	2	Straight travel solenoid 2	DT06-2S-EP06	-
CN-263	DEUTSCH	2	Air compressor relay	DT06-2S-EP06	DT04-2P-E005
CN-305	DEUTSCH	12	AAVM-Connector-1	DTM06-12SA	-
CN-306	DEUTSCH	12	AAVM-Connector-2	DTM06-12SB	-
CN-307	DEUTSCH	3	Proportional-Service tool	DT06-3S-EP06	DT06-3P-E005
CN-308	AMP	4	Proportional-PVG32	2-967059-1	-
CN-309	DEUTSCH	2	Proportional-EPPR valve-A1	DT06-2S-EP06	-
CN-310	DEUTSCH	2	Proportional-EPPR valve-A2	DT06-2S-EP06	-
CN-363	AMP	12	Haptic controller	174045-2	-
CN-365	DEUTSCH	2	Attach EPPR valve-LH	DT06-2S-EP06	DT04-2P-E005
CN-366	DEUTSCH	2	Attach EPPR valve-RH	DT06-2S-EP06	DT04-2P-E005
CN-367	DEUTSCH	2	Boom down floating solenoid	85202-1	-
CN-368	DEUTSCH	2	Boom up floating solenoid	DT06-2S-EP06	-
CN-369	DEUTSCH	2	Boom down cut off solenoid	DT06-2S-EP06	DT04-2P-E005
CN-370	DEUTSCH	2	Swing fine control solenoid	DT06-2S-EP06	DT04-2P-E005
CN-376	TYCO	34	Membrane controller	4-1437290-1	-
CN-379	TYCO	12	SCR & DEF/AdBlue® supply module	2-1703639-1	-
CN-381	TYCO	2	DEF/AdBlue® line heater 1	C-0936059-01	-
CN-382	TYCO	2	DEF/AdBlue® line heater 2	C-0936059-01	-
CN-383	TYCO	2	DEF/AdBlue® line heater 3	C-0936059-01	-
CN-384	DEUTSCH	2	Coolant valve	DT06-2S-EP06	-
CN-385	-	7	Fan clutch	965570	-
CN-398	DEUTSCH	4	RS232	DT06-4S-EP06	DT04-4P-E005
CN-399	TYCO	4	DEF/AdBlue® tank level sensor	-	1-967325-1
CN-401	FCI	90	AAVM controller	-	-
CN-402	DEUTSCH	6	Front view camera	DT06-6S-P021	DT04-6P-P021
CN-403	DEUTSCH	6	Rear view camera	DT06-6S-EP06	DT04-6P-EP14
CN-404	DEUTSCH	6	LH view camera	DT06-6S-EP06	DT04-6P-EP14
CN-405	DEUTSCH	6	RH view camera	DT06-6S-EP06	DT04-6P-EP14
CN-406	DEUTSCH	3	Service tool	DT06-3S-EP06	DT06-3P-E005
CN-407	-	4	Low wiper motor	174257-2	174259-2
CN-408	AMP	2	Low washer tank	MG640605	-
CN-419	DEUTSCH	2	Swing parking-A3	DT06-2S-EP06	-

Connector	Time	No. of	Destination	Connecto	or part No.
number	Туре	pin	Destination	Female	Male
CN-420	DEUTSCH	2	Swing parking-A2	DT06-2S-EP06	-
CN-421	DEUTSCH	2	Swing parking-A1	DT06-2S-EP06	-
CN-427	MOLEX	4	Reader-RMS	039012040	026013096
CN-429	-	4	CAC out temp sensor	-	S822-11400
CN-430	DEUTSCH	6	Aftertreatment harness	-	DT04-6P-E005
CN-J7A	TYCO	4	DOC NOx sensor	2-1418390-1	-
CN-J7B	TYCO	4	SCR NOx sensor	1-1418390-1	-
CN-J10	TYCO	4	SCR Thermistor	3-1418390-1	-
CN-J17	TYCO	4	DOC Thermistor	4-1418390-1	-
CN-J31	BOSCH	2	DEF/AdBlue® dosing module	1_928_403_874	-
· Relay					ı
CR-1	RING-TERM	-	Battery relay coll	ST710289-2	-
CR-2	-	5	Horn relay	-	-
CR-4	-	5	Working lamp relay	-	-
CR-5	-	5	Anti restart relay	-	-
CR-7	-	5	Aircon compressor relay	-	-
CR-9	-	5	Cabin lamp relay	-	-
CR-13	-	5	Head lamp relay	-	-
CR-23	KET	2	Start relay	S814-002001	S814-102001
CR-24	RING TERM	1	Preheat relay	S822-014000	-
CR-35	-	5	Power relay	-	-
CR-36	-	5	Air preheat relay	-	-
CR-39	-	5	Starter lock out relay	-	-
CR-45	-	5	Beacon lamp relay	-	-
CR-46	-	5	Fuel warmer relay	-	-
CR-50	-	5	NOx sensor relay	-	-
CR-51	-	5	DEF/AdBlue® module relay	-	-
CR-52	-	5	Line heater relay	-	-
· Switch					
CS-1	SHUR	1	Door switch	S822-014002	S822-114002
CS-2A	WP	6	Start key switch	S814-006100	-
CS-2B	DEUTSCH	3	Reader	DT06-3S-EP06	DT04-3P-E005
CS-4	DEUTSCH	3	Safety switch	DT06-3S	-
CS-5	DEUTSCH	2	Horn switch	-	DT04-2P
CS-19	DEUTSCH	2	One touch decel switch	-	DT04-2P
CS-26	DEUTSCH	2	Breaker switch	DT06-2S	-
CS-26A	AMP	2	Breaker pedal switch	S816-002002	S816-102002
CS-29	DEUTSCH	2	Power max switch	DT06-2S	-

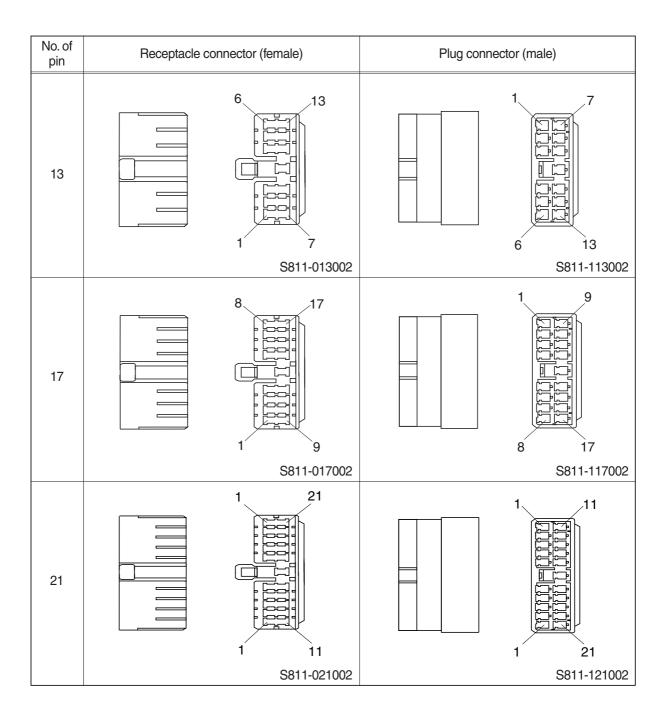
Connector	Time	No. of	Dockinskien	Connecto	or part No.
number	Type	pin	Destination	Female	Male
CS-33	AMP	6	Emergency engine stop switch	S816-006002	S816-106002
CS-52	CARLING	10	Adjust & dozer switch	VC2-01	-
CS-53	AMP	1	Wiper cut switch	S822-014002	-
CS-67	CARLING	10	Quick clamp switch	VC2-01	-
CS-73	CARLING	10	Swing lock & fine switch	VC2-01	-
CS-74A	TYCO	2	Master switch	4-1437290-1	813-130201
CS-74B	DEUTSCH	2	Master switch	-	DT04-2P-E005
CS-79	CARLING	10	Lower wiper switch	VC2-01	-
CS-83	CARLING	10	Spare switch	VC2-01	-
CS-99	CARLING	10	Air compressor switch	VC2-01	-
CS-100	CARLING	10	SCR system cleaning switch	VC2-01	-
CS-107	CARLING	10	Travel straight switch	VC2-01	-
CS-108	CARLING	10	Auto grease switch	VC2-01	-
CS-111	CARLING	10	Boom floating switch	VC2-01	-
· Light					
CL-1	KET	3	Room lamp	MG651032	-
CL-2	AMP	1	Cigar lighter	S822-014002	S822-114002
CL-3	DEUTSCH	2	Head lamp-LH	DT06-2S-EP06	DT04-2P
CL-4	DEUTSCH	2	Head lamp-RH	DT06-2S-EP06	DT04-2P
CL-5	DEUTSCH	2	Work lamp-LH	DT06-2S-EP06	DT04-2P
CL-6	DEUTSCH	2	Work lamp-RH	DT06-2S-EP06	DT04-2P
CL-7	SHUR	1	Beacon lamp	S822-014002	S822-114002
CL-8	-	1	Beacon lamp harness	S822-014004	S822-114004
CL-8	DEUTSCH	2	Cab light-LH	DT06-2S-EP06	DT04-2P
CL-9	DEUTSCH	2	Cab light-RH	DT06-2S-EP06	DT04-2P
CL-10	DEUTSCH	2	Cab light-RH	DT06-2S-EP06	DT04-2P
CL-24	DEUTSCH	2	Rear work lamp	DT06-2S-EP06	DT04-2P-E005
CL-24B	-	24	ECM J1	F934000	-
CL-36	DEUTSCH	2	Work lamp	DT06-2S-EP06	DT04-2P
CL-37	DEUTSCH	2	Work lamp	DT06-2S-EP06	DT04-2P
CL-40	DEUTSCH	2	DEF/AdBlue® purging lamp	DT06-2S-EP06	DT04-2P
CL-41	AMP	1	DEF/AdBlue® F/warning lamp	S822-01400	S822-11400
· Sensor, se	endor				

Connector	Time	No. of	Destination	Connecto	r part No.
number	Type	pin	Destination	Female	Male
CD-1	AMP	2	Hydraulic oil temp sender	85202-1	-
CD-2	DEUTSCH	2	Fuel sender	DT06-2S-EP06	-
CD-6	DEUTSCH	3	Travel pressure switch	DT06-3S-EP06	-
CD-7	DEUTSCH	3	Working pressure switch	DT06-3S-EP06	-
CD-10	SUMITOMO	4	Air cleaner switch	6098-0144	-
CD-16	AMP	3	Water level sensor	12110293	-
CD-24	DEUTSCH	3	Swing sensor	DT06-3S-EP06	-
CD-31	DEUTSCH	3	Overload sensor	DT06-3S-EP06	-
CD-32	DEUTSCH	3	Boom up sensor	DT06-3S-EP06	-
CD-35	DEUTSCH	3	Arm in/out and bucket in sensor	DT06-3S-EP06	-
CD-42	DEUTSCH	3	Pump pressure 1	DT06-3S-EP06	-
CD-43	DEUTSCH	3	Pump pressure 2	DT06-3S-EP06	-
CD-44	DEUTSCH	3	Pump pressure 3	DT06-3S-EP06	-
CD-45	DEUTSCH	2	WIF sensor	DT06-2S-EP06	-
CD-69	DEUTSCH	3	Attach pressure sensor	DT06-3S-EP06	-
CD-70	DEUTSCH	3	N1 pressure sensor	DT06-3S-EP06	-
CD-71	DEUTSCH	3	N2 pressure sensor	DT06-3S-EP06	-
CD-85	DEUTSCH	3	Boom down sensor	DT06-3S-EP06	-
CD-90	DEUTSCH	3	Arm in sensor	DT06-3S-EP06	-
CD-124	DEUTSCH	3	Boom cylinder rod pressure snensor	DT06-3S-EP06	-
CD-421	DEUTSCH	2	Swing fine control solenoid	DT06-2S-EP06	-

2. CONNECTION TABLE FOR CONNECTORS

1) PA TYPE CONNECTOR

No. of pin	Receptacle connector (female)	Plug connect	or (male)
5	2	3	2
7	1	-005002 7 4 -007002	\$811-105002 1 4 3 7 \$811-107002
9	1	9 5 -009002	1 5 4 9 3S811-109002
11	5 1 S811-	6	1 6 5 11 5811-111002

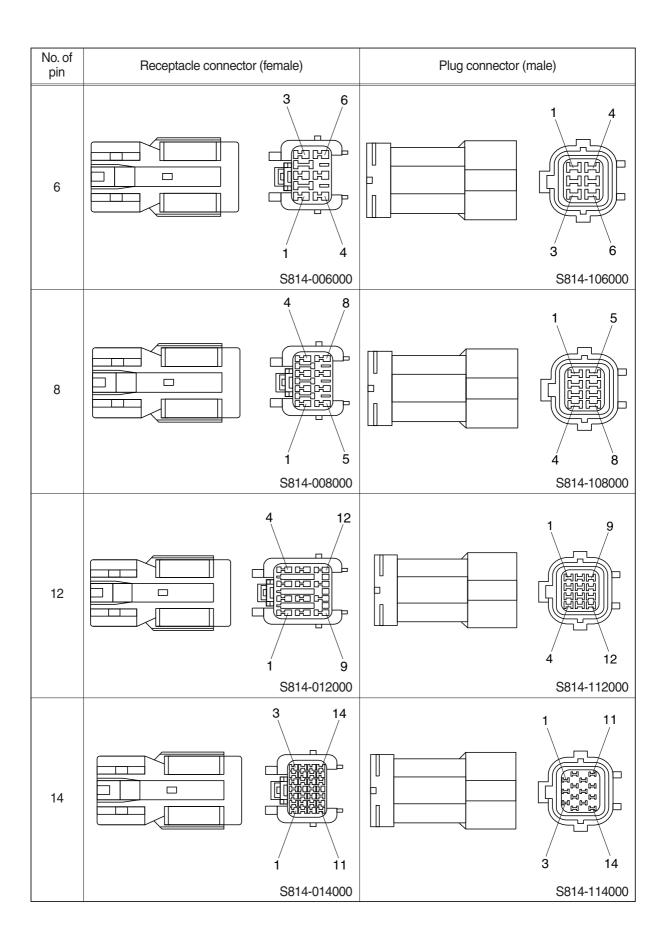


2) J TYPE CONNECTOR

No. of pin	Receptacle conne	ector (female)	Plug connector	r (male)
2		2 S816-002001		2 1 S816-102001
3		3 1 S816-003001		3 1 2 S816-103001
4		3 1 4 2 S816-004001		3 1 S816-104001
8		6 3 1 8 5 2 S816-008001		8 5 2 0000 6 3 1 S816-108001

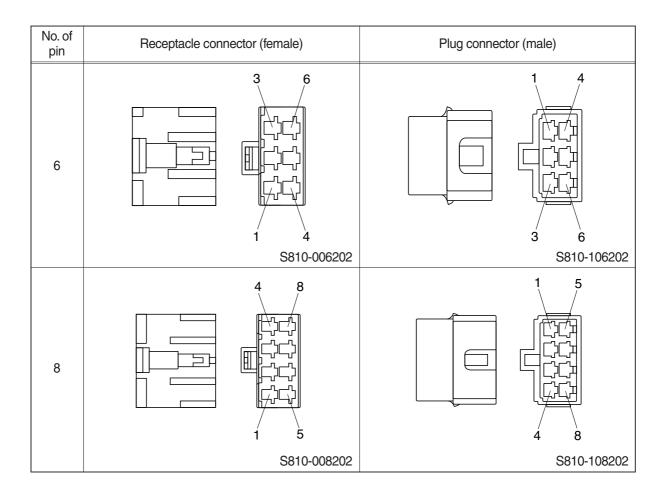
3) SWP TYPE CONNECTOR

No. of pin	Receptacle connector	(female)	Plug connector (n	nale)
1		S814-001000		S814-101000
2		2 1 S814-002000		1 2 S814-102000
3		3 2 1 S814-003000		1 2 3 S814-103000
4		2 4 1 3 S814-004000		1 3 2 4 S814-104000



4) CN TYPE CONNECTOR

No. of pin	Receptacle connecto	or (female)	Plug connector (male)
1		1		1
		S810-001202		S810-101202
2		1		1
		S810-002202		S810-102202
3		1 2		2
		S810-003202		S810-103202
4		2 4		1 3 2 4
		S810-004202		S810-104202



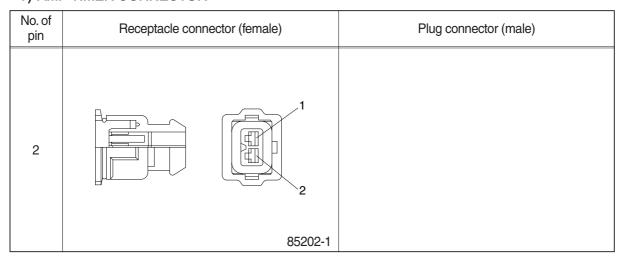
5) 375 FASTEN TYPE CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	S810-002402	S810-102402

6) AMP ECONOSEAL CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
36	12 24 36 13	13 12 36 24
	344111-1	344108-1

7) AMP TIMER CONNECTOR



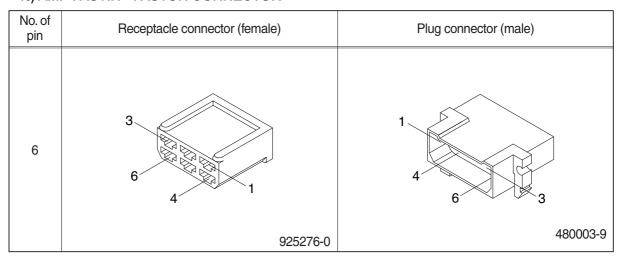
8) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
12	7	
	174045-2	

9) AMP 070 MULTILOCK CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
14	1 7 14 173852	
	173032	

10) AMP FASTIN - FASTON CONNECTOR



11) KET 090 CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	1 2	
	MG610070	

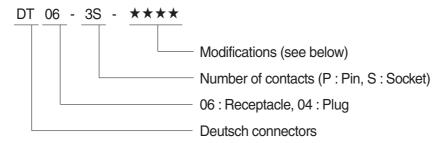
12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector (female)	Plug connector (male)
2	1 2 MG640605	
2	1	
	MG640795	

13) KET SDL CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
14	7	
	MG610406	

14) DEUTSCH DT CONNECTORS



Modification

E003: Standard end cap - gray

E004 : Color of connector to be black E005 : Combination - E004 & E003

EP04: End cap

EP06: Combination P012 & EP04

P012: Front seal enhancement - connectors color to black for 2, 3, 4 & 6pin

No. of pin	Receptacle connector (female)	Plug connector (male)
2		1 2
	DT06-2S	DT04-2P
3	1 2	2 1 1 3
	DT06-3S	DT04-3P
4		3 2
	DT06-4S	DT04-4P

No. of pin	Receptacle connector (female)	Plug connector (male)
6		
	DT06-6S	DT04-6P
8	5 4 8 1	5
	DT06-8S	DT04-8P
12	7 6	1 12
	DT06-12S	DT04-12P

15) MOLEX 2CKTS CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	1 2	
	35215-0200	

16) ITT SWF CONNECTOR

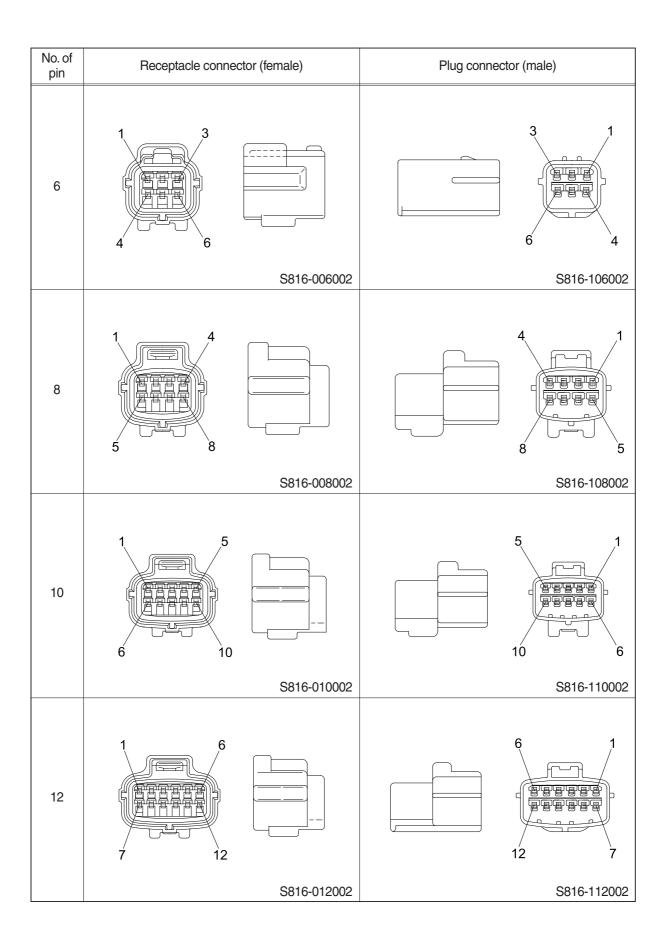
No. of pin	Receptacle connector (female)	Plug connector (male)
10	1 9	
	SWF593757	

17) MWP NMWP CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
1	1	
	NMWP01F-B	

18) ECONOSEAL J TYPE CONNECTORS

No. of pin	Receptacle connector (female)	Plug connector (male)
1	S816-001002	S816-101002
2	1 2 S816-002002	2 1 S816-102002
3	1 2 3 S816-003002	3 2 1 S816-103002
4	3 4 S816-004002	2 1 4 3 S816-104002

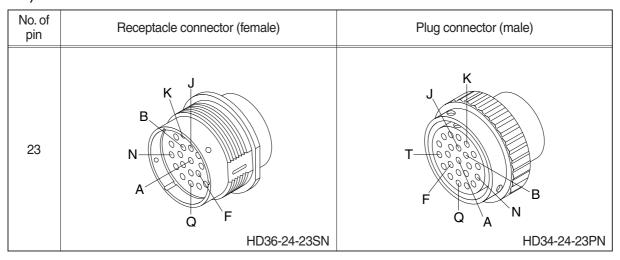


No. of pin	Receptacle connector (female)	Plug connector (male)
15	3 15 HERER B	15 3 EBB 10 EBB
	368301-1	2-85262-1

19) METRI-PACK TYPE CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	12040753	
	12040/53	

20) DEUTSCH HD30 CONNECTOR



21) DEUTSCH MCU CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
40	1 11 21 21 31 35 36 40 30	
	DRC26-40SA/B	

22) DEUTSCH SERVICE TOOL CONNECTOR

C D	
9 F B HD10-9-96P	

23) AMP FUEL WARMER CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
4	3 2 4	
	2-967325-3	

24) DEUTSCH ENGINE ECM CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
50	11 5 6 10 21 20 41 45 46 46 50 40 DRC26-50S-04	

25) DEUTSCH INTERMEDIATE CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
60	1 13 25 31 37 49 24 30 36 49 48 60 DRB16-60SAE-L018	

SECTION 5 MECHATRONICS SYSTEM

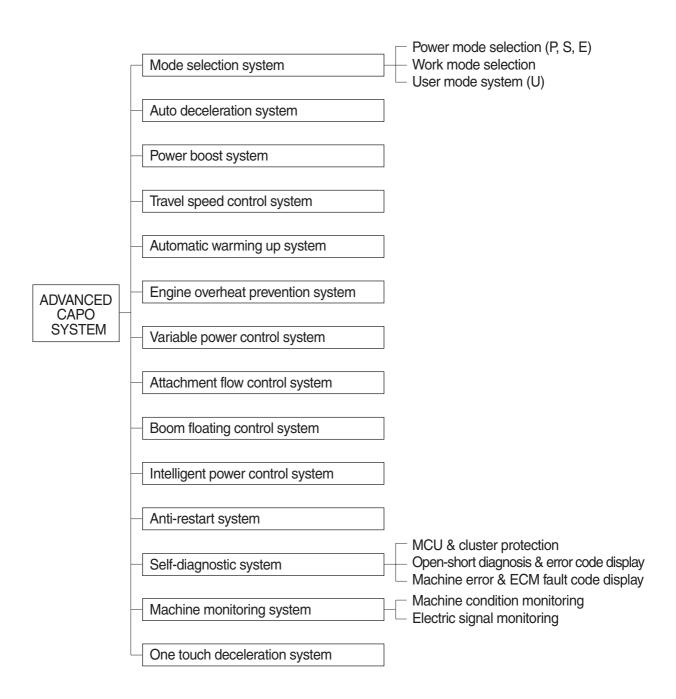
Group	1	Outline	5-1
Group	2	Mode Selection System ·····	5-3
Group	3	Automatic Deceleration System	5-6
Group	4	Power Boost System ····	5-7
Group	5	Travel Speed Control System ·····	5-8
Group	6	Automatic Warming Up System	5-9
Group	7	Engine Overheat Prevention System ·····	5-10
Group	8	Variable Power Control System ·····	5-11
Group	9	Attachment Flow Control System	5-12
Group ⁻	10	Boom Floating Control System	5-13
Group ⁻	11	Intelligent Power Control System	5-14
Group ⁻	12	Anti-Restart System ·····	5-16
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SECTION 5 MECHATRONICS SYSTEM

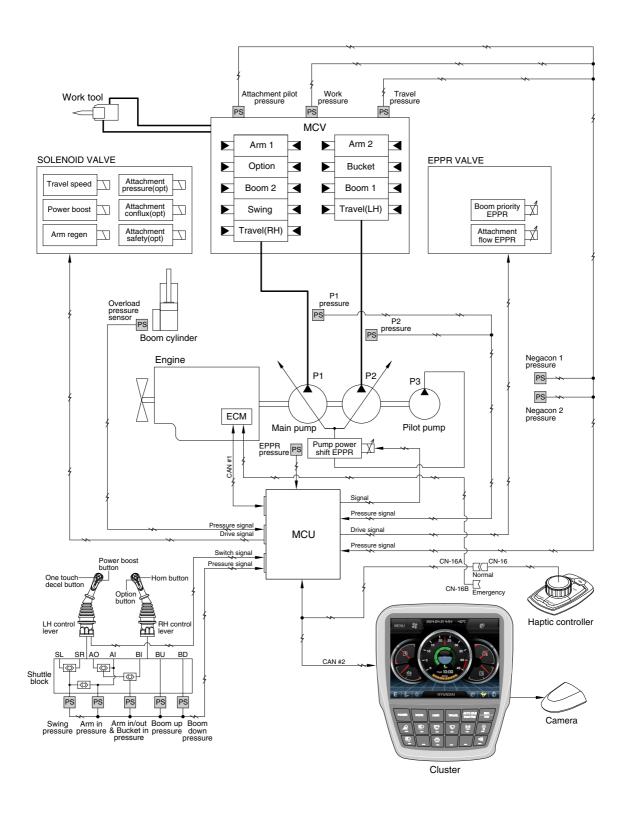
GROUP 1 OUTLINE

The ADVANCED CAPO (Computer Aided Power Optimization) system controls engine and pump mutual power at an optimum and less fuel consuming state for the selected work by mode selection, auto-deceleration, power boost function, etc. It monitors machine conditions, for instance, engine speed, coolant temperature, hydraulic oil temperature, and hydraulic oil pressure, etc.

It consists of a MCU, a cluster, an ECM, EPPR valves, and other components. The MCU and the cluster protect themselves from over-current and high voltage input, and diagnose malfunctions caused by short or open circuit in electric system, and display error codes on the cluster.



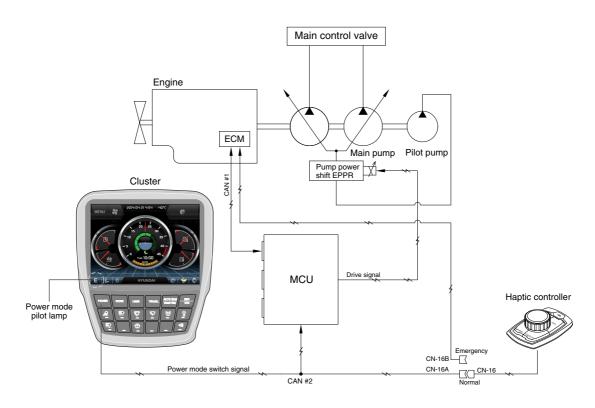
SYSTEM DIAGRAM



260L5MS01

GROUP 2 MODE SELECTION SYSTEM

1. POWER MODE SELECTION SYSTEM



300L5MS02

Mode selection system (micro computer based electro-hydraulic pump and engine mutual control system) optimizes the engine and pump performance.

The combination of 3 power modes (P, S, E) and acceleration mode (10 set) of haptic controller makes it possible to use the engine and pump power more effectively corresponding to the work conditions from a heavy and great power requesting work to a light and precise work.

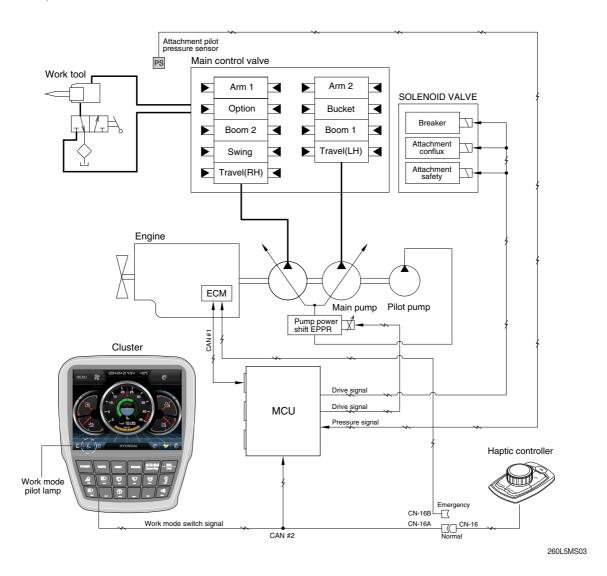
		Engine rpm			Power shift by EPPR valve				
Power	Application	Standard		Option		Standard		Option	
mode		Unload	Load	Unload	Load	Current (mA)	Pressure (kgf/cm²)	Current (mA)	Pressure (kgf/cm²)
Р	Heavy duty power	1800±50	1950±50	1900±50	2000±50	290±30	8 (~3)	290±30	8 (~3)
S	Standard power	1700±50	1850±50	1800±50	1900±50	360±30	12 (~7)±3	330±30	10 (~5)±3
Е	Economy operation	1600±50	1750±50	1700±50	1800±50	360±30	12 (~7)±3	360±30	12 (~7)±3
AUTO DECEL	Engine deceleration	1000±100	-	1000±100	-	700±30	38±3	700±30	38±3
One touch decel	Engine quick deceleration	850±100	-	850±100	-	700±30	38±3	700±30	38±3
KEY START	Key switch start position	850±100	-	850±100	-	700±30	38±3	700±30	38±3

* Power shift (Standard/Option) can be changed by "Service menu" in "Management" on the cluster.

※ (~*): Load

2. WORK MODE SELECTION SYSTEM

Work mode consists of the general operation (bucket) and the optional attachment (breaker, crusher).



1) GENERAL WORK MODE (bucket)

This mode is used to general digging work.

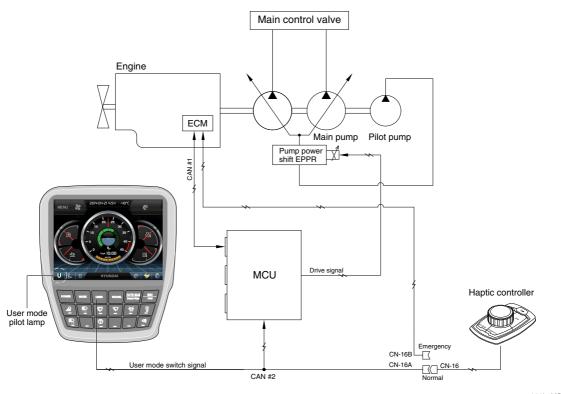
2) ATT WORK MODE (breaker, crusher)

It controls the pump flow and system pressure according to the operation of breaker or crusher.

Description	General mode	Work tool	
Description	Bucket	Breaker	Crusher
Attachment safety solenoid	OFF	-	ON
Attachment conflux solenoid	OFF	ON/OFF	ON/OFF
Attachment flow EPPR current	100 mA	100~700 mA	100~700 mA
Breaker solenoid*	OFF	ON	-

[★] When breaker operating button is pushed.

3. USER MODE SELECTION SYSTEM



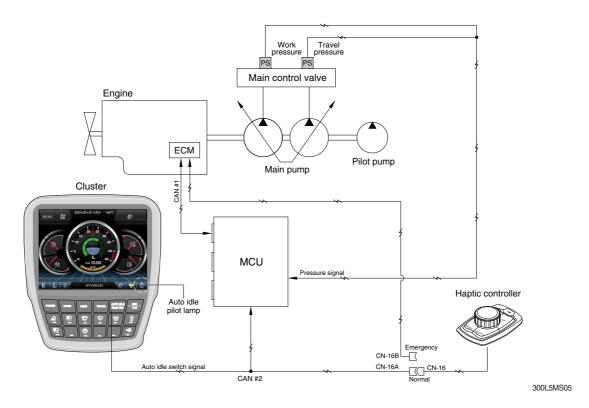
300L5MS04

1) High idle rpm, auto idle rpm and EPPR pressure can be adjusted and memorized in the U-mode.

2) LCD segment vs parameter setting

Step (▮)	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1300	750	0
2	1400	800	3
3	1500	850	6
4	1600	900	9
5	1700	950	12
6	1800	1000 (auto decel)	16
7	1850	1050	20
8	1900	1100	26
9	1950	1150	32
10	2000	1200	38

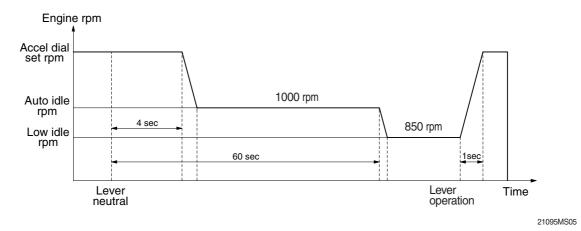
GROUP 3 AUTOMATIC DECELERATION SYSTEM



1. WHEN AUTO IDLE PILOT LAMP ON

When all of the work equipment control levers including swing and travel levers are at neutral for 4 seconds, MCU sends throttle command to ECM to reduce the engine speed to 1000 rpm. If the control levers are at neutral for 1 minute, MCU reduces the engine speed to 850 rpm. As the result of reducing the engine speed, fuel consumption and noise are effectively cut down during non-operation of the control levers.

When the Auto idle pilot lamp is turned off by pressing the switch or any control lever is operated, the reduced engine speed rises upto the speed before deceleration in a second.

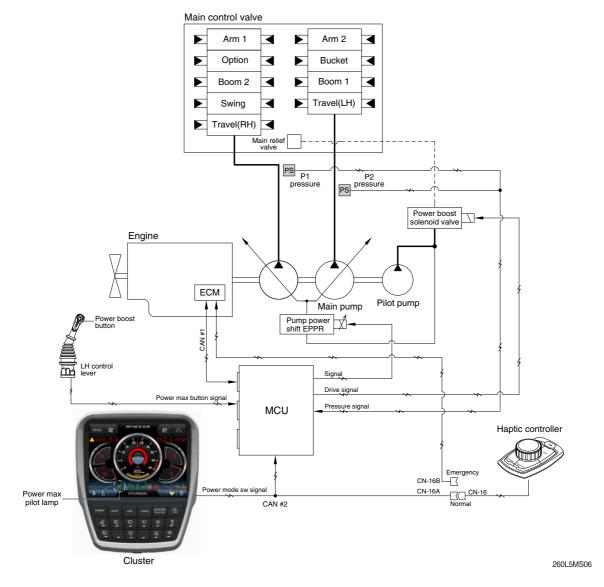


2. WHEN AUTO IDLE PILOT LAMP OFF

The engine speed can be set as desired using the accel dial switch, and even if the control levers are neutral, the engine speed is not reduced.

* Auto idle function can be activated when accel dial position is over 4.

GROUP 4 POWER BOOST SYSTEM

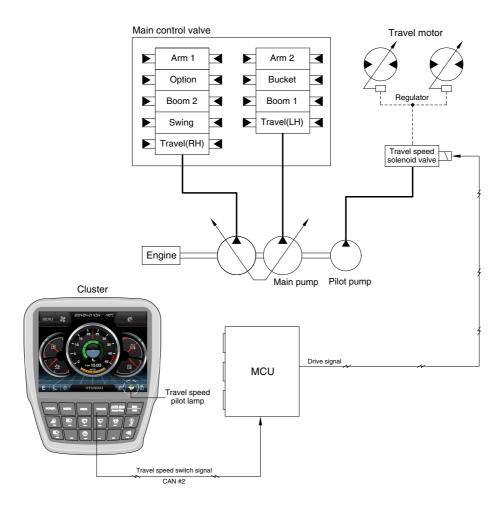


- When the power boost switch on the left control lever knob is pushed ON, the power mode is set P mode and maximum digging power is increased by 10 %.
- When the power boost function is activated, the power boost solenoid valve pilot pressure raises the set pressure of the main relief valve to increase the digging power.

Description Condition		Function
Activated Power boost switch : ON Accel dial : over 8		- Power mode : P - Accel dial power : 9 - Power boost solenoid : ON - Power boost pilot Imap : ON - Operating time : max 8 seconds
Canceled	Power boost switch : OFF	- Pre-set power mode- Power boost solenoid : OFF- Power boost pilot lamp : OFF

When the auto power boost is set to Enable and power mode is set to P mode on the cluster, the digging power is automatically increased as working conditions by the MCU. It is operated max 8 seconds.

GROUP 5 TRAVEL SPEED CONTROL SYSTEM



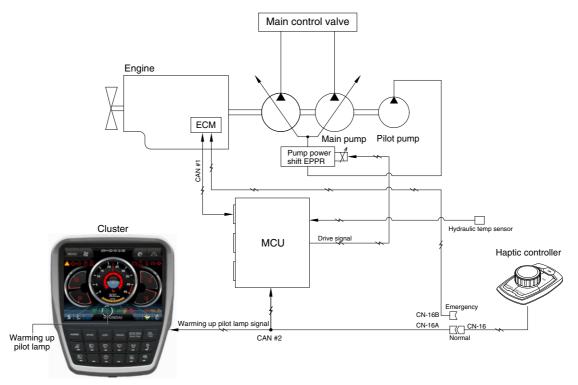
260L5MS07

Travel speed can be switched manually by pressing the travel speed switch on the cluster.

Speed	Travel speed solenoid valve	Lamp on cluster	Operation
Low	Low OFF Turtle		Low speed, high driving torque in the travel motor
High ON Rabbit		Rabbit	High speed, low driving torque in the travel motor

Default : Turtle (Low)

GROUP 6 AUTOMATIC WARMING UP SYSTEM

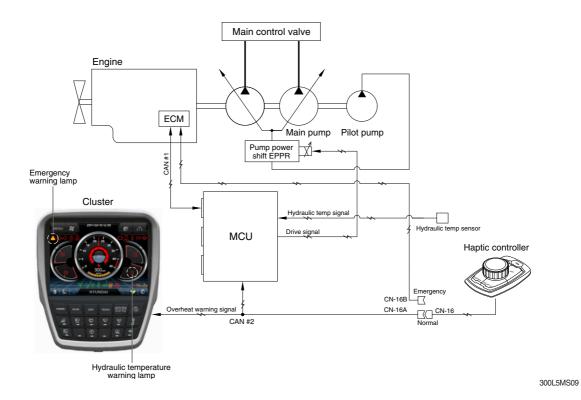


- 300L5MS08
- 1. The MCU receives the engine coolant temperature from the ECM, and if the coolant temperature is below 30°C, it increases the engine speed from key start rpm to 1200 rpm. At this time the mode does not change. If the coolant temperature sensor has fault, the hydraulic oil temperature signal is substituted.
- 2. In case of the coolant temperature increases up to 30°C, the engine speed is decreased to key start speed. And if an operator changes power mode set during the warming up function, the MCU cancels the automatic warming up function.

3. LOGIC TABLE

Description	Condition	Function
Actuated	- Coolant temperature : below 30°C (after engine run)	- Power mode : Default (E mode) - Warming up time : 10 minutes (max) - Warming up pilot lamp : ON
Canceled	- Coolant temperature : Above 30°C - Warming up time : Above 10 minutes - Changed power mode set by operator - RCV lever or pedal operating - Auto idle cancel * If any of the above conditions is applicable, the automatic warming up function is canceled	- Power mode : set mode - Warming up pilot lamp : OFF

GROUP 7 ENGINE OVERHEAT PREVENTION SYSTEM

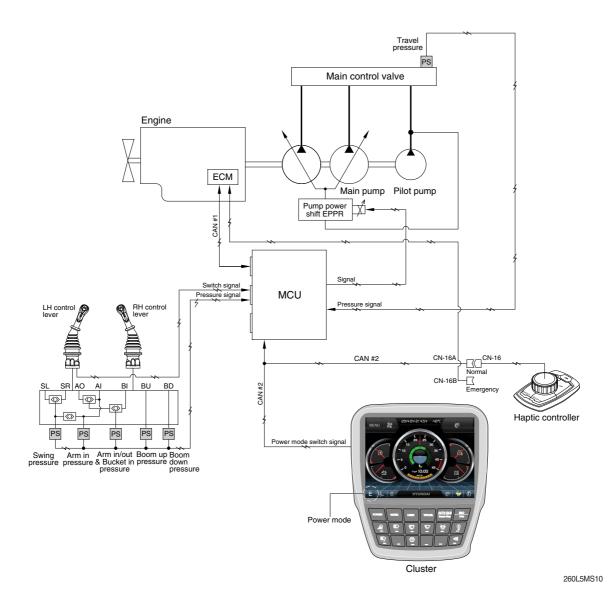


1. If the engine coolant temperature or the hydraulic oil temperature is overheated over 100°C, the warning lamp is ON and the pump input torque or the engine speed is reduced as below logic table.

2. LOGIC TABLE

Descrip	otion	Condition	Function
	Activoted	- Coolant temperature : Above 103°C	- Warning lamp : ON , buzzer : OFF - Pump input torque is reduced.
First step	Activated		Warning lamp & buzzer : ONPump input torque is reduced.
warning	Canceled	- Coolant temperature : Less than 100°C - Hydraulic oil temperature : Less than 95°C	- Return to pre-set the pump absorption torque.
Second stop	Activated	- Coolant temperature : Above 107°C - Hydraulic oil temperature : Above 105°C	Emergency warning lamp pops up on the center of LCD and the buzzer sounds.Engine speed is reduced after 10 seconds.
Second step warning	Canceled	- Coolant temperature : Less than 103°C - Hydraulic oil temperature : Less than 100°C	 Return to pre-set the engine speed. Hold pump absorption torque on the first step warning.

GROUP 8 VARIABLE POWER CONTROL SYSTEM



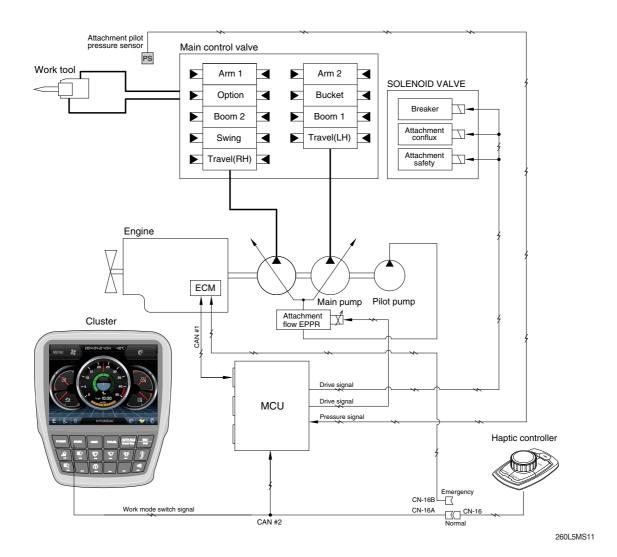
The variable power control system controls the engine and pump mutual power according to RCV lever stroke and pump load.

It makes fuel saving and smooth control at precise work.

Description	Working condition	
Power mode	P, S, E	
Work mode	General (bucket)	
Pressure sensor	Normal	

* The variable power control function can be activated when the power mode is set to all power mode.

GROUP 9 ATTACHMENT FLOW CONTROL SYSTEM

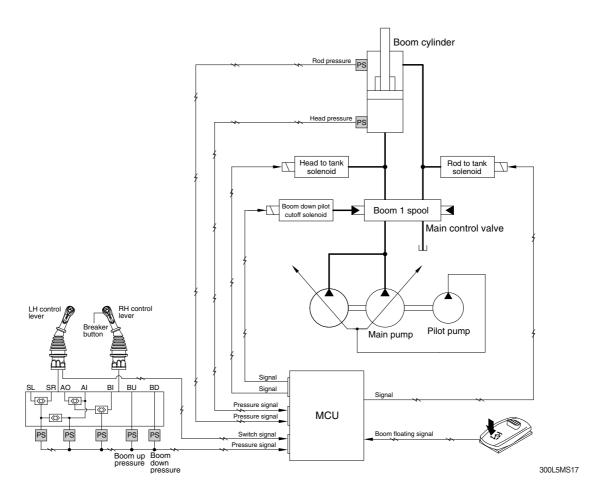


• The system is used to control the pump delivery flow according to set of the work tool on the cluster by the attachment flow EPPR valve.

Description	Work tool		
Description	Breaker	Crusher	
Flow level	100 ~ 180 lpm	100 ~ 440 lpm	
Attach safety solenoid	-	ON	
Attach conflux solenoid	ON/OFF	ON/OFF	
Breaker solenoid*	ON	-	

- * Refer to the page 5-79 for the attachment kinds and max flow.
- ★ When breaker operating button is pushed.

GROUP 10 BOOM FLOATING CONTROL SYSTEM



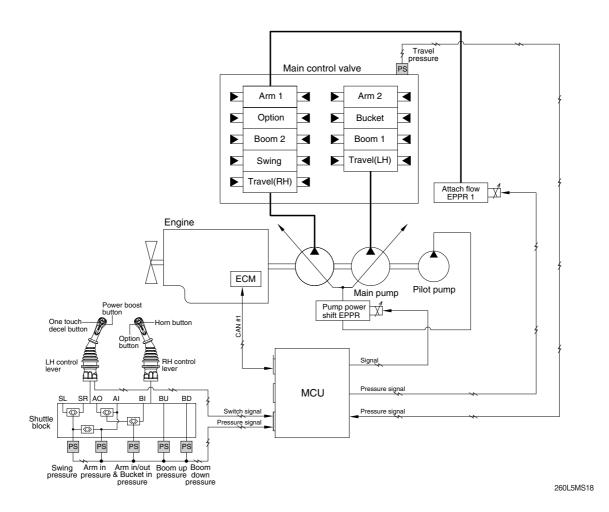
· Boom floating automatically controls boom cylinder along the ground by operating arm cylinder only.

Desc	ription	Condition	Function
Work mode*1	Floating mode	Condition	FUNCTION
	Boom up floating*2	Floating mode sw : ON	Rod to tank solenoid : ON Head to tank solenoid : OFF Boom down cutoff solenoid : OFF
General mode	Boom up/down floating*2	Floating mode sw : ON Breaker button : Pressed Boom down pilot pressure > 25 bar Boom up pilot pressure < 5 bar	Rod to tank solenoid : ON Head to tank solenoid : ON Boom down cutoff solenoid : ON
Breaker mode	Boom down floating	Floating mode sw : ON Breaker button : Pressed Boom down pilot pressure > 25 bar Boom up pilot pressure < 5 bar	Rod to tank solenoid : OFF Head to tank solenoid : ON Boom down cutoff solenoid : ON
Temporarily can	celed	During operation of boom floating Boost sw : Pressed	Rod to tank solenoid : OFF Head to tank solenoid : OFF Boom down cutoff solenoid : OFF

^{*1} Boom floating is not activated when work mode is crusher mode.

^{*2} These functions are activated just in case the excavator is not in jack up status.

GROUP 11 INTELLIGENT POWER CONTROL SYSTEM



1. When the requirement of pump flow rate is low, IPC mode controls pump flow rate to improve fuel efficiency.

Condition ^{★1}	Function
IPC mode : ON*2	
Boom up	
Arm in	Limitation of pump flow rate : Activated
Not travel motion	
Not swing motion	
None of upper condition	Limitation of pump flow rate : Canceled

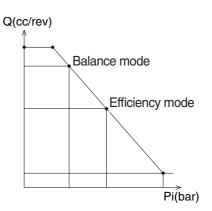
^{*1} AND condition

^{*2} IPC mode ON/OFF is selected at "Mode setup > IPC mode". See next page.

2. IPC MODE SELECTION

IPC mode ON/OFF and the levels of flow rate limit can be selected at "Mode setup > IPC mode"

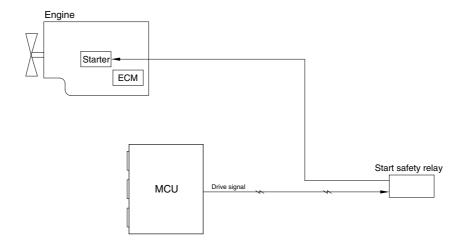




290F3CD311

IPC mode	Description
Balance mode (default)	IPC mode ON, limit level 1
Efficiency mode	IPC mode ON, limit level 2
Speed mode	IPC mode OFF

GROUP 12 ANTI-RESTART SYSTEM



300L5MS12

1. ANTI-RESTART FUNCTION

After a few seconds from the engine starts to run, MCU turns off the start safety relay to protect the starter from inadvertent restarting.

GROUP 13 SELF-DIAGNOSTIC SYSTEM

1. OUTLINE

When any abnormality occurs in the ADVANCED CAPO system caused by electric parts malfunction and by open or short circuit, the MCU diagnoses the problem and sends the error codes to the cluster and also stores them in the memory.

2. MONITORING

1) Active fault



· The active faults of the MCU, engine ECM or air conditioner can be checked by this menu.

2) Logged fault



• The logged faults of the MCU, engine ECM or air conditioner can be checked by this menu.

3) Delete logged fault



• The logged faults of the MCU, engine ECM or air conditioner can be deleted by this menu.

3. MACHINE ERROR CODES TABLE

DTC		Di di Oli di	Ap	plicat	ion			
HCESPN	FMI	Diagnostic Criteria	G	С	W			
	3	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage > 3.8V	•					
101	4	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage < 0.3V						
	(Resu	llts / Symptoms)						
	1. Mo	nitor – Hydraulic oil temperature display failure						
	2. Co	ntrol Function – Fan revolutions control failure						
	•	king list)						
	1. CD	-1 (#2), CN-52 (#24) Checking Open/Short						
	2. CD	-1 (#1), CN-51 (#5) Checking Open/Short						
	0	10 seconds continuous, Working Press. Sensor						
		Measurement Voltage > 5.2V						
	1	10 seconds continuous, 0.3V≤ Working Press. Sensor Measurement						
	'	Voltage < 0.8V	rement					
	4	10 seconds continuous, Working Press. Sensor						
	•	Measurement Voltage < 0.3V						
105	(Results / Symptoms)							
105	1. Mo	nitor – Working Press. display failure						
	2. Co	2. Control Function – Auto Idle operation failure, Engine variable horse power control operation						
		failure						
	(Chec	king list)						
	1. CD	-7 (#B) – CN-52 (#37) Checking Open/Short						
	2. CD-7 (#A) – CN-51 (#3) Checking Open/Short							
	3. CD	-7 (#C) – CN-51 (#13) Checking Open/Short						
	0	10 seconds continuous, Travel Oil Press. Sensor						
	<u> </u>	Measurement Voltage > 5.2V						
	1	10 seconds continuous, 0.3V ≤ Travel Oil Press. Sensor Measurement						
	'	Voltage < 0.8V						
	4	10 seconds continuous, Travel Oil Press. Sensor						
		Measurement Voltage < 0.3V						
100	(Resu	llts / Symptoms)						
108	1. Mo	nitor – Travel Oil Press. display failure						
	2. Co	ntrol Function – Auto Idle operation failure, Engine variable horse power control	opera	ation				
		failure, IPC operation failure, Driving alarm operation failure						
	(Chec	king list)						
	1. CD	-6 (#B) – CN-52 (#38) Checking Open/Short						
		-6 (#A) - CN-51 (#3) Checking Open/Short						
	3. CD	-6 (#C) - CN-51 (#13) Checking Open/Short						

* Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC	;	Discounting Office in	Ap	plicat	ion			
HCESPN	FMI	Diagnostic Criteria	G	С	W			
	0	10 seconds continuous, Main Pump 1 (P1) Press. Sensor Measurement Voltage > 5.2V	•					
120	1	10 seconds continuous, 0.3V ≤ Main Pump 1 (P1) Press. Sensor Measurement Voltage < 0.8V	•					
	4	10 seconds continuous, Main Pump 1 (P1) Press. Sensor Measurement Voltage < 0.3V	•					
	1. Mor 2. Cor (Chec 1. CD- 2. CD-	lts / Symptoms) nitor – Main Pump 1 (P1) Press. display failure ntrol Function – Automatic voltage increase operation failure, Overload at compe failure king list) -42 (#B) – CN-52 (#29) Checking Open/Short -42 (#A) – CN-51 (#3) Checking Open/Short	ensat	ion co	ontrol			
	3. CD-	42 (#C) – CN-51 (#13) Checking Open/Short		·				
	0	10 seconds continuous, Main Pump 2 (P2) Press. Sensor Measurement Voltage > 5.2V	•					
	1	10 seconds continuous, 0.3V≤ Main Pump 2 (P2) Press. Sensor Measurement Voltage < 0.8V	•					
	4	10 seconds continuous, Main Pump 2 (P2) Press. Sensor Measurement Voltage < 0.3V	•					
404	(Results / Symptoms)							
121		nitor – Main Pump 2 (P2) Press. display failure ntrol Function – Automatic voltage increase operation failure, Overload at comp	ensat	ion co	ontrol			
	1. CD- 2. CD-	king list) -43 (#B) – CN-52 (#12) Checking Open/Short -43 (#A) – CN-51 (#3) Checking Open/Short -43 (#C) – CN-51 (#13) Checking Open/Short						
	1	(when you had conditions mounting pressure sensor) $10 \ \ \text{seconds continuous}, \ 0.3V \leq \text{Overload Press. Sensor Measurement} \\ \text{Voltage} < 0.8V$	•					
	4	(when you had conditions mounting pressure sensor) 10 seconds continuous, Overload Press. Sensor Measurement Voltage < 0.3V	•					
122	(Resu	lts / Symptoms)						
	Monitor – Overload Press. display failure							
	2. Control Function – Overload warning alarm failure							
	l '	king list) -31 (#R) – CN-52 (#16) Checking Open/Short						
		-31 (#B) – CN-52 (#16) Checking Open/Short -31 (#A) – CN-51 (#3) Checking Open/Short						
		-31 (#C) – CN-51 (#3) Checking Open/Short						

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	,	Discounting Office in	Ар	plicat	ion				
HCESPN	FMI	Diagnostic Criteria	G	С	W				
	0	10 seconds continuous, Negative 1 Press. Sensor							
	U	Measurement Voltage > 5.2V							
	1	10 seconds continuous, 0.3V≤ Negative 1 Press. Sensor Measurement							
		Voltage < 0.8V							
	4	10 seconds continuous, Negative 1 Press. Sensor							
100	(Pool	Measurement Voltage < 0.3V ilts / Symptoms)							
123	`	nitor – Negative 1 Press. display failure							
		ntrol = Negative 11 less, display failure htrol Function – IPC operation failure, Option attachment flow control operation f	ailure	1					
		sking list)	andre	,					
	٠,	-70 (#B) – CN-52 (#33) Checking Open/Short							
		-70 (#A) – CN-51 (#3) Checking Open/Short							
		-70 (#C) – CN-51 (#13) Checking Open/Short							
	_	10 seconds continuous, Negative 2 Press. Sensor							
	0	Measurement Voltage > 5.2V	•						
	1	10 seconds continuous, 0.3V≤ Negative 2 Press. Sensor Measurement							
	'	Voltage < 0.8V							
	4	10 seconds continuous, Negative 2 Press. Sensor							
		Measurement Voltage < 0.3V							
124	٠,	lts / Symptoms)							
		nitor – Negative 2 Press. display failure							
		Control Function – Option attachment flow control operation failure							
	,	(Checking list)							
		-71 (#B) – CN-52 (#17) Checking Open/Short							
	2. CD-71 (#A) – CN-51 (#3) Checking Open/Short								
	3. UD	-71 (#C) – CN-51 (#13) Checking Open/Short 10 seconds continuous, Boom Up Pilot Press. Sensor							
	0	Measurement Voltage > 5.2V							
		10 seconds continuous, 0.3V≤ Boom Up Pilot Press. Sensor Measurement							
	1	Voltage < 0.8V							
	4	10 seconds continuous, Boom Up Pilot Press. Sensor Measurement < 0.3V	•						
	(Resu	llts / Symptoms)							
127	,	nitor – Boom Up Pilot Press. display failure							
	2. Coi	ntrol Function – Engine/Pump variable horse power control operation failure, IPC	Соре	ration	ı				
		failure, Boom first operation failure							
	(Checking list)								
	1. CD	-32 (#B) – CN-52 (#19) Checking Open/Short							
	2. CD	-32 (#A) – CN-51 (#3) Checking Open/Short							
	3. CD	-32 (#C) – CN-5 1(#13) Checking Open/Short							

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC	,	Dia was akin Oritaria	Ар	plicati	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	0	(when you had conditions mounting pressure sensor) 10 seconds continuous, Boom Down Pilot Press. Sensor Measurement Voltage > 5.2V	•		
	1	(when you had conditions mounting pressure sensor) 10 seconds continuous, 0.3V≤ Boom Down Pilot Press. Sensor Measurement Voltage < 0.8V	•		
128	4	(when you had conditions mounting pressure sensor) 10 seconds continuous, Boom Down Pilot Press. Sensor Measurement Voltage < 0.3V	•		
	1. Moi 2. Cor (Chec 1. CD 2. CD	Its / Symptoms) nitor – Boom Down Pilot Press. display failure ntrol Function – Boom floating operation failure king list) -85 (#B) – CN-53 (#23) Checking Open/Short -85 (#A) – CN-53 (#3) Checking Open/Short -85 (#C) – CN-53 (#13) Checking Open/Short			
	0	10 seconds continuous, Arm In Pilot Press. Sensor Measurement Voltage > 4.8V 10 seconds continuous, 0.3V≤ Arm In Pilot Press. Sensor Measurement	•		
	4	Voltage < 0.8V 10 seconds continuous, Arm In Pilot Press. Sensor Measurement Voltage < 0.3V	•		
129	1. Moi 2. Cor (Chec 1. CD- 2. CD-	Its / Symptoms) nitor – Arm In Pilot Press. display failure ntrol Function – IPC operation failure king list) -90 (#B) – CN-52 (#28) Checking Open/Short -90 (#A) – CN-51 (#3) Checking Open/Short -90 (#C) – CN-51 (#13) Checking Open/Short			
	0	10 seconds continuous, Arm In/Out & Bucket In Pilot Press. Sensor Measurement Voltage > 5.2V 10 seconds continuous, 0.3V≤ Arm In/Out & Bucket In Pilot Press. Sensor Measurement Voltage < 0.8V	•		
133	4	10 seconds continuous, Arm In/Out & Bucket In Pilot Press. Sensor Measurement Voltage < 0.3V	•		
133	1. Moi 2. Cor (Chec 1. CD 2. CD	Its / Symptoms) nitor – Arm In/Out & Bucket In Pilot Press. display failure ntrol Function – Engine variable horse power control operation failure king list) -35 (#B) – CN-52 (#14) Checking Open/Short -35 (#A) – CN-51 (#3) Checking Open/Short -35 (#C) – CN-51 (#13) Checking Open/Short			

* Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	;		Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
		10 seconds continuous, Swing Pilot Press. Sensor			
	0	Measurement Voltage > 5.2V			
	1	10 seconds continuous, 0.3V≤ Swing Pilot Press. Sensor Measurement			
	'	Voltage < 0.8V			
	4	10 seconds continuous, Swing Pilot Press. Sensor			
		Measurement Voltage < 0.3V			
135	l ,	lts / Symptoms)			
		nitor – Swing Pilot Press. display failure			
		ntrol Function – IPC operation, Boom first operation failure			
	,	king list)			
		-24 (#B) – CN-52 (#36) Checking Open/Short			
		-24 (#A) – CN-51 (#3) Checking Open/Short			
	3. CD	-24 (#C) – CN-51 (#13) Checking Open/Short			
		Monitor – Select Attachment(breaker / crusher)	_		
	0	10 seconds continuous, Attachment Pilot Press. Sensor Measurement			
		Voltage > 5.2V			
	1	Monitor – Select Attachment(breaker / crusher)			
		10 seconds continuous, 0.3V≤ Attachment Pilot Press. Sensor			
		Measurement Voltage < 0.8V			
	4	Monitor – Select Attachment(breaker / crusher)			
138	4	10 seconds continuous, Attachment Pilot Press. Sensor Measurement Voltage < 0.3V			
	/Deau	-			
	,	lts / Symptoms) nitor – Attachment Pilot Press. display failure			
		ntrol – Attachment Fliot Fless, display failure ntrol Function – Option attachment flow control operation failure			
		king list)			
	`	-69 (#B) – CN-53 (#14) Checking Open/Short			
		-69 (#A) – CN-53 (#3) Checking Open/Short			
		-69 (#C) – CN-53 (#13) Checking Open/Short			
	5. 55	10 seconds continuous, 0.3V≤ Option Pilot Press. Sensor Measurement			
	1	Voltage < 0.8V			
		10 seconds continuous, Option Pilot Press. Sensor			
	4	Measurement Voltage < 0.3V			
	(Resu	Its / Symptoms)			
139	`	nitor – Option Pilot Press. display failure			
		ntrol Function – Auto Idle operation failure			
		king list)			
	l ,	-100 (#B) – CN-52 (#21) Checking Open/Short			
		-100 (#A) – CN-51 (#3) Checking Open/Short			
		-100 (#C) – CN-1 (#6) Checking Open/Short			

 $\ensuremath{\,\times\,}$ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC	,	Dia manatia Critaria	Ap	plicat	ion
HCESPN	FMI	•		С	W
HCESPN 140	5	(Detection) (When Pump EPPR Current is more than 10 mA) 10 seconds continuous, Pump EPPR drive current < 0 mA (Cancellation) (When Pump EPPR Current is more than 10 mA) 3 seconds continuous, Pump EPPR drive current ≥10 mA (Detection) 10 seconds continuous, Pump EPPR drive current > 1.0A (Cancellation)	• •	C	W
	1. Cor (Chec	3 seconds continuous, Pump EPPR drive current ≤ 1.0 A lts / Symptoms) ntrol Function – Pump horse power setting specification difference (Fuel efficiency/speed specification failure) eking list) -75 (#2) – CN-52 (#9) Checking Open/Short -75 (#1) – CN-52 (#10) Checking Open/Short			
	5	(Model Parameter) mounting Boom Priority EPPR (Detection) (When Boom Priority EPPR Current is more than 10 mA) 10 seconds continuous, Boom Priority EPPR drive current < 0 mA (Cancellation) (When Boom Priority EPPR Current is more than 10 mA) 3 seconds continuous, Boom Priority EPPR drive current ≥ 10 mA	•		
141	6	(Detection) 10 seconds continuous, Boom Priority EPPR drive current > 1.0 A (Cancellation) 3 seconds continuous, Boom Priority EPPR drive current ≤ 1.0 A	•		
	1. Cor (Chec 1. CN	olts / Symptoms) Introl Function – Boom first control operation failure Eking list) Introl Function – Boom first control operation failure Introl Function failure			

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC	;	Dia supostia Critaria	Application		
HCESPN	FMI			С	W
	5	(Detection) (When Travel EPPR Current is more than 10 mA) 10 seconds continuous, Travel EPPR drive current = 0 mA (Cancellation) (When Travel EPPR Current is more than 100 mA) 3 seconds continuous, Travel EPPR drive current ≥ 10 mA			•
143	6	(Detection) 10 seconds continuous, Travel EPPR drive current > 1.0 A (Cancellation) 3 seconds continuous, Travel EPPR drive current ≤ 1.0 A			•
	`	Its / Symptoms)			
		ntrol Function – cruise control operation failure king list)			
	1. CN	-246 (#2) – CN-54 (#39) Checking Open/Short			
	2. CN	-246 (#1) – CN-51 (#40) Checking Open/Short			
	5	 (Model Parameter) mounting Remote Cooling Fan EPPR (Detection) (When Remote Cooling Fan EPPR Current is more than 10 mA) 10 seconds continuous, Remote Cooling Fan EPPR drive current = 0 mA (Cancellation) (When Remote Cooling Fan EPPR Current is more than 10 mA) 3 seconds continuous, Remote Cooling Fan EPPR drive current ≥ 10 mA 	•		
145	6	(Detection) 10 seconds continuous, Remote Cooling Fan EPPR drive current > 1.0 A (Cancellation) 3 seconds continuous, Remote Cooling Fan EPPR drive current ≤ 1.0 A	•		
	1. Cor (Chec 1. CD	Its / Symptoms) htrol Function – Remote fan control operation failure king list) -52 (#1) – CN-51 (#9) Checking Open/Short -52 (#2) – CN-51 (#14) Checking Open/Short			

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	;	Diagnostic Critoria	Ар	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	4	(Detection) (When Working Cutoff Relay is Off) 10 seconds continuous, Working Cutoff Relay drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Working Cutoff Relay is Off) 3 seconds continuous, Working Cutoff Relay drive unit Measurement Voltage > 3.0V			•
164	6	(Detection) (When Working Cutoff Relay is On) 10 seconds continuous, Working Cutoff Relay drive current > 6.5 A (Cancellation) (When Working Cutoff Relay is On) 3 seconds continuous, Working Cutoff Relay drive current ≤ 6.5 A			•
	(Resu	Ilts / Symptoms)			
	(Chec	ntrol Function – (Wheel Excavator) In driving mode, attachment hydraulic pilot p failure king list) -47 (#85) – CN-54 (#9) Checking Open/Short -47 (#30, #86) – CN-45 (#B+ term) Checking Open/Short	ressu	ire cu	OII
166	4	(Detection) (When Power Max Solenoid is Off) 10 seconds continuous, Power Max Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Power Max Solenoid is Off) 3 seconds continuous, Power Max Solenoid drive unit Measurement Voltage > 3.0V	•		
	6	(Detection) (When Power Max Solenoid is On) 5 seconds continuous, Power Max Solenoid drive current > 4.5 A (Cancellation) (When Power Max Solenoid is On) 3 seconds continuous, Power Max Solenoid drive current ≤ 4.5 A	•		
	1. Col (Chec 1. CN	ults / Symptoms) ntrol Function – Voltage increase operation failure king list) -88 (#1) – CN-52 (#2) Checking Open/Short -88 (#2) – CN-45 (#B+ term) Checking Open/Short			

* Some error codes are not applied to this machine.

 $\mbox{G : General} \qquad \qquad \mbox{C : Crawler Type} \qquad \qquad \mbox{W : Wheel Type}$

DTC HCESPN FMI		Diagnostic Critaria		Application		
HCESPN	FMI	Diagnostic Criteria	G	С	W	
167		(Detection) (When Travel Speed Solenoid is Off) 10 seconds continuous, Travel Speed Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Travel Speed Solenoid is Off) 3 seconds continuous, Travel Speed Solenoid drive unit Measurement Voltage > 3.0V		•		
	4	(When Parking mode is not) (Detection) (When Travel Speed Solenoid is Off) 10 seconds continuous, Travel Speed Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Travel Speed Solenoid is Off) 3 seconds continuous, Travel Speed Solenoid drive unit Measurement Voltage > 3.0V			•	
	6	(Detection) (When Travel Speed Solenoid is On) 10 seconds continuous, Travel Speed Solenoid drive current > 4.5 A (Cancellation) (When Travel Speed Solenoid is On) 3 seconds continuous, Travel Speed Solenoid drive current ≤ 4.5 A	•			
	1. Cor (Chec 1. CN	Its / Symptoms) Its /				

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC		Discussion Cuitorio	Ар	Application				
HCESPN	FMI	Diagnostic Criteria	G	С	W			
	4	Monitor – Selecting attachment(breaker / crusher) (Detection) (When Attachment Conflux Solenoid is Off) 10 seconds continuous, Attachment Conflux Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Attachment Conflux Solenoid is Off) 3 seconds continuous, Attachment Conflux Solenoid drive unit Measurement Voltage > 3.0V	•					
169	6	(Detection) (When Attachment Conflux Solenoid is On) 10 seconds continuous, Attachment Conflux Solenoid drive Current > 6.5 A (Cancellation) (When Attachment Conflux Solenoid is On) 3 seconds continuous, Attachment Conflux Solenoid drive Current ≤ 6.5 A	•					
	,	lts / symptoms) htrol Function – Option attachment flow control – Joining operation failure						
	(Eco	breaker mode, crusher mode)						
	(Checking list)							
	1. CD	-237 (#1) – CN-53 (#7) Checking Open/Short						
	2. CD	-237 (#2) – CR-35 (#87) Checking Open/Short						
	4	(Model Parameter) mounting Arm Regenerating Solenoid (Detection) (When Arm Regeneration Solenoid is Off) 10 seconds continuous, Arm Regeneration Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Arm Regeneration Solenoid is Off) 3 seconds continuous, Arm Regeneration Solenoid drive unit Measurement Voltage > 3.0V	•					
170	6	(Detection) (When Arm Regeneration Solenoid is On) 10 seconds continuous, Arm Regeneration Solenoid drive current > 4.5 A (Cancellation) (When Arm Regeneration Solenoid is On) 3 seconds continuous, Arm Regeneration Solenoid drive current ≤ 4.5 A	•					
	(Detec							
	(When	n Arm Regeneration Solenoid is On) conds continuous, Arm Regeneration Solenoid drive current > 4.5 A ellation) n Arm Regeneration Solenoid is On)						
		onds continuous, Arm Regeneration Solenoid drive current ≤ 4.5 A						

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	;	Discountie Office	Application		ion			
HCESPN	FMI	Diagnostic Criteria	G	С	W			
	4	Monitor – Selecting attachment(crusher) (Detection) (When Attachment Safety Solenoid is Off) 10 seconds continuous, Attachment Safety Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Attachment Safety Solenoid is Off) 3 seconds continuous, Attachment Safety Solenoid drive unit Measurement Voltage > 3.0V	•					
171	6	(Detection) (When Attachment Safety Solenoid is On) 10 seconds continuous, Attachment Safety Solenoid drive current > 6.5 A (Cancellation) (When Attachment Safety Solenoid is On) 3 seconds continuous, Attachment Safety Solenoid drive current ≤ 6.5 A	•					
	(Resu	Its / Symptoms)						
	l '	ntrol Function – Option attachment flow control – Option spool pilot pressur	e cut	off fa	ailure			
	(crusher mode)							
	(Checking list)							
	1. CD-149 (#1) – CN-53 (#8) Checking Open/Short							
	2. CD	-149 (#2) – CR-35 (#87) Checking Open/Short						
179	6	Monitor – Selecting attachment(breaker / crusher) (Detection) (When Breaker Operating Solenoid is Off) 10 seconds continuous, Attachment Safety Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Breaker Operating Solenoid is Off) 3 seconds continuous, Attachment Safety Solenoid drive unit Measurement Voltage > 3.0V (Detection) (When Breaker Operating Solenoid is On) 10 seconds continuous, Attachment Safety Solenoid drive current > 6.5 A (Cancellation)	•					
	1. Cor (Chec 1. CD	(When Breaker Operating Solenoid is On) 3 seconds continuous, Attachment Safety Solenoid drive current ≤ 6.5 A Its / Symptoms) Itrol Function – Option attachment flow control – Breaker operation failure (breaking list) -66 (#1) – CN-53 (#9) Checking Open/Short -66 (#2) – CN-45 (#B+ term) Checking Open/Short -66 (#C) – CN-51 (#13) Checking Open/Short	ıker m	node)				

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

 $\mbox{G : General} \qquad \qquad \mbox{C : Crawler Type} \qquad \qquad \mbox{W : Wheel Type}$

DTC	;	Discounting Office to	Ар	plicati	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
181	4	(Model Parameter) mounting Reverse Cooling Fan Solenoid (Detection) (When Reverse Cooling Fan Solenoid is Off) 10 seconds continuous, Reverse Cooling Fan Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Reverse Cooling Fan Solenoid is Off) 3 seconds continuous, Reverse Cooling Fan Solenoid drive unit Measurement Voltage > 3.0V	•		
	6	 (Detection) (When Reverse Cooling Fan Solenoid is On) 10 seconds continuous, Reverse Cooling Fan Solenoid drive current > 4.5 A (Cancellation) (When Reverse Cooling Fan Solenoid is On) 3 seconds continuous, Reverse Cooling Fan Solenoid drive current ≤ 4.5 A 	•		
	(Resu	lts / Symptoms)			
	1. Cor	ntrol Function – Cooling Fan reverse control operation failure (not applicable)			
	5	(Detection) (When Attachment Flow EPPR 1 current is equal or more than 300 mA) 10 seconds continuous, Attachment Flow EPPR drive current < 100 mA (Cancellation) (When Attachment Flow EPPR 1 current is equal or more than 300 mA) 3 seconds continuous, Attachment Flow EPPR drive current ≥ 100 mA	•		
188	6	(Detection) 10 seconds continuous, Attachment Flow EPPR 1 drive current > 1.0 A (Cancellation) 3 seconds continuous, Attachment Flow EPPR 1 drive current ≤ 1.0 A	•		
	1. Cor (Chec 1. CN	Its / Symptoms) htrol Function – IPC operation failure, Option attachment flow control operation f king list) -242 (#2) – CN-52 (#39) Checking Open/Short -242 (#1) – CN-52 (#40) Checking Open/Short	ailure)	

 $[\]ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC	,	Diamontia Critoria	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	5	(Detection) (When Attachment Flow EPPR 2 current is equal or more than 300 mA) 10 seconds continuous, Attachment Flow EPPR drive current < 100 mA (Cancellation) (When Attachment Flow EPPR 2 current is equal or more than 300 mA) 3 seconds continuous, Attachment Flow EPPR drive current ≥ 100 mA	•		
189	6	(Detection) 10 seconds continuous, Attachment Flow EPPR 2 drive current > 1.0 A (Cancellation) 3 seconds continuous, Attachment Flow EPPR 2 drive current ≤ 1.0 A	•		
	1. Cor (Chec 1. CN	lts / Symptoms) ntrol Function – Option attachment flow control operation failure king list) -243 (#2) – CN-52 (#6) Checking Open/Short -243 (#1) – CN-52 (#7) Checking Open/Short			,
	0	HW145 10 seconds continuous, Attachment flow control EPPR 1 press. Sensor Measurement Voltage > 5.2V HW145			
	1	10 seconds continuous, 0.3V≤ Attachment flow control EPPR 1 press. Sensor Measurement Voltage < 0.8V HW145			
196	4	10 seconds continuous, Attachment flow control EPPR 1 press. Sensor Measurement Voltage < 0.3V			
	1. Cor (Chec 1. CD- 2. CD-	Its / Symptoms) Its /			
200	0 1 4	10 seconds continuous, Pump EPPR Press. Sensor Measurement Voltage > 5.2V 10 seconds continuous, 0.3V≤ Pump EPPR Press. Sensor Measurement Voltage < 0.8V 10 seconds continuous, Pump EPPR Press. Sensor Measurement Voltage < 0.3V	•		
	1. Moi 2. Cor	Its / Symptoms) nitor – Pump EPPR Press. display failure ntrol Function – Pump input horse power control failure, Overload at compensat operation failure efficiency/speed performance failure)	tion co	ontrol	
	(Chec 1. CD 2. CD	king list) -44 (#B) – CN-52 (#32) Checking Open/Short -44 (#A) – CN-51 (#3) Checking Open/Short -44 (#C) – CN-51 (#13) Checking Open/Short			

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	·	Dia was akin Oribania	Application		
HCESPN	FMI	Diagnostic Criteria	G	С	W
	0	(Mounting pressure sensor) 10 seconds continuous, Boom Cylinder Rod Press. Sensor Measurement Voltage > 5.2V	•		
	1	(Mounting pressure sensor) 10 seconds continuous, 0.3V≤ Boom Cylinder Rod Press. Sensor Measurement Voltage < 0.8V	•		
205	4	(Mounting pressure sensor) 10 seconds continuous, Boom Cylinder Rod Press. Sensor Measurement Voltage < 0.3V	•		
	1. Mo 2. Col (Chec 1. CD 2. CD	ults / Symptoms) nitor – Boom Cylinder Rod Press. display failure ntrol Function – Boom floating control operation failure sking list) -124 (#B) – CN-53 (#5) Checking Open/Short -124 (#A) – CN-53 (#3) Checking Open/Short -124 (#C) – CN-53 (#13) Checking Open/Short			
218	4	Mounting pressure sensor (HCESPN128 or HCESPN 205) (Detection) (When Boom Up Floating Solenoid is Off) 10 seconds continuous, Boom Up Floating Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Boom Up Floating Solenoid is Off) 3 seconds continuous, Boom Up Floating Solenoid drive unit Measurement Voltage > 3.0V	•		
	6	(Detection) (When Boom Up Floating Solenoid is On) 10 seconds continuous, Boom Up Floating Solenoid drive current > 6.5 A (Cancellation) (When Boom Up Floating Solenoid is On) 3 seconds continuous, Boom Up Floating Solenoid drive current ≤ 6.5 A	•		
	1. Col (Chec 1. CD	ults / Symptoms) ntrol Function – Boom floating control operation failure king list) -368 (#1) – CN-53 (#20) Checking Open/Short -368 (#2) – CR-35 (#87) Checking Open/Short			

※ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC		D:	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	4	Mounting pressure sensor (HCESPN 128 or 205) (Detection) (When Boom Down Pilot Pressure Cutoff Solenoid is Off) 10 seconds continuous, Boom Down Pilot Pressure Cutoff Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Boom Down Pilot Pressure Cutoff Solenoid is Off) 3 seconds continuous, Boom Down Pilot Pressure Cutoff Solenoid drive unit	•		•
220	6	Measurement Voltage > 3.0V (Detection) (When Boom Down Pilot Pressure Cutoff Solenoid is On) 10 seconds continuous, Boom Down Pilot Pressure Cutoff Solenoid drive current > 6.5 A (Cancellation) (When Boom Down Pilot Pressure Cutoff Solenoid is On) 3 seconds continuous, Boom Down Pilot Pressure Cutoff Solenoid drive current ≤ 6.5 A	•		
	,	ults / Symptoms)			
	(Chec	ntrol Function – Boom floating control operation failure cking list) -369 (#1) – CN-53 (#35) Checking Open/Short -369 (#2) – CR-35 (#87) Checking Open/Short			
221	5	Monitor – Selecting attachment(breaker / crusher) (Detection) (When ATT Relief Setting EPPR 1 Current is equal or more than 10 mA) 10 seconds continuous, ATT Relief Setting EPPR 1 drive current = 0 mA (Cancellation) ATT Relief Setting EPPR 1 Current is equal or more than 10 mA) 3 seconds continuous, ATT Relief Setting EPPR 1 drive current ≥ 10 mA	•		
	6	(Detection) 10 seconds continuous, ATT Relief Setting EPPR 1 drive current > 1.0 A (Cancellation) 3 seconds continuous, ATT Relief Setting EPPR 1 drive current ≤ 1.0 A	•		
	1. Co (Chec 1. CD	ults / Symptoms) ntrol Function – Option attachment flow control – P1 relief pressure setting failur cking list) -365 (#2) – CN-53 (#39) Checking Open/Short -365 (#1) – CN-53 (#40) Checking Open/Short	е		

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\:Type} \qquad \qquad {\sf W:Wheel\:Type}$

DTC	;	Dia manatia Critaria	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	5	Monitor – Selecting attachment(crusher) (Detection) (When ATT Relief Setting EPPR 2 Current is equal or more than 10 mA) 10 seconds continuous, ATT Relief Setting EPPR 2 drive current = 0 mA (Cancellation) (When ATT Relief Setting EPPR 2 Current is equal or more than 10 mA) 3 seconds continuous, ATT Relief Setting EPPR 2 drive current ≥ 10mA	•		
222	6	(Detection) 10 seconds continuous, ATT Relief Setting EPPR 2 drive current > 1.0 A (Cancellation) 3 seconds continuous, ATT Relief Setting EPPR 2 drive current ≤ 1.0 A	•		
	1. Cor (Chec 1. CD	alts / Symptoms) Introl Function – Option attachment flow control – P2 relief pressure setting failusking list) -366 (#2) – CN-53 (#32) Checking Open/Short -366 (#1) – CN-53 (#33) Checking Open/Short	ure		
	3	10 seconds continuous, Fuel Level Measurement Voltage > 3.8V			
	4	10 seconds continuous, Fuel Level Measurement Voltage < 0.3V			
301	1. Mo (Chec 1. CD	ults / Symptoms) nitor – Fuel remaining display failure sking list) -2 (#2) – CN-52 (#26) Checking Open/Short -2 (#1) – CN-51 (#5) Checking Open/Short			
	4	(Model Parameter) mounting Fuel Warmer Relay (Detection) (When Fuel Warmer Relay is Off) 10 seconds continuous, Fuel Warmer Relay drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Fuel Warmer Relay is Off) 3 seconds continuous, Fuel Warmer Relay drive unit Measurement Voltage > 3.0V	•		
325	6 (Besu	(Detection) (When Fuel Warmer Relay is On) 10 seconds continuous, Fuel Warmer Relay drive current > 4.5 A (Cancellation) (When Fuel Warmer Relay is On) 3 seconds continuous, Fuel Warmer Relay drive current ≤ 4.5 A lts / Symptoms)	•		
	1. Cor (Chec 1. CR	ntrol Function – Fuel warmer operation failure sking list) -46 (#85) – CN-52 (#30) Checking Open/Short -46 (#86) – CN-45 (#B+ term) Checking Open/Short			

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	;	Diamenta Oritoria	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	0	10 seconds continuous, Transmission Oil Press. Sensor Measurement Voltage > 5.2V			•
	1	10 seconds continuous, 0.3V≤ Transmission Oil Press. Sensor Measurement Voltage < 0.8V			•
504	4	10 seconds continuous, Transmission Oil Press. Sensor Measurement Voltage < 0.3V			•
501	1. Mo (Chec 1. CD 2. CD	ults / Symptoms) nitor – Transmission Oil Press. display failure, Transmission Oil low pressure wasking list) -5 (#B) – CN-54 (#27) Checking Open/Short -5 (#A) – CN-54 (#3) Checking Open/Short -5 (#C) – CN-54 (#13) Checking Open/Short	arninç	g failu	ŕe
	0	10 seconds continuous, Brake Oil Press. Sensor Measurement Voltage > 5.2V			•
	1	10 seconds continuous, 0.3V≤ Brake Oil Press. Sensor Measurement Voltage < 0.8V			•
500	4	10 seconds continuous, Brake Oil Press. Sensor Measurement Voltage < 0.3V			•
503	1. Mo (Chec 1. CD 2. CD	ults / Symptoms) nitor – Brake Oil Press. display failure, Brake Oil low pressure warning failure sking list) -3 (#B) – CN-54 (#4) Checking Open/Short -3 (#A) – CN-54 (#3) Checking Open/Short -3 (#C) – CN-54 (#13) Checking Open/Short			
	0	10 seconds continuous, Working Brake Press. Sensor Measurement Voltage > 5.2V			•
	1	10 seconds continuous, 0.3V≤ Working Brake Press. Sensor Measurement Voltage < 0.8V			•
505	4	10 seconds continuous, Working Brake Press. Sensor Measurement Voltage < 0.3V			•
	1. Mo (Chec 1. CD 2. CD	ults / Symptoms) nitor – Working Brake Oil Press. display failure, Working Brake Oil low pressure sking list) -38 (#B) – CN-54 (#5) Checking Open/Short -38 (#A) – CN-54 (#3) Checking Open/Short -38 (#C) – CN-54 (#13) Checking Open/Short	warr	ning fa	illure

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

G : General C : Crawler Type W : Wheel Type

DTC		Diagnostic Critoria	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria		С	W
	4	(Detection) (When Parking Relay is Off) 10 seconds continuous, Parking Relay drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Parking Relay is Off) 3 seconds continuous, Parking Relay drive unit Measurement Voltage > 3.0V			•
514	6	(Detection) (When Parking Relay is On) 10 seconds continuous, Parking Relay drive current > 6.5 A (Cancellation) (When Parking Relay is On) 3 seconds continuous, Parking Relay drive current ≤ 6.5 A			•
	(Results / Symptoms) 1. Control Function – Parking Relay operation failure (Checking list) 1. CR-66 (#1) – CN-54 (#20) Checking Open/Short 2. CR-66 (#2) – CN-45 (#B+ term) Checking Open/Short				
	4	(Detection) (When Traveling Cutoff Relay is Off) 10 seconds continuous, Traveling Cutoff Relay drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Traveling Cutoff Relay is Off) 3 seconds continuous, Traveling Cutoff Relay drive unit Measurement Voltage > 3.0V			•
517	6	(Detection) (When Traveling Cutoff Relay is On) 10 seconds continuous, Traveling Cutoff Relay drive current > 6.5 A (Cancellation) (When Traveling Cutoff Relay is On) 3 seconds continuous, Traveling Cutoff Relay drive current ≤ 6.5 A			•
	1. Cor (Chec 1. CR	lts / Symptoms) htrol Function – Traveling Cutoff Relay operation failure king list) -47 (#85) – CN-54 (#9) Checking Open/Short -47 (#86) – CN-45 (#B+ term) Checking Open/Short			

* Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\:Type} \qquad \qquad {\sf W:Wheel\:Type}$

DTC		Diamontia Critaria	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	4	(Detection) (When Ram Lock Solenoid is Off) 10 seconds continuous, Ram Lock Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Ram Lock Solenoid is Off) 3 seconds continuous, Ram Lock Solenoid drive unit Measurement Voltage > 3.0V			•
525	6	(Detection) (When Ram Lock Solenoid is On) 10 seconds continuous, Ram Lock Solenoid drive current > 6.5 A (Cancellation) (When Ram Lock Solenoid is On) 3 seconds continuous, Ram Lock Solenoid drive current ≤ 6.5 A			•
	(Resu	Its / Symptoms)			
	 Control Function – Ram lock control operation failure (Checking list) CN-69 (#1) – CN-54 (#8) Checking Open/Short CN-69 (#2) – CN-45 (#B+ term) Checking Open/Short 				
	4	(Detection) (When Creep Solenoid is Off) 10 seconds continuous, Creep Solenoid drive unit Measurement Voltage ≤ 3.0V (Cancellation) (When Creep Solenoid is Off) 3 seconds continuous, Creep Solenoid drive unit Measurement Voltage > 3.0V			•
527	6	(Detection) (When Creep Solenoid is On) 10 seconds continuous, Creep Solenoid drive current > 6.5 A (Cancellation) (When Creep Solenoid is On) 3 seconds continuous, Creep Solenoid drive current ≤ 6.5 A			•
	1. Cor (Chec 1. CN	lts / Symptoms) ntrol Function – Creep mode operation failure king list) -206 (#1) – CN-54 (#7) Checking Open/Short -206 (#2) – CN-45 (#B+ term) Checking Open/Short			,

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

DTC		Discounting Office in	Ap	plicat	ion
HCESPN	FMI	Diagnostic Criteria		С	W
	0	10 seconds continuous, Travel Forward Press. Sensor Measurement Voltage > 5.2V			•
	1	10 seconds continuous, $0.3V \le$ Travel Forward Press. Sensor Measurement Voltage $< 0.8V$			•
	4	10 seconds continuous, Travel Forward Press. Sensor Measurement Voltage < 0.3V			•
530	(Resu	Its / Symptoms)			
	1. Mor	nitor – Travel Forward Press. display failure			
	2. Cor	ntrol Function – Driving interoperability power control operation failure			
	(Chec	king list)			
	1. CD	-73 (#B) – CN-54 (#6) Checking Open/Short			
	2. CD	-73 (#A) – CN-54 (#3) Checking Open/Short			
	3. CD	-73 (#C) - CN-54 (#13) Checking Open/Short			
	1	10 seconds continuous, $0.3V \le$ Travel Reverse Press. Sensor Measurement Voltage $< 0.8V$			•
	4	10 seconds continuous, Travel Reverse Press. Sensor Measurement Voltage < 0.3V			•
	(Resu	Its / Symptoms)		,	
531	1. Mor	nitor – Travel Reverse Press. display failure			
	2. Cor	ntrol Function – Driving interoperability power control operation failure			
	(Chec	king list)			
	1. CD	-74 (#B) – CN-54 (#23) Checking Open/Short			
	2. CD	-74 (#A) – CN-54 (#3) Checking Open/Short			
	3. CD	-74 (#C) – CN-54 (#13) Checking Open/Short			
	0	10 seconds continuous, Battery input Voltage > 35V			
	1	10 seconds continuous, Battery input Voltage < 18V			
705	(Resu	Its / Symptoms)			
703	1. Cor	ntrol Function – Startup impossibility			
	(Chec	king list)			
	1. CS-	-74A (#1) – CN-51 (#1) Checking Open/Short			
		(When Engine is equal or more than 400 rpm) 10 seconds continuous,			
	1	Alternator Node L Measurement Voltage < 18V			
		(In case 12v goods, Alternator Node L Measurement Voltage < 9V)			
707	(Resu	Its / Symptoms)			
	1. Cor	ntrol Function – Battery charging circuit failure			
	(Chec	king list)			
	1. CS-	-74A (#1) – CN-51 (#2) Checking Open/Short			

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

DTC	;	Discounting Office in	Ар	plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	0	(Model Parameter) Mounting Acc. Dial			
	3	10 seconds continuous, Acc. Dial Measurement Voltage > 5.2V			
	4	(Model Parameter) Mounting Acc. Dial			
		10 seconds continuous, Acc. Dial Measurement Voltage < 0.3V			
714	(Resu	lts / Symptoms)			
	1. Mo	nitor – Acc. Dial Voltage display failure			
	2. Cor	ntrol Function – Engine rpm control failure			
	(Chec	king list)			
	1. CN	-7 (#15) – CN-52 (#23) Checking Open/Short			
		(Detection)			
		(When Travel Alarm (Buzzer) Sound is Off)			
		10 seconds continuous, Travel Alarm (Buzzer) Sound Relay drive unit			
	4	Measurement Voltage ≤ 3.0V			
	4	(Cancellation)			
		(When Travel Alarm (Buzzer) Sound Relay is Off)			
		3 seconds continuous, Travel Alarm (Buzzer) Sound Relay drive unit			
		Measurement Voltage > 3.0V			
		(Detection)			
		(When Travel Alarm (Buzzer) Sound is On)			
722		10 seconds continuous, Travel Alarm (Buzzer) Sound Relay drive			
		current > 4.5 A			
	6	(Cancellation)			
		(When Travel Alarm (Buzzer) Sound is On)			
		3 seconds continuous, Travel Alarm (Buzzer) Sound Relay drive			
		current ≤ 4.5 A			
	(Resu	llts / Symptoms)			
	1. Cor	ntrol Function – Driving alarm operation failure			
		king list)			
	1. CN	-81 (#1) – CN-52 (#31) Checking Open/Short			
	2. CN	-81 (#2) – CN-45 (#B+ term) Checking Open/Short			
		(When mounting the A/C Controller)			
	2	60 seconds continuous, A/C Controller Communication Data Error			
	(Resu	llts / Symptoms)			
831	,	ntrol Function – A/C Controller operation failure			
651		king list)			
	l ,	-11 (#8) – CN-51 (#22) Checking Open/Short			
		-11 (#7) – CN-51 (#32) Checking Open/Short			
	2	60 seconds continuous, Cluster Communication Data Error			
		lts / Symptoms)			
	,	ntrol Function – Cluster operation failure			
840		king list)			
	,	-56A (#7) – CN-51 (#22) Checking Open/Short			
		-56A (#6) – CN-51 (#32) Checking Open/Short			
	Z. UN				

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

 ${\sf G:General} \qquad \qquad {\sf C:Crawler\,Type} \qquad \qquad {\sf W:Wheel\,Type}$

DTC	;	Dia supartia Cuitaria		plicat	ion
HCESPN	FMI	Diagnostic Criteria	G	С	W
	2	10 seconds continuous, ECM Communication Data Error	•		
	(Resu	Its / Symptoms)			1
841	1. Cor	ntrol Function – ECM operation failure			
041	(Chec	king list)			
	1. CN	-93 (#22) – CN-51 (#21) Checking Open/Short			
	2. CN	-93 (#46) – CN-51 (#31) Checking Open/Short			
	2	(When mounting the I/O Controller 1)			
		60 seconds continuous, I/O Controller 1 Communication Data Error			
	(Resu	Its / Symptoms)			
845	1. Cor	ntrol Function – I/O Controller 1 operation failure			
	(Chec	king list)			
	1. CN	-53 (#21) - CN-51 (#23) Checking Open/Short			
	2. CN	-53 (#31) – CN-51 (#33) Checking Open/Short			
	2	(When mounting the Haptic Controller)			
		60 seconds continuous, Haptic Controller Communication Data Error			
	(Resu	Its / Symptoms)			
848	1. Cor	ntrol Function – Haptic Controller operation failure			
	l '	king list)			
		-8 (#2) – CN-51 (#22) Checking Open/Short			
	2. CN	-8 (#3) – CN-51 (#32) Checking Open/Short			
	2	(When mounting the RMCU)			
		60 seconds continuous, RMCU communication Data Error			
	l ,	luts / Symptoms)			
850		ntrol Function – RMCU operation failure			
	l ,	king list)			
		-125 (#3) – CN-51 (#22) Checking Open/Short			
	2. CN	-125 (#11) – CN-51 (#32) Checking Open/Short			
	2	(When mounting the I/O Controller 2)			
	(D	60 seconds continuous, I/O Controller 2 communication Data Error			
004	`	Its / Symptoms)			
861		ntrol Function – I/O Controller 2 operation failure			
	,	king list) 54 (#21) CN 51 (#22) Chapking Open/Short			
		-54 (#21) – CN-51 (#23) Checking Open/Short			
	2. UN	-54 (#31) – CN-51 (#33) Checking Open/Short			

 $\ensuremath{\,\mathbb{X}\,}$ Some error codes are not applied to this machine.

DTC	;	Diamagatia Odhada	Ар	plicat	ion
HCESPN	FMI	Diagnostic Criteria		С	W
	2	(When mounting the AAVM)			
		60 seconds continuous, AAVM communication Data Error			
	(Resu	lts / Symptoms)			
866	1. Cor	ntrol Function – AAVM operation failure			
	(Chec	king list)			
		-401 (#86) – CN-51 (#22) Checking Open/Short			
	2. CN	-401 (#87) – CN-51 (#32) Checking Open/Short			
	2	60 seconds continuous, RDU communication Data Error			
	(Resu	lts / Symptoms)			
867	1. Cor	ntrol Function – RDU operation failure			
007	(Chec	king list)			
	1. CN	-376 (#10) – CN-51 (#22) Checking Open/Short			
	2. CN	-376 (#18) – CN-51 (#32) Checking Open/Short			
	2	60 seconds continuous, Switch Controller communication Data Error			
	(Resu	lts / Symptoms)			
868	1. Cor	ntrol Function – Switch Controller operation failure			
	(Chec	king list)			
	1. CN	-56A (#7) - CN-51 (#22) Checking Open/Short			
	2. CN	-56A (#6) – CN-51 (#32) Checking Open/Short			
	2	(When mounting the BKCU)			
869		60 seconds continuous, BKCU communication Data Error			
	(Resu	Its / Symptoms)			
	1. Cor	ntrol Function – BKCU operation failure			
	`	king list)			
		-2B (#A) – CN-51 (#22) Checking Open/Short			
	2. CS	-2B (#B) – CN-51 (#32) Checking Open/Short			

 $\ensuremath{\,\%\,}$ Some error codes are not applied to this machine.

4. ENGINE FAULT CODE

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
111 629 12	Engine control module critical internal failure - Bad intelligent device or component. Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Possible no noticeable performance effects, engine dying, or hard starting.
115 612 2	Engine magnetic crankshaft speed/position lost both of two signals - Data erratic, intermittent, or incorrect. The ECM has detected the primary and backup speed sensor signals are connected backwards.	The engine will shut down or will not start.
122 102 3	Intake manifold 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the intake manifold pressure circuit.	Engine power derate.
123 102 4	Intake manifold 1 pressure sensor circuit - Voltage below normal, or shorted to low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.	Engine power derate.
124 102 16	Intake manifold 1 pressure - Data valid but above normal operational range - Moderately severe level. Intake manifold pressure is above the maximum operating limit.	Engine power derate.
125 102 18	Intake Manifold 1 Pressure - Data valid but below normal operating range - Moderately severe level. Intake manifold pressure is below the minimum operating limit.	Engine power derate.
131 91 3	Accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at accelerator pedal position number 1 circuit.	The engine will operate in limp home mode.
132 91 4	Accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at accelerator pedal position number 1 signal circuit.	The engine will operate in limp home mode.
133 974 3	Remote accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
134 974 4	Remote accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
143 100 18	Engine oil rifle pressure - Data valid but below normal operational range - Moderately severe level. Engine oil pressure signal indicates engine oil pressure is below the engine protection warning limit.	Engine power derate.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
144 110 3	Engine coolant temperature 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
145 110 4	Engine coolant temperature 1 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
146 110 16	Engine coolant temperature - Data valid but above normal operational range - Moderately severe level. Engine coolant temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
151 110 0	Engine coolant temperature - Data valid but above normal operational range - Most severe level. Engine coolant temperature signal indicates engine coolant temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
153 105 3	Intake manifold 1 temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
154 105 4	Intake manifold 1 temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
155 105 0	Intake manifold 1 temperature - Data valid but above normal operational range - Most severe level. Intake manifold air temperature signal indicates intake manifold air temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
175 3464 3	Electronic throttle control actuator driver circuit - Voltage above normal, or shorted to high source. A short circuit to battery or open circuit has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
176 3464 4	Electronic throttle control actuator driver circuit - Voltage below normal, or shorted to low source. A short circuit to ground has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
177 3464 7	Electronic throttle control actuator - Mechanical system not responding or out of adjustment. The engine intake air throttle actuator has failed the auto zero span check.	Possible reduced engine performance.
187 3510 4	Sensor supply 2 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the sensor supply number 2 circuit.	Engine power derate.
195 111 3	Coolant level sensor 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at engine coolant level circuit.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
196 111 4	Coolant level sensor 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant level circuit.	None on performance.
197 111 18	Coolant level - Data valid but below normal operational range - Moderately severe level. Low coolant level has been detected.	Engine power derate.
221 108 3	Barometric pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at barometric pressure circuit.	Engine power derate.
222 108 4	Barometric pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at barometric pressure circuit.	Engine power derate.
227 3510 3	Sensor supply 2 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 2 circuit.	Engine power derate.
234 190 0	Engine crankshaft speed/position - Data valid but above normal operational range - Most severe level. Engine speed signal indicates engine speed above engine protection limit.	Engine power derate.
238 3511 4	Sensor supply 3 circuit - Voltage below normal, or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
239 3511 3	Sensor supply 3 circuit - Voltage above normal or shorted to high source. High voltage detected on the 5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
241 84 2	Wheel-based vehicle speed - Data erratic, intermittent, or incorrect. The ECM lost the vehicle speed signal or is reading an erratic value.	Engine speed limited to ,maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
245 647 4	Fan control circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fan control circuit when commanded on.	The fan may stay on continuously or not run at all.
249 171 3	Ambient air temperature sensor 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
256 171 4	Ambient air temperature sensor 1 circuit - Voltage below normal or shorted to low source. Low voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
271 1347 4	Fuel pump pressurizing assembly 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel pump actuator circuit.	Engine power derate.

 $[\]ensuremath{\,\%\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
272 1347 3	Fuel pump pressurizing assembly 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the fuel pump actuator circuit.	Engine may run rough, may stop running, may not start, or may be difficult to start.
285 639 9	SAE J1939 multiplexing PGN timeout error - Abnormal update rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 639 13	SAE J1939 multiplexing configuration error - Out of calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
288 974 19	Sae J1939 multiplexing remote accelerator pedal or lever position sensor circuit - Received network data in error. The oem vehicle electronic control unit (VECM) detected a fault with the remote accelerator.	Remote accelerator will not operate.
295 108 2	Barometric pressure - Data erratic, intermittent, or incorrect. An error in the barometric pressure sensor signal was detected by the ECM.	Engine power derate.
322 651 5	Injector solenoid driver cylinder 1 circuit - Current below normal, or open circuit. Current detected at injector 1 when voltage is turned OFF.	Engine power derate.
323 655 5	Injector solenoid driver cylinder 5 circuit - Current below normal, or open circuit. Current detected at injector 5 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
324 653 5	Injector solenoid driver cylinder 3 circuit - Current below normal, or open circuit. Current detected at injector 3 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
325 656 5	Injector solenoid driver cylinder 6 circuit - Current below normal, or open circuit. Current detected at injector 6 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
331 652 5	Injector solenoid driver cylinder 2 circuit - Current below normal, or open circuit. Current detected at injector 2 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
332 654 5	Injector solenoid driver cylinder 4 circuit - Current below normal, or open circuit. Current detected at injector 4 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
334 110 2	Engine coolant temperature - Data erratic, intermittent, or incorrect. The engine coolant temperature sensor is reading an erratic value at initial key ON.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault and a		
Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
338 1267 3	Idle shutdown vehicle accessories relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or short to voltage source detected at the idle shutdown vehicle accessory/ignition bus relay circuit.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
339 1267 4	Idle shutdown vehicle accessories relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at the idle shutdown vehicle accessory or ignition bus relay circuit when commanded ON.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
343 629 12	Engine control module warning internal hardware failure - Bad intelligent device or component. ECM power supply errors have been detected.	Engine power derate.
346 630 12	Engine control module calibration memory software - Bad intelligent device or component. Invalid switch configuration adjustable parameter setting have been detected by the engine control module (ECM).	Various optional switch inputs to the ECM may not operate correctly.
351 627 12	Injector power supply - Bad intelligent device or component. The ECM measured injector boost voltage is low.	Engine power derate.
352 3509 4	Sensor supply 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at sensor supply number 1 circuit.	Engine power derate.
383 729 5	Engine intake air heater 1 circuit - Current below normal or open circuit. A malfunctioning engine intake air heater circuit has been detected.	Engine may not start or may be difficult to start.
386 3509 3	Sensor supply 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 1 circuit.	Engine power derate.
415 100 1	Engine oil rifle pressure - Data valid but below normal operational range - Most severe level. Oil pressure signal indicates oil pressure below the engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red stop lamp starts flashing.
418 97 15	Water in fuel indicator - Data valid but above normal operational range - Least severe level. water has been detected in the fuel filter.	None on performance.
427 639 9	J1939 data link - Abnormal update rate. Communication between the engine control module (ECM) and another device on the SAE J1939 data link has been lost.	Engine will only idle.
428 97 3	Water in fuel indicator sensor circuit - Voltage above normal, or shorted to high source. High voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
435 100 2	Engine oil rifle pressure - Data erratic, intermittent, or incorrect. The engine oil pressure sensor is reading an erratic value.	None on performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
436 105 2	Intake manifold 1 temperature - Data erratic, intermittent, or incorrect. The intake manifold temperature sensor is reading an erratic value at initial key on or while the engine is running.	Possible reduced engine performance.
441 168 18	Battery 1 voltage - Data valid but below normal operational range - Moderately severe level. ECM supply voltage is below the minimum system voltage level.	Engine may run rough, may stop running, may not start, or may be difficult to start.
442 168 16	Battery 1 Voltage - Data valid but above normal operational range - Moderately severe level. ECM supply voltage is above the maximum system voltage level.	None on performance.
451 157 3	Injector metering rail 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
452 157 4	Injector metering rail 1 pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
483 1349 3	Injector metering rail 2 pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
484 1349 4	Injector metering rail 2 pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
515 3514 3	Sensor supply 6 circuit - Voltage above normal or shorted to high source. High voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
516 3514 4	Sensor supply 6 circuit - Voltage below normal or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
553 157 16	Injector metering rail 1 pressure - Data valid but above normal operational range - Moderately severe level. The ECM has detected that fuel pressure is higher than commanded pressure.	Possible reduced engine performance.
555 101 16	Crankcase pressure - Data valid but above normal operational range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.
556 101 0	Crankcase pressure - Data valid but above normal operational range - Most severe level. The crankcase breather filter requires maintenance.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
559 157 18	Injector metering rail 1 pressure - Data valid but below normal operational range - Moderately severe level. The ECM has detected that fuel pressure is lower than commanded pressure.	Possibly hard to start or low power. Engine could possibly not start.
584 677 3	Starter relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
585 677 4	Starter relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
595 103 16	Turbocharger 1 speed - Data valid but above normal operating range - Moderately severe level. High turbocharger speed has been detected by the ecm.	Engine power derate.
596 167 16	Electrical charging system voltage - Data valid but above normal operational range - Moderately severe level. High battery voltage detected by the battery voltage monitor feature.	None on performance.
597 167 18	Electrical charging system voltage - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the battery voltage monitor feature.	None on performance.
649 1378 31	Engine oil change interval - Condition exists. Change engine oil and filter.	None on performance.
687 103 18	Turbocharger 1 speed - Data valid but below normal operational range - Moderately severe level. Low turbocharger speed detected by the ECM.	Engine power derate. The ECM uses an estimated turbocharger speed.
689 190 2	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. The ECM has detected an error in the engine speed signal.	Possible reduced engine performance.
691 1172 3	Turbocharger 1 compressor inlet temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
692 1172 4	Turbocharger 1 compressor inlet temperature circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
693 1172 2	Turbocharger 1 compressor intake temperature - Data erratic, intermittent, or incorrect. A temperature too high or low for the operating conditions has been detected by the turbocharger compressor intake temperature sensor.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN	Reason	Effect (only when fault code is active)
731 723 7	Engine speed / position camshaft and crankshaft misalignment - Mechanical system not responding properly or out of adjustment. Engine position signal from the crankshaft position sensor and camshaft position sensor do not match.	Engine power derate.
755 157 7	Injector metering rail 1 pressure - Mechanical system not responding or out of adjustment. The ECM has detected a difference in the 2 fuel rail pressure signals.	Possible reduced engine performance.
778 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. The ECM has detected an error in the camshaft position sensor signal.	Possible reduced engine performance.
784 1590 2	Adaptive cruise control mode - Data erratic, intermittent, or incorrect. Loss of communication with adaptive cruise control.	Adaptive cruise control will not operate. Standard cruise control may not operate.
1117 627 2	Power supply lost with ignition on - Data erratic, intermittent, or incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily, or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).	Possible no noticeable performance.
1139 651 7	Injector solenoid driver cylinder 1 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1141 652 7	Injector solenoid driver cylinder 2 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1142 653 7	Injector solenoid driver cylinder 3 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1143 654 7	Injector solenoid driver cylinder 4 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1144 655 7	Injector solenoid driver cylinder 5 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1145 656 7	Injector solenoid driver cylinder 6 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1228 27 2	Egr valve position - Data erratic, intermittent, or Incorrect. The EGR valve is unable to meet commanded position.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1239 2623 3	Accelerator pedal or lever position sensor 2 circuit - Voltage above normal or shorted to high source. High voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1241 2623 4	Accelerator pedal or lever position sensor 2 circuit - Voltage below normal or shorted to low source. Low voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1242 91 2	Accelerator pedal or lever position sensor 1 and 2 - Data erratic, intermittent, or incorrect. Accelerator position sensor number 1 and number 2 are reading different values.	The engine will only idle.
1515 91 19	Sae J1939 multiplexed accelerator pedal or lever sensor system - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the multiplexed accelerator pedal.	The engine will only idle.
1654 1323 31	Engine misfire cylinder 1- Condition exists. Engine misfire has been detected in cylinder number 1.	Possible reduced engine performance.
1655 1324 31	Engine misfire cylinder 2 - Condition exists. Engine misfire has been detected in cylinder number 2.	Possible reduced engine performance.
1656 1325 31	Engine misfire cylinder 3 - Condition exists. Engine misfire has been detected in cylinder number 3.	Possible reduced engine performance.
1657 1326 31	Engine misfire cylinder 4 - Condition exists. Engine misfire has been detected in cylinder number 4.	Possible reduced engine performance.
1658 1327 31	Engine misfire cylinder 5 - Condition exists. Engine misfire has been detected in cylinder number 5.	Possible reduced engine performance.
1659 1328 31	Engine misfire cylinder 6 - Condition exists. Engine misfire has been detected in cylinder number 6.	Possible reduced engine performance.
1668 1761 4	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank level sensor circuit.	Possible reduced engine performance.
1669 1761 3	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst tank level sensor circuit.	Possible reduced engine performance.
1673 1761 1	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Most severe level. The aftertreatment diesel exhaust fluid tank level has fallen below the critical warning level.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1677 3031 4	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1678 3031 3	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1679 3031 2	Aftertreatment diesel exhaust fluid tank temperature - Data erratic, intermittent, or incorrect. The diesel exhaust fluid tank temperature sensor has indicated a tank temperature too high or too low for the ambient conditions.	Possible reduced engine performance.
1682 3362 31	Aftertreatment diesel exhaust fluid dosing unit input lines - Condition exists. The aftertreatment diesel exhaust fluid dosing unit is unable to prime.	Possible reduced engine performance.
1683 3363 3	Aftertreatment diesel exhaust fluid tank heater - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1684 3363 4	Aftertreatment diesel exhaust fluid tank heater - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1691 100 18	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. The temperature increase across the aftertreatment catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
1695 3513 3	Sensor supply 5 - Voltage above normal or shorted to high source. High voltage detected at sensor supply 5 circuit in the oem harness.	the engine will operate in limp home mode.
1696 3513 4	Sensor supply 5 - Voltage below normal or shorted to low source. Low voltage detected at sensor supply number 5 circuit in the oem harness.	the engine will operate in limp home mode.
1712 3363 18	Aftertreatment diesel exhaust fluid tank heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank heater is unable to thaw the frozen diesel exhaust fluid.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1713 3363 16	Aftertreatment diesel exhaust fluid tank heater - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid tank heater is continuously in the on position.	None on performance.
1718 1322 31	Engine misfire for multiple cylinders - Condition exists. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1776 2634 3	Power relay driver circuit - Voltage above normal or shorted to high source. High voltage detected at power relay driver circuit.	Possible reduced engine performance.
1777 2634 4	Power relay driver circuit - Voltage below normal or shorted to low source. An open circuit or low voltage has been detected at the power relay circuit.	Possible reduced engine performance.
1843 101 3	Crankcase pressure circuit - Voltage above normal or shorted to high source. High signal voltage detected at the crankcase pressure circuit.	None on performance.
1844 101 4	Crankcase pressure circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the crankcase pressure circuit.	None on performance.
1866 411 2	Exhaust gas recirculation valve delta pressure - Data erratic, intermittent, or incorrect. An error in the EGR delta pressure signal was detected at initial key on or the sensor failed the autozero test.	possible reduced engine performance.
1867 412 2	Engine gas recircuilation temperature - Data erratic, intermittent, or incorrect. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1879 3251 3	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1881 3251 4	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage or open circuit detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1883 3251 2	Aftertreatment diesel particulate filter differential pressure sensor - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter differential pressure sensor is reading an erratic value at initial key on or during engine operation.	possible reduced engine performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1885 3216 4	Aftertreatment intake NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
1887 3226 4	Aftertreatment outlet NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
1896 2791 13	EGR valve controller - Out of calibration. The EGR valve has failed the automatic calibration procedure at initial key ON.	Possible reduced engine performance.
1921 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Moderately severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
1922 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Most severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits. Engine protection derate is enabled.	Possible reduced engine performance.
1938 3597 1	Ecu power output supply voltage 1 - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the VGT actuator.	Possible reduced engine performance.
1942 101 2	Crankcase pressure - Data erratic, intermittent, or incorrect. The ECM has detected that the crankcase pressure signal is reading an erratic value at initial key ON or during engine operation.	None on performance.
1961 2791 0	EGR valve control circuit calculated over temperature - Data valid but above normal operational range - Least severe level. High EGR valve driver temperature has been detected.	Possible reduced engine performance.
1962 641 0	VGT Actuator driver over temperature (calculated) - Data valid but above normal operating range - Least severe level. High internal VGT actuator temperature has been detected.	None on performance.
1974 101 16	Crankcase pressure - Data valid but above normal operating range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1993 4795 31	Aftertreatment diesel particulate filter missing - Condition exists. The aftertreatment diesel particulate filter in the exhaust system is not present.	Active aftertreatment diesel particulate filter regeneration will be disabled.
2185 3512 3	Sensor supply 4 circuit - Voltage above normal, or shorted to high source. High voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2186 3512 4	Sensor supply 4 circuit - Voltage below normal, or shorted to low source. Low voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2198 641 11	VGT Actuator driver circuit - Root cause not known. Intermittent communication between the smart VGT controller and the ECM has been detected. The VGT controller is not interpreting the J1939 message from the ECM correctly.	Possible reduced engine performance.
2272 27 4	EGR Valve position circuit - Voltage below normal or shorted to low source. Low signal voltage has been detected at the EGR valve position sensor circuit	Possible reduced engine performance.
2273 411 3	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2274 411 4	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2288 103 15	Turbocharger 1 speed - Data valid but above normal operating range - Least severe level. High turbocharger speed has been detected by the ECM.	Possible reduced engine performance.
2311 633 31	Electronic fuel injection control valve circuit - Condition exists. Fuel pump actuator circuit resistance too high or too low, or an intermittent connection has been detected.	Possible reduced engine performance.
2322 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. Camshaft engine speed sensor intermittent synchronization.	None on performance.
2349 2791 5	EGR Valve control circuit - Current below normal or open circuit. Motor terminal or motor coil open circuit has been detected by the ECM.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2353 2791 6	EGR Valve control circuit - Current above normal or grounded circuit. A short circuit to ground has been detected in the EGR valve motor circuit.	Possible reduced engine performance.
2372 95 16	Fuel filter differential pressure - Data valid but above normal operational range - Moderately severe level. Excessive fuel flow restriction to the high pressure fuel pump has been detected.	Possible reduced engine performance.
2373 1209 3	Exhaust gas pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2374 1209 4	Exhaust gas pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2375 412 3	Exhaust gas recirculation temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2376 412 4	Exhaust gas recirculation temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2377 647 3	Fan control circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at the fan control circuit.	The fan can stay on continuously or not run at all.
2387 641 7	VGT Actuator driver circuit (motor) - Mechanical system not responding or out of adjustment. The smart VGT controller has detected incorrect stop limits, or the VGT is unable to move to the closed position.	Possible reduced engine performance.
2398 171 2	Ambient air temperature - Data erratic, intermittent, or incorrect. The ambient air temperature sensor is reading an erratic value.	Possible reduced engine performance.
2448 111 17	Coolant level - Data valid but below normal operational range - Least severe level. Low engine coolant level detected.	none on performance.
2449 641 13	Vgt actuator controller - Out of calibration. The VGT actuator has been installed incorrectly.	Possible reduced engine performance.
2468 102 3	Engine crankshaft speed/position - Data valid but above normal operating range - Moderately severe level. The engine speed has exceeded a critical limit.	Engine will be shut down.
2554 1209 2	Exhaust gas pressure - Data erratic, intermittent or incorrect. The exhaust gas pressure sensor is reading an erratic value.	possible reduced engine performance.

 $[\]ensuremath{\,\%\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2555 729 3	Intake air heater 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2556 729 4	Intake air heater 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2634 641 12	VGT Actuator controller - Bad intelligent device or component. An internal error has been detected by the smart VGT controller.	Possible reduced engine performance.
2636 641 9	VGT Actuator driver circuit - abnormal update rate. No communications on the J1939 data link between the engine ECM and the smart VGT controller.	Possible reduced engine performance.
2638 5298 17	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Least severe level. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
2639 3251 15	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Least severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
2646 110 32	Engine coolant temperature - Condition exists. The EGR valve was closed to reduce engine coolant temperature.	Possible reduced engine performance.
2718 520325 31	Brake switch and accelerator pedal position incompatible - Condition exists. The ECM has detected the brake pedal and accelerator pedal were depressed simultaneously.	The engine will operate in limp home mode.
2771 3226 9	Aftertreatment outlet NOx sensor - Abnormal update rate. No communications or an invalid data transfer rate detected on the J1939 data link between the ECM and the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
2777 3703 31	Particulate trap active regeneration inhibited due to inhibit switch - Condition exists. Regeneration of the diesel particulate filter has been prevented due to the permit switch being disabled.	Possible frequent need for aftertreatment regeneration.
2961 412 15	Exhaust gas recirculation temperature - Data valid but above normal operational range - Least severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.
2962 412 16	Exhaust gas recirculation temperature - Data valid but above normal operational range - Moderately severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2963 110 15	Engine coolant temperature - Data valid but above normal operational range - Least severe level. Engine coolant temperature is above the engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2964 105 15	Intake manifold 1 temperature - Data valid but above normal operational range - Least severe level. Intake manifold air temperature signal indicates intake manifold air temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2973 102 2	Intake manifold 1 pressure - Data erratic, intermittent, or incorrect. The intake manifold pressure sensor is reading an erratic value.	Possible reduced engine performance.
2976 3361 2	Aftertreatment diesel exhaust fluid dosing unit temperature - Data erratic, intermittent, or incorrect. An internal error has been detected in the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3133 3610 3	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3134 3610 4	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3135 3610 2	Aftertreatment diesel particulate filter outlet pressure - Data erratic, intermittent or incorrect. The aftertreatment diesel particulate filter outlet pressure sensor is reading an erratic value at initial key ON or during engine operation.	Possible reduced engine performance.
3146 4363 3	Aftertreatment SCR outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3147 4363 4	Aftertreatment SCR outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3148 4363 2	Aftertreatment SCR outlet temperature sensor - Data erratic, intermittent, or incorrect. The SCR outlet temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3151 4794 31	Aftertreatment SCR catalyst system missing - Condition exists. The aftertreatment SCR catalyst in the exhaust system is not present.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3165 4363 0	Aftertreatment SCR outlet temperature - Data valid but above normal operational range - Most severe level. The SCR outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3168 3936 16	Aftertreatment diesel particulate filter system - Data valid but above normal operating range - Moderately severe level. The system has detected a malfunction in the filtering capability of the aftertreatment diesel particulate filter.	None on performance.
3186 1623 9	Tachograph output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the tachograph output shaft speed sensor.	None on performance.
3213 1623 19	Tachograph output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the tachograph output shaft speed sensor.	None on performance.
3228 3216 2	Aftertreatment Intake NOx sensor - Data erratic, intermittent, or incorrect. An incorrect NOx sensor reading has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3232 3216 9	Aftertreatment Intake NOx sensor - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3235 4363 16	Aftertreatment SCR outlet temperature - Data valid but above normal operating range - Moderately severe level. The SCR outlet temperature sensor reading has exceeded the maximum temperature limit.	Possible reduced engine performance.
3237 4340 3	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3238 4340 4	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3239 4342 3	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.
3241 4342 4	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3242 3363 7	Aftertreatment diesel exhaust fluid tank heater - Mechanical system not responding or out of adjustment. The aftertreatment diesel exhaust fluid temperature did not increase when the aftertreatment diesel exhaust fluid tank heater was commanded ON.	Possible reduced engine performance.
3243 3060 18	Engine cooling system monitor - Data valid but below normal operating range - Moderately severe level. The engine is not warming up as expected.	None on performance.
3251 4765 16	Aftertreatment diesel oxidation catalyst intake temperature - Data valid but above normal operating range - Moderately severe level. The diesel oxidation catalyst intake temperature sensor reading has exceeded the maximum temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3253 3242 16	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3254 3242 15	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3255 3246 16	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3256 3246 15	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3258 4340 5	Aftertreatment diesel exhaust fluid line heater 1 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 1.	Possible reduced engine performance.
3261 4342 5	Aftertreatment diesel exhaust fluid line heater 2 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 2.	Possible reduced engine performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3311 3242 0	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3312 3246 0	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3313 4765 4	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the catalyst intake sensor circuit.	Possible reduced engine performance.
3314 4765 3	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst intake temperature sensor circuit.	Possible reduced engine performance.
3315 4765 2	Aftertreatment diesel oxidation catalyst intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel oxidation catalyst intake temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3316 3242 4	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3317 3242 3	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3318 3242 2	Aftertreatment diesel particulate filter intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter intake temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3319 3246 3	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3321 3246 4	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.
3322 3246 2	Aftertreatment diesel particulate filter outlet temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter outlet temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3326 91 9	SAE J1939 Multiplexed accelerator pedal or lever sensor system - Abnormal update rate. The ECM expected information from a multiplexed accelerator pedal or lever sensor but did not receive it soon enough or did not receive it at all.	Engine will only idle.
3328 191 9	Transmission output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the transmission output shaft speed sensor.	None on performance.
3342 4752 18	Engine exhaust gas recirculation cooler efficiency - Data valid but below normal operating range - Moderately severe level. The EGR cooler is not cooling the recirculated exhaust gas sufficiently.	None on performance.
3343 5285 18	Engine charge-air cooler efficiency - Data valid but below normal operating range - Moderately severe level. The engine charge air cooler is not cooling the intake air flow sufficiently.	None on performance.
3361 102 10	Intake manifold 1 pressure - Abnormal rate of change. The VGT position reading is stuck.	Possible reduced engine performance.
3366 111 18	Coolant level - Data valid but below normal operating range - Moderately severe level. Very low engine coolant level detected.	None on performance.
3374 1818 31	Roll over protection brake control active - Condition exists. The ECM received a message from the anti-lock braking (ABS) controller, inhibiting cruise control operation.	Cruise control could possibly not operate.
3375 5397 31	Aftertreatment diesel particulate filter regeneration too frequent - Condition exists. The system has detected the need for an active regeneration has occurred too soon following the last active regeneration.	None on performance.
3376 5319 31	Aftertreatment diesel particulate filter incomplete regeneration - Condition exists. The system has detected that the aftertreatment diesel particulate filter differential pressure is too high following an active regeneration.	Possible frequent need for aftertreatment regeneration.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3382 3058 18	Engine exhaust gas recirculation (EGR) system - Data valid but below normal operating range - Moderately severe level. Measured egr flow is lower than commanded.	Possible reduced engine performance.
3383 3058 16	Engine exhaust gas recirculation (EGR) system - Data valid but above normal operating range - Moderately severe Level. Measured EGR flow is higher than commanded.	Possible reduced engine performance.
3394 4766 18	Aftertreatment 1 diesel oxidation catalyst outlet gas temperature - Data valid but below normal operating range - Moderately severe level. The diesel oxidation catalyst outlet Temperature is below the operating limit	Possible frequent need for aftertreatment regeneration.
3396 3750 31	Diesel particulate filter 1 conditions not met for active regeneration - Condition exists. The aftertreatment temperatures are not warm enough for aftertreatment injection.	Possible frequent need for aftertreatment regeneration.
3418 191 19	Transmission output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the transmission output shaft speed sensor.	None on performance.
3422 4344 3	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3423 4344 4	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3425 4344 5	Aftertreatment diesel exhaust fluid line heater 3 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 3.	Possible reduced engine performance.
3488 563 9	Anti-lock braking (ABS) controller - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the anti-lock braking (ABS) controller.	None on performance.
3492 251 10	Real time clock - Abnormal rate of change. The real time clock indicates a stuck engine off timer.	None on performance.
3494 1081 7	Engine wait to start lamp - Mechanical system not responding or out of adjustment. Wait to Start lamp has malfunction.	None on performance.
3497 1761 17	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Least severe level. The aftertreatment diesel exhaust fluid tank level is low.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3498 1761 18	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank level is very low.	None on performance.
3525 84 19	Wheel-based vehicle speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3526 84 9	Wheel-Based vehicle speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3527 558 19	Accelerator pedal or lever idle validation switch - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the accelerator pedal or lever idle validation switch.	The engine will only idle.
3528 558 9	Accelerator pedal or lever idle validation switch - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the accelerator pedal or lever idle validation switch.	Engine will only idle.
3531 171 9	Ambient air temperature - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the ambient air temperature sensor.	Possible reduced engine performance.
3532 171 19	Ambient air temperature - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the ambient air temperature sensor.	Possible reduced engine performance.
3539 51 3	Engine intake throttle actuator position sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3541 51 4	Engine intake throttle actuator position sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3542 51 2	Engine intake throttle actuator position sensor - Data erratic, intermittent or incorrect. The engine intake air throttle posistion feedback is erratic or incorrect.	Possible reduced engine performance.
3545 3226 10	Aftertreatment outlet NOx sensor circuit - Abnormal rate of change. The aftertreatment outlet NOx sensor reading is not valid.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3547 4096 31	Aftertreatment diesel exhaust fluid tank empty - Condition exists. The diesel exhaust fluid tank is empty.	Possible reduced engine performance.
3555 1081 9	Engine wait to start lamp - Abnormal update rate. A loss of communication has been detected.	None on performance.
3556 1081 19	Engine wait to start lamp - Received network data in error. The ECM received an invalid signal on the SAE J1939 datalink.	None on performance.
3558 3361 3	Aftertreatment diesel exhaust fluid dosing unit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3559 3361 4	Aftertreatment diesel exhaust fluid dosing unit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3562 5491 3	Aftertreatment diesel exhaust fluid line heater relay - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3563 5491 4	Aftertreatment diesel exhaust fluid line heater relay - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3567 5394 5	Aftertreatment diesel exhaust fluid dosing valve - Current below normal or open circuit. A circuit error has been detected in the aftertreatment diesel exhaust fluid dosing valve circuit.	Possible reduced engine performance.
3568 5394 7	Aftertreatment diesel exhaust fluid (DEF) Dosing valve - Mechanical system not responding or out of adjustment. A mechanical malfunction has been detected in the DEF dosing valve.	Possible reduced engine performance.
3571 4334 3	Aftertreatment diesel exhaust fluid pressure sensor - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3572 4334 4	Aftertreatment diesel exhaust fluid pressure sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3574 4334 18	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but below normal operating range - Moderately severe level. Low diesel exhaust fluid pressure has been detected in the dosing unit.	Possible reduced engine performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3575 4334 16	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid dosing unit has detected a blockage in the diesel exhaust fluid return flow.	Possible reduced engine performance.
3577 4376 3	Aftertreatment diesel exhaust fluid return valve - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid return valve.	Possible reduced engine performance.
3578 4376 4	Aftertreatment diesel exhaust fluid return valve - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid return valve.	Possible reduced engine performance.
3582 4364 18	Aftertreatment SCR catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. NOx conversion across the SCR catalyst is too low.	Possible reduced engine performance.
3583 5031 10	Aftertreatment outlet NOx sensor heater - Abnormal rate of change. The aftertreatment outlet NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3596 4334 2	Aftertreatment diesel exhaust fluid pressure sensor - Data erratic, intermittent, or incorrect. The diesel exhaust fluid pressure sensor has reported a reading too high or low for the operating conditions.	Possible reduced engine performance.
3649 5024 10	Aftertreatment Intake NOx sensor heater - Abnormal rate of change. The aftertreatment intake NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3681 3228 2	Aftertreatment outlet NOx sensor power supply - Data erratic, intermittent, or incorrect. The aftertreatment outlet NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3682 3218 2	Aftertreatment Intake NOx sensor power supply - Data erratic, entermittent or encorrect. The aftertreatment intake NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3697 630 12	Engine control module calibration memory - Bad intelligent device or component. Error internal to the ECM related to engine software failures.	Engine may not start or may be difficult to start.
3712 5246 0	Aftertreatment SCR operator inducement - Data valid but above normal operational range - Most severe level. Critical SCR related fault codes have been active for an extended period of time and require immediate attention.	Vehicle speed will be limited to 8 km [5 miles] per hour.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3714 1569 31	Engine protection torque derate - Condition exists. Critical fault codes related to engine operation are active.	Possible reduced engine performance.
3715 188 16	Engine speed at idle - Data valid but below normal operating range - Moderately severe level. The engine speed at idle has exceeded the governed idle speed.	Possible reduced engine performance.
3716 188 18	Engine speed at idle - Data valid but below normal operational range - Moderately severe level. Engine is not maintaining the governed idle speed.	None on performance.
3717 3226 13	Aftertreatment outlet NOx sensor - Out of calibration. A calibration mismatch between the aftertreatment outlet NOx sensor and the ECM has been detected.	None on performance.
3718 3216 13	Aftertreatment intake NOx - Out of calibration. A calibration mismatch between the aftertreatment intake NOx sensor and the ECM has been detected.	None on performance.
3724 168 17	Battery 1 voltage - Data valid but below normal operating range - Least severe level. Low voltage to the EGR valve device driver has been detected.	Possible reduced engine performance.
3725 3216 10	Aftertreatment Intake NOx sensor - Abnormal rate of change. The aftertreatment intake NOx sensor reading is not valid.	None on performance.
3727 5571 7	High pressure common rail fuel pressure relief valve - Mechanical system not responding or out of adjustment. The fuel rail high-pressure relief valve has opened at a lower than expected pressure.	Possible reduced engine performance.
3737 1675 31	Engine starter mode overcrank protection - Condition exists. The starter motor has been temporarily disabled in order to prevent starter damage.	Starter operation is prohibited until the starter motor has adequately cooled.
3741 5571 0	High pressure common rail fuel pressure relief valve - Data valid but above normal operational range - Most severe level. The fuel rail pressure relief valve has opened due to high fuel rail pressure.	Engine may run rough, may stop running, may not start, or may be difficult to start.
3749 3226 20	Aftertreatment outlet NOx sensor - Data not rational - Drifted high. An offset in the outlet NOx sensor reading has been detected.	None on performance.
3838 2978 9	Estimated engine parasitic losses - Percent torque - Abnormal update rate. A loss of communication has been detected.	None on performance.
3843 5603 9	Cruise control disable command - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the cruise control.	None on performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3844 5605 31	Cruise control pause command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3845 5603 31	Cruise control disable command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3899 5848 4	Aftertreatment 1 SCR Intermediate NH3 sensor - Voltage below normal, or shorted to low source. A circuit error has been detected in the NH3 sensor.	None on performance.
3911 5848 9	Aftertreatment SCR Intermediate NH3 sensor - Abnormal update rate. Loss of communication with the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3912 5853 10	Aftertreatment SCR Intermediate NH3 sensor heater - Abnormal rate of change. A malfunction of the aftertreatment SCR intermediate NH3 sensor heater has been detected.	Possible reduced engine performance.
3932 5851 16	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but above normal operating range - Moderately severe level. High battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3933 5851 18	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but below normal operating range - Moderately severe level. Low battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3934 5851 2	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data erratic, intermittent or incorrect. Intermittent battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3935 5848 13	Aftertreatment SCR Intermediate NH3 sensor - Out of calibration. Incorrect trim resistance has been detected in the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3936 5848 12	Aftertreatment SCR Intermediate NH3 sensor - Bad intelligent device or component. An internal error of the aftertreatment SCR intermediate NH3 sensor has been detected.	Possible reduced engine performance.
3937 5848 10	Aftertreatment 1 SCR Intermediate NH3 sensor - Abnormal rate of change. The aftertreatment SCR intermediate NH3 sensor reading is NOT valid.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4149 2623 8	Accelerator pedal or lever position sensor 2 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in Limp Home mode.
4151 5742 9	Aftertreatment diesel particulate filter temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4152 5743 9	Aftertreatment selective catalytic reduction temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4155 5746 3	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4156 5746 4	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4157 4376 7	Aftertreatment diesel exhaust fluid return valve - Mechanical system not responding or out of adjustment. A stuck aftertreatment diesel exhaust fluid return valve has been detected.	None on performance.
4158 5742 12	Aftertreatment diesel particulate filter temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4159 5743 12	Aftertreatment selective catalytic reduction temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4161 5742 3	Aftertreatment diesel particulate filter temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4162 5742 4	Aftertreatment diesel particulate filter temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4163 5742 16	Aftertreatment diesel particulate filter temperature sensor module- Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4164 5743 3	Aftertreatment selective catalytic reduction temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4165 5743 4	Aftertreatment selective catalytic reduction temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4166 5743 16	Aftertreatment selective catalytic reduction temperature sensor module - Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4168 5745 3	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage above normal, or shorted to high source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck on.	None on performance.
4169 5745 5	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage below normal, or shorted to low source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck off.	Possible reduced engine performance.
4171 5745 18	Aftertreatment diesel exhaust fluid dosing unit heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid dosing unit failed to thaw.	Possible reduced engine performance.
4213 3695 2	Aftertreatment diesel particulate filter regeneration inhibit switch - Data erratic, intermittent or incorrect. The diesel particulate filter regeneration permit switch is stuck in the OFF or INHIBIT position.	Possible frequent need for aftertreatment regeneration.
4215 563 31	Anti-lock braking (ABS) Active - Condition exists. Cruise control was paused due to an anti-wheel slip message from teh ABS controller.	Adaptive cruise control will not operate. Standard cruise control may not operate.
4244 4337 2	Aftertreatment diesel exhaust fluid dosing temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing temperature is irrational.	None on performance.

^{*} Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4245 5798 2	Aftertreatment diesel exhaust fluid dosing unit heater temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing unit heater temperature is irrational.	None on performance.
4249 4337 10	Aftertreatment diesel exhaust fluid dosing temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit temperature is stuck.	None on performance.
4251 5798 10	Aftertreatment 1 diesel exhaust fluid dosing unit heater temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit heater temperature sensor reading is stuck.	None on performance.
4252 1081 31	Engine wait to start lamp - Condition exists. The received signal does not match the commanded signal.	None on performance.
4259 5742 11	Aftertreatment diesel particulate filter temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4261 5743 11	Aftertreatment selective catalytic reduction temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4279 5848 21	Aftertreatment 1 SCR Intermediate NH3 - Data not rational - Drifted low. An in range low failure has been detected.	Possible reduced engine performance.
4281 5848 2	Aftertreatment SCR Intermediate NH3 - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate NH3 sensor reading is stuck.	None on performance.
4284 5793 9	Desired engine fueling state - Abnormal update rate. A valid message from the transmission ECU has NOT been received.	Engine may not start or may be difficult to start.
4289 91 8	Accelerator pedal or lever position sensor 1 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in limp home mode.
4452 520668 31	Aftertreatment outlet NOx sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	Possible reduced engine performance.
4453 520669 31	Aftertreatment intermediate NH3 sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	None on performance.
4517 237 13	Vehicle Identification number - Out of calibration. The vehicle identification number has not been programmed into the ECM.	None on performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4518 5862 3	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4519 5862 4	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4521 5862 2	Aftertreatment SCR Intermediate gas temperature sensor - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate temperature sensor reading is irrational.	Possible reduced engine performance.
4524 5862 0	Aftertreatment SCR intermediate gas temperature - Data valid but above normal operational range - Most severe level. The aftertreatment SCR intermediate temperature sensor reading is above the engine protection limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4525 5862 16	Aftertreatment 1 SCR intermediate gas temperature - Data valid but above normal operating range - Moderately severe level. High SCR Intermediate temperature detected.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4526 521 2	Brake pedal position - Data erratic, intermittent or incorrect. The values of the 2 brake switch signals do not match.	None on performance.
4572 3031 9	Aftertreatment diesel exhaust fluid tank temperature - Abnormal update rate. The ECM lost communication with the aftertreatment diesel exhaust fluid tank temperature sensor.	Possible reduced engine performance.
4584 3936 14	Aftertreatment diesel particulate filter system - Special instructions. The incorrect aftertreatment diesel particulate filter system has been installed with the engine.	Engine will be shut down.
4585 4792 14	Aftertreatment 1 SCR catalyst system - Special instructions. The incorrect SCR system has been Installed.	Engine will be shut down.
4612 520701 31	Engine intake manifold pressure system monitor - Condition exists. The engine is unable to meet the air handling system commands.	Possible reduced engine performance.
4658 4331 18	Aftertreatment SCR actual dosing reagent quantity - Data valid but below normal operating range - Moderately severe level. Low aftertreatment diesel exhaust fluid flow detected.	Possible reduced engine performance.

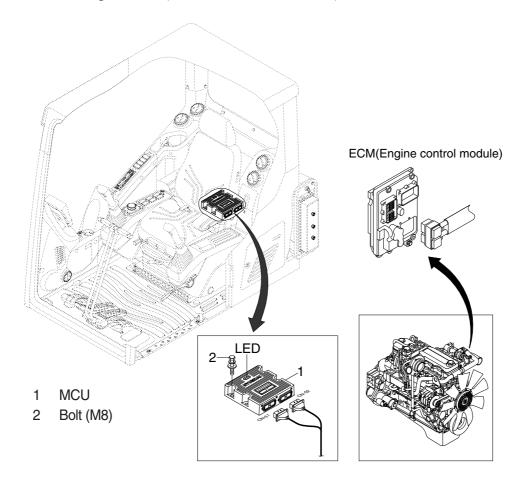
 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4691 5585 18	Engine injector metering rail 1 cranking pressure - Data valid but below normal operating range - Moderately severe level. The fuel rail pressure during cranking is too low for the engine to start.	Engine may not start or may be difficult to start.
4713 5357 31	Engine fuel injection quantity error for multiple cylinders - Condition exists. A malfunction of all fuel injectors has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4726 1239 16	Engine fuel leakage - Data valid but above normal operating range - Moderately severe level. Fuel rail pressure decay has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4727 157 15	Injector metering rail 1 pressure - Data valid but above normal operating range - Least severe level. A self pumping condition has been detected in the fuel system.	Possible reduced engine performance.
4731 3031 13	Aftertreatment diesel exhaust fluid tank temperature sensor - Out of calibration. The received datalink message was not valid.	Possible reduced engine performance.
4732 1761 13	Aftertreatment diesel exhaust fluid tank level sensor - Out of calibration. The received datalink message was not valid.	None on performance.
4739 1761 11	Aftertreatment 1 diesel exhaust fluid tank level sensor - Root cause not known. An unknown error has been detected with the aftertreatment diesel exhaust fluid tank level sensor.	Possible reduced engine performance.
4769 1761 10	Aftertreatment 1 diesel exhaust fluid tank level sensor - Abnormal rate of change. A valid diesel exhaust fluid tank level reading has NOT been received.	Possible reduced engine performance.
4865 6303 3	Engine coolant level 2 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4866 6303 4	Engine coolant level 2 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4956 520750 13	Engine variable geometry turbo (VGT) software - Out of calibration. VGT software does not match application.	Possible reduced engine performance.
4957 520750 31	Engine variable geometry turbo (VGT) software - Condition exists. The VGT actuator and ECM software is not compatible.	Possible reduced engine performance.

 $[\]ensuremath{\,\mathbb{X}\,}$ Some fault codes are not applied to this machine.

GROUP 14 ENGINE CONTROL SYSTEM

1. MCU and Engine ECM (Electronic Control Module)



300L5MS13

2. MCU ASSEMBLY

- 1) To match the pump absorption torque with the engine torque, MCU varies EPPR valve output pressure, which control pump discharge amount whenever feedbacked engine speed drops under the reference rpm of each mode set.
- 2) Three LED lamps on the MCU display as below.

LED lamp	Trouble	Service	
G is turned ON	Normal	-	
G and R are turned ON	Trouble on MCU	· Change the MCU	
G and Y are turned ON Trouble on serial		· Check if serial communication	
	communication line	lines between MCU and cluster are disconnected	
Three LED are turned OFF	Trouble on MCU power	· Check if the input power wire (24 V, GND) of MCU	
		is disconnected	
		· Check the fuse	

G: green, R: red, Y: yellow

GROUP 15 EPPR VALVE

1. PUMP EPPR VALVE

1) COMPOSITION

EPPR (Electro Proportional Pressure Reducing) valve consists of electro magnet and spool valve installed at main pump.

(1) Electro magnet valve

Receive electric current from MCU and move the spool proportionally according to the specific amount of electric current value.

(2) Spool valve

Is the two way direction control valve for pilot pressure to reduce main pump flow. When the electro magnet valve is activated, pilot pressure enters into flow regulator of main pump.

(3) Pressure and electric current value for each mode

Mode		Pressure		Electric current	Engine rpm
		kgf/cm ²	psi	(mA)	(at accel dial 10)
	Р	8	114	290 ± 30	1800 ± 50
Standard	S	12 ± 3	171 ± 40	360 ± 30	1700 ± 50
	E	12 ± 3	171 ± 40	360 ± 30	1600 ± 50
	Р	8	114	290 ± 30	1900 ± 50
Option	S	10 ± 3	142 ± 40	330 ± 30	1800 ± 50
	E	12 ± 3	171 ± 40	360 ± 30	1700 ± 50

2) HOW TO SWITCH THE POWER SHIFT (STANDRAD ↔ OPTION) ON THE CLUSTER

You can switch the EPPR valve pressure set by selecting the power shift (standard ↔ option).

- Management

· Service menu

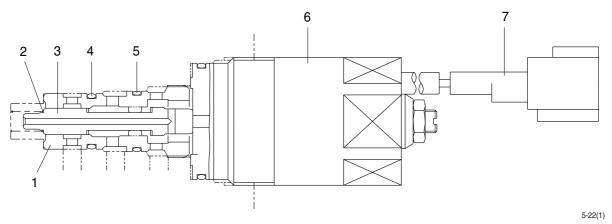


290F3CD151

· Power shift (standard/option): Power shift pressure can be set by option menu.

3) OPERATING PRINCIPLE (pump EPPR valve)

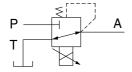
(1) Structure



- 1 Sleeve
- 2 Spring
- 3 Spool

- 4 O-ring
- 5 O-ring

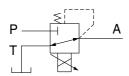
- 6 Solenoid valve
- 7 Connector

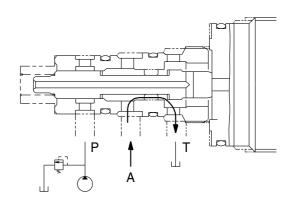


- P Pilot oil supply line (pilot pressure)
- T Return to tank
- A Secondary pressure to flow regulator at main pump

(2) Neutral

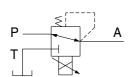
Pressure line is blocked and A oil returns to tank.

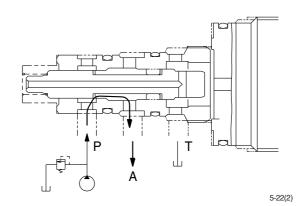




(3) Operating

Secondary pressure enters into A.





5-56

4) EPPR VALVE CHECK PROCEDURE

(1) Check electric current value at EPPR

 $_{ extstyle \cap}$ valve

Disconnect connector CN-75 from $_{\scriptsize (2)}$ EPPR valve.

Insert the adapter to CN-75 and install 3 multimeter as figure.

 $_{\textcircled{4}}$ Start engine.

Set S-mode and cancel auto decel

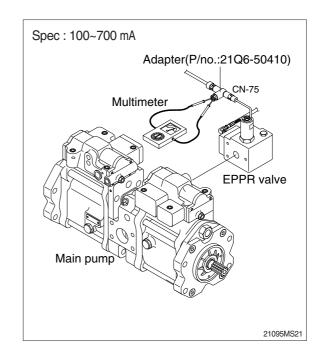
⑤ mode.

 $_{\scriptsize{\textcircled{6}}}$ Position the accel dial at 10.

If rpm display show approx 1700 ± 50 rpm check electric current at bucket

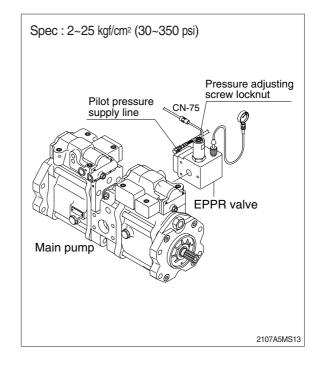
 $_{\scriptsize{(7)}}$ circuit relief position.

Check electric current at bucket circuit



(2) Check pressure at EPPR valve

- ① Remove plug and connect pressure gauge as figure.
 - · Gauge capacity: 0 to 50 kgf/cm² (0 to 725 psi)
- ② Start engine.
- 3 Set S-mode and cancel auto decel mode.
- 4 Position the accel dial at 10.
- 6 If pressure is not correct, adjust it.
- 7 After adjust, test the machine.



2. BOOM PRIORITY EPPR VALVE

1) COMPOSITION

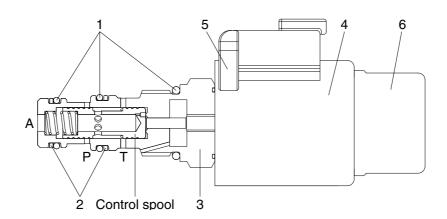
The boom priority EPPR valve is built in a manifold and mainly consisting of valve body and coil. This EPPR valve installed under the solenoid valve.

2) CONTROL

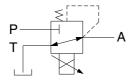
The boom priority EPPR valve has to be controlled by a specific electronic amplifier card, which is supplying the coil with a current 580 mA at 30Ω and 24 V.

3) OPERATING PRINCIPLE

(1) Structure



21095MS14



P: Pilot supply line T: Return to tank

A: Secondary pressure to flow MCV

1 O-ring2 Support ring

3 Valve body4 Coil

5 Connector

6 Cover cap

(2) Operation

In de-energized mode the inlet port (P) is closed and the outlet port (A) is connected to tank port (T).

In energized mode the solenoid armature presses onto the control spool with a force corresponding to the amount of current. This will set a reduced pressure at port A. The setting is proportional to the amount of current applied.

(3) Maximum pressure relief

If a pressure from outside is applied on port A the valve may directly switch to tank port (T) and protect the system before overload.

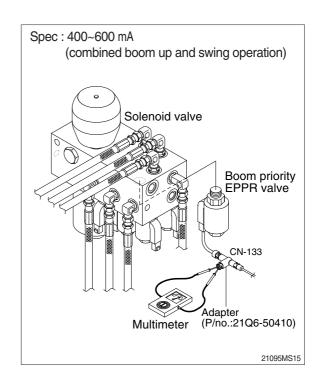
2) EPPR VALVE CHECK PROCEDURE

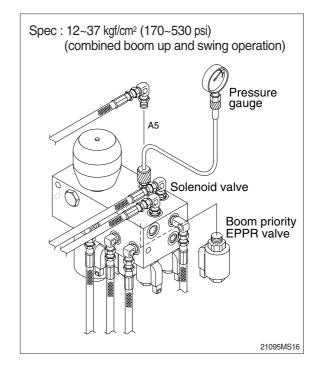
(1) Check electric current value at EPPR valve

- ① Disconnect connector CN-133 from EPPR valve.
- ② Insert the adapter to CN-133 and install multimeter as figure.
- 3 Start engine.
- Set S-mode and cancel auto decel mode.
- ⑥ Check electric current in case of combined boom up and swing operation.

(2) Check pressure at EPPR valve

- ① Remove hose from A5 port and connect pressure gauge as figure.
 - · Gauge capacity: 0 to 50 kgf/cm² (0 to 725 psi)
- ② Start engine.
- 3 Set S-mode and cancel auto decel mode.
- ④ If rpm display approx 1700±50 rpm check pressure (In case of combined boom up and swing operation).
- (5) If pressure is not correct, adjust it.
- 6 After adjust, test the machine.





GROUP 16 MONITORING SYSTEM

1. OUTLINE

Monitoring system consists of the monitor part and switch part.

The monitor part gives warnings when any abnormality occurs in the machine and informs the condition of the machine.

Various select switches are built into the monitor panel, which act as the control portion of the machine control system.

2. CLUSTER

1) MONITOR PANEL

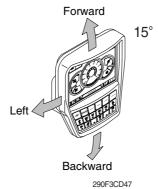


220F3CD01

* The warning lamp pops up and/or blinks and the buzzer sounds when the machine has a problem.

The warning lamp blinks until the problem is cleared. Refer to page 5-65 for details.

** This cluster is adjustable.· Vertical (forward/backward) : each· Horizontal (left only) : 8°



2) CLUSTER CHECK PROCEDURE

(1) Start key: ON

① Check monitor

- a. Buzzer sounding for 4 seconds with HYUNDAI logo on cluster.
- * If the ESL mode is set to the enable, enter the password to start engine.
- ② After initialization of cluster, the operating screen is displayed on the LCD. Also, self diagnostic function is carried out.
 - a. Engine rpm display: 0 rpm
 - b. Engine coolant temperature gauge: White range
 - c. Hydraulic oil temperature gauge: White range
 - d. Fuel level gauge: White range

③ Indicating lamp state

- a. Power mode pilot lamp: E mode or U mode
- b. Work mode pilot lamp : General operation mode (bucket)
- c. Travel speed pilot lamp: Low (turtle)

(2) Start of engine

① Check machine condition

- a. RPM display indicates at present rpm
- b. Gauge and warning lamp: Indicate at present condition.
- When normal condition : All warning lamp OFF
- c. Work mode selection: General work
- d. Power mode selection: E mode or U mode
- e. Travel speed pilot lamp: Low (turtle)

2 When warming up operation

- a. Warming up pilot lamp: ON
- b. After engine started, engine speed increases to 1200 rpm.
- * Others same as above.

③ When abnormal condition

- a. The warning lamp lights up and the buzzer sounds.
- b. If BUZZER STOP switch is pressed, buzzer sound is canceled but the lamp warning lights up until normal condition.
- * The pop-up warning lamp moves to the original position and blink when the buzzer stop switch is pushed. Also the buzzer stops.

3. CLUSTER CONNECTOR

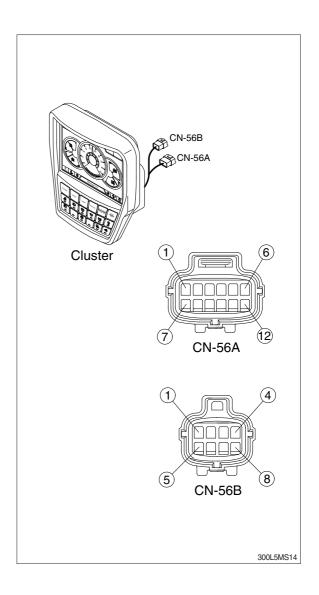
1) CN-56A

No.	Name	Signal
1	Battery 24V	20~32V
2	Power IG (24V)	20~32V
3	GND	-
4	CAN 1 (H)	0~5V
5	CAN 1 (L)	0~5V
6	CAN 2 (H)	20~32V
7	CAN 2 (L)	20~32V
8	RS-232 (RX)	±15V
9	RS-232 (TX)	±15V
10	Aux left	0~5V
11	Aux right	0~5V
12	Aux GND	-

2) CN-56B

No.	Name	Signal
1	CAM 6.5V	6.3~6.7V
2	CAM GND	-
3	CAM DIFF (H)	0~5V
4	CAM DIFF (L)	0~5V
5	CAM 1	NTSC signal
6	CAM 2	NTSC signal
7	CAM 3	NTSC signal
8	CAM shield	-

NTSC: National Television System Committee



2) GAUGE

(1) Operation screen

When you first turn starting switch ON, the operation screen will appear.





290F3CD51

- 1 RPM / Speed gauge
- 2 Engine coolant temperature gauge
- 3 Hydraulic oil temperature gauge
- 4 Fuel level gauge

- 5 DEF/AdBlue® level gauge
- 6 Tripmeter display
- 7 Eco guage
- 8 Accel dial gauge
- * Operation screen type can be set by the screen type menu of the display.
 Refer to page 5-86 for details.

(2) RPM / Speed gauge



① This display the engine speed.

(3) Engine coolant temperature gauge



290F3CD53

- ① This gauge indicates the temperature of coolant.
 - · White range: 40-107°C (104-225°F)
 - · Red range : Above 107°C (225°F)
- ② If the indicator is in the red range or lamp pops up and the buzzer sounds turn OFF the engine and check the engine cooling system.
- * If the gauge indicates the red range or lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(4) Hydraulic oil temperature gauge



290F3CD54

- ① This gauge indicates the temperature of hydraulic oil.
 - · White range: 40-105°C(104-221°F)
 - · Red range : Above 105°C(221°F)
- ② If the indicator is in the red range or limit lamp pops up and the buzzer sounds reduce the load on the system. If the gauge stays in the red range, stop the machine and check the cause of the problem.
- * If the gauge indicates the red range or lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(5) Fuel level gauge



- ① This gauge indicates the amount of fuel in the fuel tank.
- * If the gauge indicates the red range or lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(6) DEF/AdBlue® Level gauge



- ① This gauge indicates the amount of liquid in the DEF/AdBlue®
- ② Fill the DEF/AdBlue® when the red range, or 😂 lamp pops up and the buzzer sounds.
- ③ Do not pour DEF/AdBlue® any more when the DEF/AdBlue® fill up warning lamp lights ON.
- * Refer to page 5-70.
- * If the gauge indicates the red range or lamp blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(7) Tripmeter display



- ① This displays the engine the tripmeter.
- ※ Refer to page 5-88 for details.

(8) Eco gauge



290F3CD58

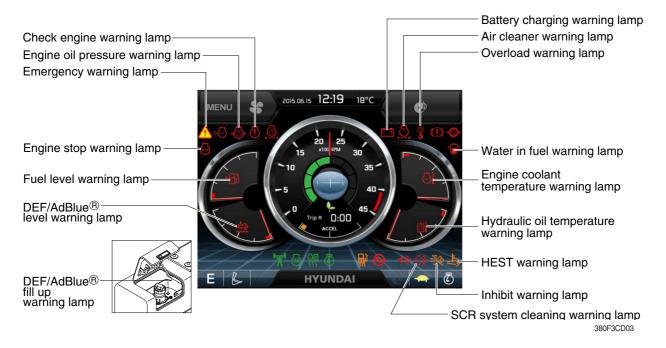
- ① This gauge indicates the fuel consumption rate and machine load status. So that operators can be careful with fuel economy.
- ② The fuel consumption rate or machine load is higher, the number of segment is increased.
- ③ The color of Eco gauge indicates operation status.
 - · White: Idle operation
 - · Green : Economy operation
 - · Yellow : Non-economy operation at a medium level.
 - · Red : Non-economy operation at a high level.

(9) Accel dial gauge



① This gauge indicates the level of accel dial.

3) WARNING LAMPS



*** Warning lamps and buzzer**

Warnings	When error happened	Lamps and buzzer
All warning lamps	Warning lamp pops up on	· The pop-up warning lamp moves to the original position and
except below	the center of the LCD and	blinks, and the buzzer stops when ;
	the buzzer sounds	- the buzzer stop switch
		- the knob of the haptic controller is pushed
		- the lamp of the LCD is touched
<u>-4−</u> 3;	Warning lamp pops up on	· The pop-up warning lamp moves to the original position and
~~~	the center of the LCD and	light ON or blinks, and the buzzer stops when;
	the buzzer sounds	- the buzzer stop switch which is pushed
		- the knob of the haptic controller is pushed
		- the lamp of the LCD is touched
		* Refer to page 5-70 for details.
	Warning lamp pops up on	· The pop-up warning lamp moves to the original position and
	the center of the LCD and	lights ON, and the buzzer stops when 2 seconds elapsed.
	the buzzer sounds	
====3	Warning lamp pops up on	· The pop-up warning lamp moves to the original position and
	the center of the LCD and	blinks, and the buzzer stops when 2 seconds elapsed.
	the buzzer sounds	
•	Warning lamp pops up on	* Refer to page 5-66 for details.
	the center of the LCD and	
	the buzzer sounds	

^{*} Refer to page 5-75 for the buzzer stop switch and operator's manual page 3-57 for the haptic controller.

### (1) Engine coolant temperature warning lamp



290F3CD61

- ① Engine coolant temperature warning is indicated two steps.
  - 103°C over : The □ lamp pops up and the buzzer sounds.
  - 107°C over: The <u>(1)</u> lamp pops up and the buzzer sounds.
- 2 The pop-up , \(\hat{\cdot}\) lamps move to the original position and blinks when the buzzer stop switch when the buzzer is pushed. And the buzzer stops and (1), (1) lamps keep blink.
- 3 Check the cooling system when the lamps keep blink.

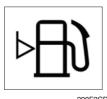
#### (2) Hydraulic oil temperature warning lamp



290F3CD62

- ① Hydraulic oil temperature warning is indicated two steps.
  - 100°C over: The  $|\delta|$  lamp pops up and the buzzer sounds.
  - 105°C over: The ∕₁\ lamp pops up and the buzzer sounds.
- ② The pop-up |b|, |c| lamps move to the original position and blinks when the buzzer stop switch witch is pushed. And the buzzer stops and | | , / | lamps keep blink.
- 3 Check the hydraulic oil level and hydraulic oil cooling system.

#### (3) Fuel level warning lamp



290F3CD63

- ① This warning lamp pops up and the buzzer sounds when the level of fuel is below 55  $\ell$  (14.5 U.S. gal).
- ② Fill the fuel immediately when the lamp blinks.

#### (4) Emergency warning lamp



290F3CD64

- ① This warning lamp pops up and the buzzer sounds when each of the below warnings is happened.
  - Engine coolant overheating (over 107°C)
  - Hydraulic oil overheating (over 105°C)
  - MCU input voltage abnormal
  - Cluster communication data error
  - Engine ECM communication data error
- * The pop-up warning lamp moves to the original position and blinks when the buzzer stop switch is pushed. And the buzzer stops.
- 2 When this warning lamp blinks, machine must be checked and serviced immediately.

#### (5) Engine oil pressure warning lamp



290F3CD65

- ① This warning lamp pops up and the buzzer sounds when the engine oil pressure is low.
- ② If the lamp blinks, shut OFF the engine immediately. Check oil level.

#### (6) Check engine warning lamp

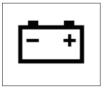


290F3CD66

- ① This warning lamp pops up and the buzzer sounds when the communication between MCU and engine ECM on the engine is abnormal, or if the cluster received specific fault code from engine ECM.
- ② Check the communication line between them.

  If the communication line is OK, then check the fault codes on the cluster.

#### (7) Battery charging warning lamp



290F3CD67

- ① This warning lamp pops up and the buzzer sounds when the battery charging voltage is low.
- ② Check the battery charging circuit when this lamp blinks.

#### (8) Air cleaner warning lamp



290F3CD68

- ① This warning lamp pops up and the buzzer sounds when the filter of air cleaner is clogged.
- ② Check the filter and clean or replace it.

#### (9) Overload warning lamp (opt)



290F3CD69

- ① When the machine is overload, the overload warning lamp pops up and the buzzer sounds during the overload switch is ON. (if equipped)
- 2 Reduce the machine load.

#### (10) Engine stop warning lamp



- ① This warning lamp pops up and the buzzer sounds when 30 minutes elapsed with empty condition of the DEF/AdBlue® tank, stop the engine immediately and check the DEF/AdBlue® tank.
- ② Fill the DEF/AdBlue® immediately in the DEF/AdBlue® tank.
- * Refer to page 5-70.
- ③ This lamp pops up and the buzzer sounds when the stationary SCR system cleaning is not performed.
- * Refer to page 5-68.
- * Please contact your HD Hyundai Construction Equipment service center or local dealer.

#### (11) SCR (selective catalytic reduction) system cleaning warning lamp



290F3CD70

① This warning lamp lights ON or blinks when the SCR system cleaning is needed as table below.

	Warning lamp		
SCR	Check engine	Stop engine	
= <u>[</u> :3>	<u>(Ī)</u>	STOP	Description
Off	Off	Off	Automatic SCR system cleaning
Blink	Off	Off	The status of a manual (stationary) SCR system cleaning when the SCR system cleaning switch has been activated.      **Refer to page 5-69.**
On	On	Off	<ul> <li>The aftertreatment SCR system needs to be cleaned immediately.</li> <li>Engine power will be reduced automatically if action is not taken.</li> <li>** The SCR system cleaning can be accomplished by:</li> <li>Changing to more challenging duty cycle.</li> <li>Performing a manual SCR system cleaning.</li> </ul>
On	On	On	<ul> <li>These lamps will be ON when a stationary (manual) SCR system cleaning is not performed.</li> <li>Stop the engine immediately.</li> <li>Please contact your HD Hyundai Construction Equipment service center or local dealer.</li> </ul>

#### (12) SCR system cleaning inhibit warning lamp



- ① This warning lamp indicates, when illuminated, the SCR system cleaning switch is pushed inhibit position, therefore automatic and manual SCR system cleaning can not occur.
- * Refer to the operator's manual page 3-36 for the SCR system cleaning switch.

2609A3CD20

#### Manual SCR system cleaning



- Manual SCR system cleaning applies if the machine is in a fireproof area.
- ** To stop a manual SCR system cleaning before it has completed, set to the SCR system cleaning switch to the inhibit position or turn OFF the engine.
- ① Stop and park the machine.

- ② Pull the safety button and push the switch to position ② to initiate the manual SCR system cleaning.
- ** Refer to the page 3-36 for the SCR system cleaning switch operation.
- ** The engine speed may increase to 950~1050 rpm and SCR system cleaning begins and it will take approximately 20~60 minutes.
- The SCR system cleaning warning lamp will blink and HEST warning lamp will light ON during the SCR system cleaning is operating.
- The SCR system cleaning and/or HEST warning lamp will light OFF when the SCR system cleaning is completed.

#### (13) HEST (High exhaust system temperature) warning lamp



2609A3CD21

- ① This warning lamp indicates, when illuminated, that exhaust temperatures are high due to SCR system cleaning.
- ② The lamp will also illuminate during a manual SCR system cleaning.
- When this lamp is illuminated, be sure the exhaust pipe outlet is not directed at any surface or material that can melt, burn, or explode.
- ♠ When this lamp is illuminated, the exhaust gas temperature could reach 800°C [1500°F], which is hot enough to ignite or melt common materials, and to burn people.
- * The lamp does not signify the need for any kind of equipment or engine service; It merely alerts the equipment operator to high exhaust temperatures. It will be common for the lamp to illuminate on and off during normal equipment operation as the engine completes SCR system cleaning.

#### (14) DEF/AdBlue® level warning lamp

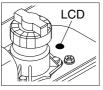


- ① This warning lamp indicates when ON or blinking, that the DEF/AdBlue® level is low as table below.
- It is recommended that the DEF/AdBlue® tank be filled completely full of the DEF/AdBlue® in order to correct any fault conditions.

290F3CD257

Warning lamp				
DEF/AdBlue® level	Check engine	Stop engine	D dalla.	
-4-37	<u>(I)</u>	STOP	Description	
On	Off	Off	The DEF/AdBlue® level has fallen below the initial warning level (10%).	
Blink	Off	Off	The DEF/AdBlue® level has fallen below the critical warning level (5%).	
Blink	On	Off	<ul> <li>The DEF/AdBlue® level has fallen below the initial derate level (2.5%).</li> <li>The engine power will be limited automatically.</li> </ul>	
Blink	On	On	<ul> <li>This is happened when 30 minutes elapsed with empty conditions (0%) of the DEF/AdBlue® tank.</li> <li>The engine will enter the final derate level which may include low idle lock or engine shutdown with restart limitations.</li> <li>In order to remove the final derate, the DEF/AdBlue® tank must be filled to above 10 persent gauge reading.</li> </ul>	

#### (15) DEF/AdBlue® fill up warning lamp



290F3CD272

- ① This lamp lights ON when the DEF/AdBlue® tank is completely filled with DEF/AdBlue®.
- * Fill the tank with the DEF/AdBlue® after start switch ON and then turn OFF the start switch.
- Do not pour DEF/AdBlue® any more when this lamp lights
   ON. Otherwise DEF/AdBlue® tank may freeze and burst in
   winter season.

#### (16) Water in fuel warning lamp



210WF3CD02

- ① This warning lamp pops up and the buzzer sounds when the water separator is full of water or malfunctioning.
- When this lamp blinks, stop the machine and spill water out of the separator.

# 4) PILOT LAMPS



# (1) Mode pilot lamps

No	Mode	Pilot lamp	Selected mode
1	Power mode	P S	Heavy duty power work mode Standard power mode
		E	Economy power mode
2	User mode	U	User preferable power mode
3	Work tool mode		General operation - IPC speed mode  General operation - IPC balance mode  General operation - IPC efficiency mode  Breaker operation mode  Crusher operation mode
4	Travel mode	<b>*</b>	Low speed traveling High speed traveling
5	Auto idle mode		Auto idle

#### (2) Power max pilot lamp



- ① The lamp will be ON when pushing power max switch on the LH RCV lever.
- ② The power max function is operated maximum 8 seconds.
- * Refer to the operator's manual page 3-41 for power max function.

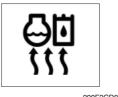
#### (3) Preheat pilot lamp



290F3CD79

- ① Turning the start key switch ON position starts preheating in cold weather.
- 2 Start the engine after this lamp is OFF.

#### (4) Warming up pilot lamp



290F3CD80

- ① This lamp is turned ON when the coolant temperature is below 30°C(86°F).
- ② The automatic warming up is cancelled when the engine coolant temperature is above 30°C, or when 10 minutes have passed since starting the engine.

#### (5) Decel pilot lamp



290F3CD81

- ① Operating one touch decel switch on the RCV lever makes the lamp ON.
- ② Also, the lamp will be ON and engine speed will be lowered automatically to save fuel consumption when all levers and pedals are at neutral position, and the auto idle function is selected.
- * One touch decel is not available when the auto idle pilot lamp is turned ON.
- * Refer to the operator's manual page 3-38.

#### (6) Fuel warmer pilot lamp



290F3CD82

- ① This lamp is turned ON when the coolant temperature is below 10°C (50°F) or the hydraulic oil temperature 20°C (68°F).
- ② The automatic fuel warming is cancelled when the engine coolant temperature is above 60°C, and the hydraulic oil temperature is above 45°C since the start switch was ON position.

#### (7) Maintenance pilot lamp



290F3CD83

- ① This lamp will be ON when the consuming parts are needed to change or replace. It means that the change or replacement interval of the consuming parts remains below 30 hours.
- ② Check the message in maintenance information of main menu. Also, this lamp lights ON for 3 minutes when the start switch is ON position.
- * Refer to the page 5-82.

# (8) Entertainment pilot lamp



290F3CD84

- ① This lamp is on when audio or video files are playing.
- * Refer to the page 5-87.

# (9) Smart key pilot lamp (opt)



290F3CD214

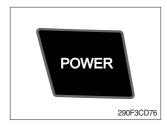
- ① This lamp is ON when the engine is started by the start button.
- ② This lamp is red when the a authentication fails, green when succeeds.
- * Refer to the page 5-83.

### 5) SWITCHES



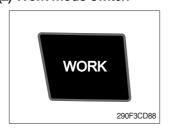
* When some of the switches are selected, the pilot lamps are displayed on the LCD. Refer to the page 5-71 for details.

#### (1) Power mode switch



- ① This switch is to select the machine power mode and selected power mode pilot lamp is displayed on the pilot lamp position.
  - · P : Heavy duty power work.
  - · S : Standard power work.
  - · E : Economy power work.
- ② The pilot lamp changes  $E \rightarrow S \rightarrow P \rightarrow E$  in order.

#### (2) Work mode switch



- ① This switch is to select the machine work mode, which shifts from general operation mode to optional attachment operation mode.
  - · 💪 : General operation mode
  - · 🔊 : Breaker operation mode (if equipped)
  - : Grusher operation mode (if equipped)
  - · Not installed : Breaker or crusher is not installed.
- Refer to the operator's manual page 4-7 for details.

#### (3) User mode switch



- ① This switch is used to memorize the current machine operating status in the MCU and activate the memorized user mode.
  - · Memory: Automatically saved after key OFF.
  - · Action : Push this switch.
  - · Cancel : Push this switch once more.
- ② Refer to the page 5-79 for another set of user mode.

#### (4) Travel speed switch



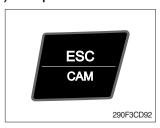
- ① This switch is used to select the travel speed alternatively.
  - · Low speed : High speed
- Do not change the setting of the travel speed switch. Machine stability may be adversely affected.
- ♠ Personal injury can result from sudden changes in machine stability.

#### (5) Auto idle/ buzzer stop switch



- ① This switch is used to activate or cancel the auto idle function.
  - · Pilot lamp ON : Auto idle function is activated.
  - · Pilot lamp OFF: Auto idle function is cancelled.
- ② The buzzer sounds when the machine has a problem. In this case, push this switch and buzzer stops, but the warning lamp blinks until the problem is cleared.

#### (6) Escape/Camera switch



- ① This switch is used to return to the previous menu or parent menu.
- ② In the operation screen, pushing this switch will display the view of the camera on the machine (if equipped).

  Please refer to page 5-88 for the camera.
- ③ If the camera is not installed, this switch is used only ESC function.

#### (7) Work light switch



- ① This switch is used to operate the work light.
- ② The pilot lamp is turned ON when operating the switch.

#### (8) Head light switch



- ① This switch is used to operate the head light.
- ② The pilot lamp is turned ON when operating the switch.

#### (9) Intermittent wiper switch



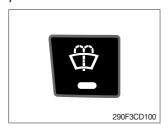
- ① This switch is used to wipe operates intermittently.
- $\ensuremath{\textcircled{2}}$  The pilot lamp is turned ON when operating the switch.

#### (10) Wiper switch



- $\ensuremath{\textcircled{1}}$  This switch is used to operate the window wiper.
- 2 Note that the wiper will self-park when switched off.
- ③ The pilot lamp is turned ON when operating the switch.
- If the wiper does not operate with the switch in ON position, turn the switch OFF immediately. Check the cause.
  If the switch remains ON, motor failure can result.

#### (11) Washer switch



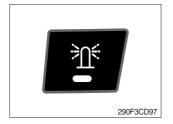
- ① The washer liquid is sprayed and the wiper is operated only while pressing this switch.
- ② The pilot lamp is turned ON when operating the switch.

#### (12) Cab light switch



- ① This switch turns ON the cab light on the cab.
- ② The pilot lamp is turned ON when operating the switch.

#### (13) Beacon switch



- ① This switch turns ON the rotary light on the cab.
- ② The pilot lamp is turned ON when operating the switch.

#### (14) Overload switch



- ① When this switch turned ON, buzzer makes sound and overload warning lamp comes ON in case that the machine is overload.
- ② When it turned OFF, buzzer stops and warning lamp goes out.
- ⚠ Overloading the machine could impact the machines stability which could result in tipover hazard. A tipover hazard could result in serious injury or death. Always activate the overload warning device before you handle or lift objects.

#### (15) Travel alarm switch



- ① This switch is to activate travel alarm function surrounding when the machine travels to forward and backward.
- ② On pressing this switch, the alarm operates only when the machine is traveling.
- ③ The pilot lamp is turned ON when operating the switch.

#### (16) Air conditioner quick touch switch



- ① This switch used to select air conditioner control mode.
- * Refer to the page 5-90.

### (17) Main menu quick touch switch



- ① This switch is to activate the main menu in the cluster.
- * Refer to the page 5-78.

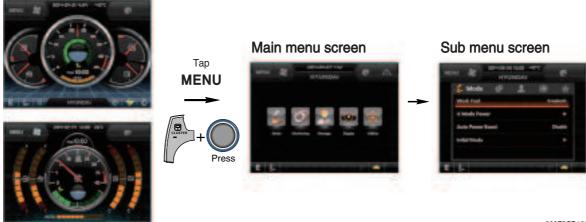
#### (18) Entertainment quick touch switch



- ① This switch is to activate the entertainment control menu in the cluster.
- * Refer to the page 5-87.

# 6) MAIN MENU

- You can select or set the menu by the haptic controller or touch screen.
   On the operation screen, tap MENU to access the main menu screen.
   On the sub menu screen, you can tap the menu bar to access functions or applications.
- · Operation screen



290F3CD102

* Please refer to the haptic controller, operator's manual page 3-60 for selection and change of menu and input value.

# (1) Structure

,	iciui <del>c</del>		
No	Main menu	Sub menu	Description
1	Mode 290F3CD103	Work tool U mode power Boom/Arm speed Auto power boost IPC mode Auto engine shutdown (option) Initial mode Emergency mode	Breaker, Crusher, Not installed User mode only Boom speed, Arm speed Enable, Disable Speed mode, Balance mode, Efficiency mode One time, Always, Disable Key on initial mode, Accel initial mode / step Switch function
2	Monitoring 290F3CD104	Active fault Logged fault Delete logged fault Monitoring	MCU, Engine ECM MCU, Engine ECM All logged fault delete, Initialization canceled Machine information, Switch status, Output status,
3	Management 290F3CD105	Fuel rate information Maintenance information Machine security Machine information  Contact Service menu  Clinometer Update	General record, Hourly, Daily, Mode record Replacement, Change interval oils and filters ESL mode setting, Password change Model, MCU, Monitor, Haptic / switch controller, RMCU, Relay drive unit, FATC, AAVM (opt) A/S phone number, A/S phone number change Power shift, Operating hour, Breaker mode pump acting, EPPR current level, Overload pressure Clinometer setting Cluster, ETC device
4	Display 290F3CD106	Display item Clock Brightness Unit setup Language selection Screen type	Engine speed, Tripmeter A, Tripmeter B, Tripmeter C Clock Manual, Auto Temperature, Pressure, Flow, Distance, Date format Korean, English, Chinese, ETC A type, B type
5	Utilities 290F3CD107	Entertainment Tripmeter Camera	Play Video, Audio, Smart terminal. 3 kinds (A, B, C) Number of active, Display order, AAVM (opt)

#### (2) Mode setup

#### ① Work tool



- · Select on installed optional attachment
  - A: It can set the user's attachment.
     It is available in setting #1~#10.
  - B : Max flow Set the maximum flow for the attachment. Relief pressure - Set the relief pressure.

#### 2 U mode power



290F3CD112

- Engine high idle rpm, auto idle rpm and pump torque (power shift) can be modulated and memorized separately in U-mode.
- · U-mode can be activated by user mode switch.

Step ( ■ )	Engine speed (rpm)	Idle speed (rpm)	Power shift (bar)
1	1300	750	0
2	1400	800	3
3	1500	850	6
4	1600	900	9
5	1700	950	12
6	1800	1000 (auto decel)	16
7	1850	1050	20
8	1900	1100	26
9	1950	1150	32
10	2000	1200	38

*One touch decel & low idle: 1000 rpm

# 3 Boom/Arm speed



#### Boom speed

Boom priority function can be activated or cancelled
 Enable - Boom up speed is automatically adjusted as working conditions by the MCU.
 Disable - Normal operation

#### · Arm speed

Arm regeneration function can be activated or cancelled.
 Enable - Arm in speed is up.
 Disable - Normal operation.

### 4 Auto power boost

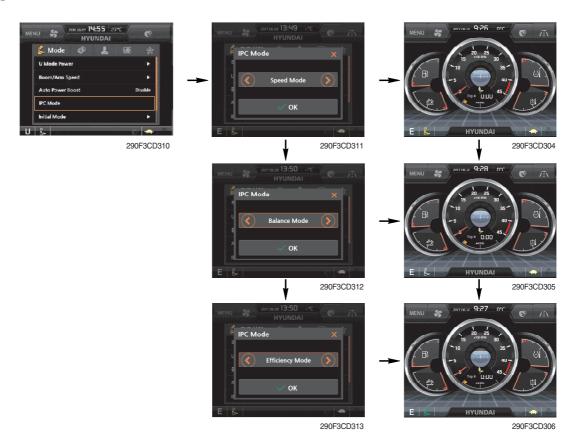


· The power boost function can be activated or cancelled.

Enable - The digging power is automatically increased as working conditions by the MCU. It is operated max 8 seconds.

Disable - Not operated.

#### ⑤ IPC mode



- · The IPC mode can be selected by this menu.
  - Speed mode
  - Balance mode (default)
  - Efficiency mode
- · This mode is applied only general operation mode of the work tool mode.
- ** Please update the cluster programs if this mode is not displayed in the mode setup menu. Refer to the operator's manual page 3-28.

### 6 Automatic engine shutdown (option)



- · The automatic engine shutdown function can be set by this menu.
  - One time
  - Always
  - Disable
  - Wait time setting: Max 40 minutes, min 2 minutes

#### 7 Initial mode



290F3CD119

- · Key on initial mode
  - Selected the power mode is activated when the engine is started.
- · Accel initial mode
  - Last setting value
  - User setting value
- · Accel initial step
  - 0~9 step

#### **8 Emergency mode**



- · This mode can be use when the switches are abnormal on the cluster.
- · The cluster switches will be selected by touched each icon.

#### (3) Monitoring

#### ① Active fault



· The active faults of the MCU, engine ECM or air conditioner can be checked by this menu.

#### 2 Logged fault



· The logged faults of the MCU, engine ECM or air conditioner can be checked by this menu.

#### 3 Delete logged fault



• The logged faults of the MCU, engine ECM or air conditioner can be deleted by this menu.

#### **4** Monitoring



- The machine status such as the engine rpm, oil temperature, voltage and pressure etc. can be checked by this menu (Analog input).
- The switch status or output status can be confirmed by this menu (Digital input & Digital output).
- The activated switch or output pilot lamps 
  are light ON.

### (4) Management

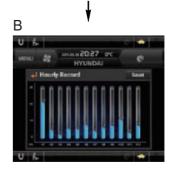
#### ① Fuel rate information

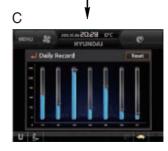


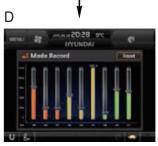


A • • •









210WF3CD16

### · General record (A)

- Average fuel rate (left) (from "Reset" to now)
   Fuel consumption devided by engine run time (service meter time).
- A days fuel used (right)
   Fuel consumption from 24:00 (or "Reset" time) to now (MCU real time).

#### · Hourly record (B)

- Hourly fuel rates for past 12 hours (service meter time).
- No record during key-off time.
- One step shift to the right for every one hour.
- Automatic deletion for 12 hours earlier data.
- All hourly records deletion by "Reset".

#### · Daily record (C)

- Daily fuel consumption for past seven days (MCU real time).
- No record during key-off time.
- One step shift to the right at 24:00 for every day.
- Automatic deletion for 7 days earlier data.
- All daily records deletion by "Reset".

#### · Mode record (D)

- Average fuel rate for each power mode/accel dial (at least 7) from "Reset" to now.
- No record during idle.
- All mode records deletion by "Reset".

# 2 Maintenance information



- · Alarm lamp ( ) is ON when oil or filter needs to be changed or replaced.
- · Replacement : The elapsed time will be reset to zero (0).
- · Change interval: The change or replace interval can be changed in the unit of 50 hours.

# · Change or relpace interval

No	Item	Interval
1	Engine oil	500
2	Final gear oil	1000
3	Swing gear oil	1000
4	Hydraulic oil	5000
5	Pilot line filter	1000
6	Drain filter	1000
7	Hydraulic oil return filter	1000
8	Engine oil filter	500
9	Fuel filter	500
10	Pre-filter	500
11	Hydraulic tank breather	1000
12	Air cleaner (inner & outer)	4000
13	Radiator coolant	2000
14	Swing gear pinion grease	1000
15	DEF/AdBlue® supply module filter	4500
16	Crankcase Breather Filter	2000
17	DEF/AdBlue® Tank Filter	4000

#### 3 Machine security



#### · ESL mode setting

- ESL: Engine Starting Limit
- ESL mode is desingned to be a theft deterrent or will prevent the unauthorized operation of the machine.
- When you Enable the ESL mode, the password will be required when the starting switch is turned to the on position.
- Machine security

Disable: ESL function is disabled and password is not required to start engine.

Enable (always): The password is required whenever the operator starts engine.

- Interval: The password is required when the operator starts engine first. But the operator can restart the engine within the interval time without inputting the password. The interval time can be set to a maximum 4 hours.

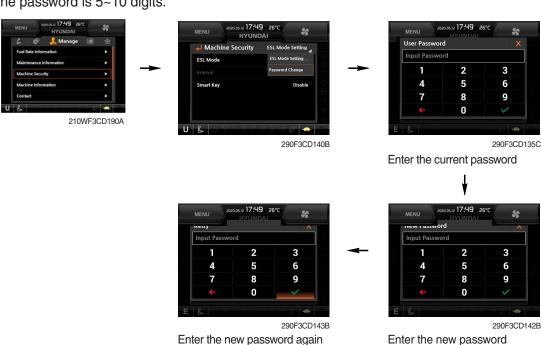
※ Default password : 00000 + 
✓

※ Password length: (5~10 digits) + 

✓ - Smart key (option) : Refer to next page.

#### Password change

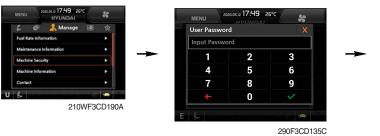
- The password is 5~10 digits.



* Before first use, please set user password and owner password in advance for machine security.



# - Smart key



- · Smart key is registered when equipped with optional smart key. If smart key is not inside of the cabin, authentication
- · Tag management menu is activated when the Smart key menu is Enabled.

You can register and delete the tags.

process fails and the password is needed.

#### - Tag management

- · When registering a tag : Only the tag you want to register must be in the cabin.
- $\cdot$  When deleting a tag : All registered tags are deleted.



← Machine Security

ESL Mode





5-86-1

#### 4 Machine Information



· This can confirm the identification of the model information (ECU), MCU, monitor, haptic controller, switch controller, RMCU, relay driver unit, FATC (air conditioner controller), AAVM (opt).

#### 5 Contact (A/S phone number)



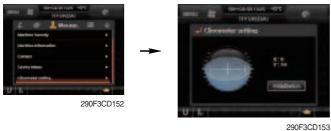
Enter the new A/S phone number

#### 6 Service menu



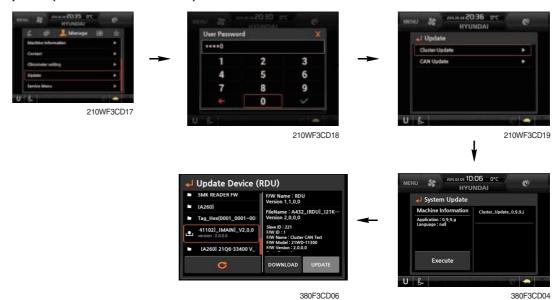
- · Power shift (standard/option): Power shift pressure can be set by option menu.
- · Operating hours: Operating hours since the machine line out can be checked by this menu.
- · Breaker mode pump acting (1 pump/2 pump)
- · EPPR current level (attach flow EPPR 1 & 2, boom priority EPPR, attach relief pressure EPPR 1& 2)
- Overload pressure: 100 ~ 350 bar

#### **7 Clinometer**



- · When the machine is on the flatland, if tap the "initialization", the values of X, Y reset "0".
- · You can confirm tilt of machine in cluster's operating screen.

# **8 Update (cluster & ETC devices)**



- · ETC devices and cluster can be updated through CAN 2 network.
- $\cdot\,$  Insert USB memory stick which includes program files, start download.

#### (5) Display

### ① Display item



- · The center display type of the LCD can be selected by this menu.
- The engine speed or each of the tripmeter (A,B,C) is displayed on the center display.

# 2 Clock



- The first line's three spots "**/**/***" represent Month/Day/Year each.
- The second line shows the current time. (0:00~23:59)

### 3 Brightness



· If "Auto" is chosen, brightness for day and night can be differently set up. Also by using the bar in lower side, users can define which time interval belongs to day and night. (in bar figure, white area represents night time while orange shows day time)

# 4 Unit



· Temperature :  $^{\circ}C \leftrightarrow ^{\circ}F$ 

· Pressure : bar  $\leftrightarrow$  MPa  $\leftrightarrow$  kgf/cm²

 $\begin{array}{lll} \cdot & \text{Volume} & : \ell \longleftrightarrow \text{gal} \\ \cdot & \text{Flow} & : \text{lpm} \longleftrightarrow \text{gpm} \\ \cdot & \text{Distance} & : \text{km} \longleftrightarrow \text{mile} \end{array}$ 

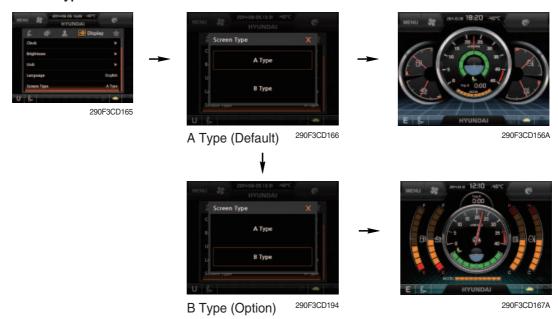
· Date format :  $yy/mm/dd \leftrightarrow mm/dd/yy \leftrightarrow dd-mm-yy$ 

# **5** Language



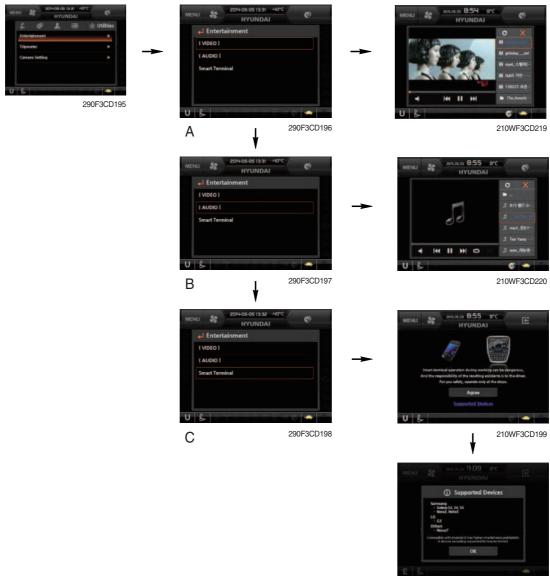
· User can select preferable language and all displays are changed the selected language.

# 6 Screen type



# (6) Utilities

#### ① Entertainment



210WF3CD22

- Video (A): This menu operates the video play function. mp4, mkv, avi files and so on.
- Audio (B): This menu operates the play music. mp3, mp4 files and so on.
- Smart terminal (C): The menu features a smartphone and operates the miracast.

# 2 Tripmeter



- · Maximum 3 kinds of tripmeters can be used at the same time.
- · Each tripmeter can be turned on by choosing "Start" while it also can be turned off by choosing "Stop".
- · If the tripmeter icon is activated in the operation screen, it can be controlled directly there.

# 3 Camera setting

- · If the rear camera is not installed on the machine, set disable.
- · If the rear camera installed on the machine, set enable.



· In the operation screen, rear camera screen show up when ESC/CAM button is pushed.



- 4 AAVM (All Around View Monitoring, option)
- · The AAVM buttons of the cluster consist of ESC/CAM and AUTO IDLE/Buzzer stop.



- Escape button
- · It will enter into the AAVM mode from the beginning screen if the AAVM is installed.
- · While in the AAVM mode, select the ESC button to return to the beginning screen.



- Buzzer stop button
- · In AAVM mode, it detects surrounding pedestrians or objects and the warning buzzer sounds.
- · User can turn OFF the warning sound by pressing buzzer stop button.



290F3CD246

- When the worker or pedestrian go to the blue line (radius 5 m), an external danger area of equipping on the cluster screen, the warning buzzer sounds and it displays the blue rectangular box for the recognition of the worker and pedestrian.
  - At this time, the operator should stop work immediately, and stop the buzzer by pressing the buzzer stop button. And then, please work after you check whether the danger factors are solved.



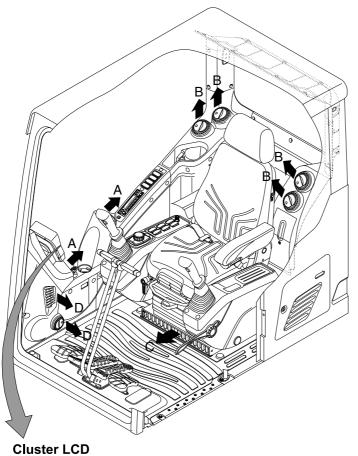
290F3CD247

- When the worker or pedestrian go inside of red line (radius 3 m), an internal danger area of equipping on the cluster screen, the warning buzzer sounds and it displays the red rectangular box for the recognition of the worker and pedestrian.
  - At this time, the operator should stop work immediately, and stop the buzzer by pressing the buzzer stop button. And then, please work after you check whether the danger factors are solved.
- * In AAVM mode, a touch screen of the LCD is available only. The multimodal dial of the haptic controller is not available.

#### 7) AIR CONDITIONER AND HEATER

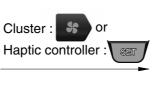
Full auto air conditioner and heater system automatically keeps the optimum condition in accordance with operator's temperature configuration sensing ambient and cabin inside temperature.

#### · Location of air flow ducts

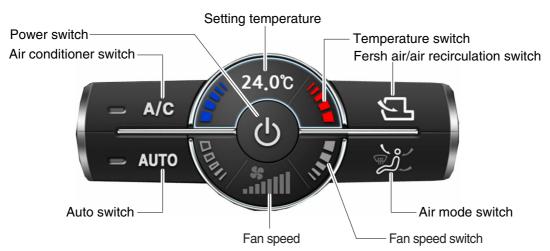












* Haptic controller: Refer to the operator's manual page 3-57.

290F3CD201

#### (1) Power switch



- ① This switch makes the system ON/OFF.

  Just before the power OFF, set values are stored.
- ② Default setting values

Funct	ion	Air conditioner	In/outlet	LCD	Temperature	Mode
Valu	ie	OFF	Inlet	OFF	Previous sw OFF	Previous sw OFF

#### (2) Air conditioner switch



- ① This switch turns the compressor ON/OFF.
- ** Air conditioner operates to remove vapor and drains water through a drain hose. Water can be sprayed into the cab in case that the drain cock at the ending point of drain hose has a problem.

In this case, exchange the drain cock.

# (3) Auto switch



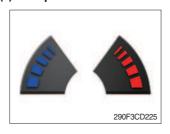
① Auto air conditiner and heater system automatically keeps the optimum condition in accordance with operator's temperature configuration sensing ambient and cabin inside temperature.

#### (4) Setting temperature



① Display the temperature setting out.

#### (5) Temperature switch



- ① Setting temperature indication
  - · Lo (17°C), 17.5~31.5°C, Hi (32°C)
- 2 Max cool and max warm beeps 5 times.
- The max cool or the max warm position operates as following table.

Temperature	Compressor	Fan speed	In/outlet	Mode
Max cool	ON	Hi (8 step)	Recirculation	Face
Max warm	OFF	Hi (7 step)	Fresh	Def/Foot

- Temperature unit can be changed between celsius (°C) and fahrenheit (°F)
  - a. Default status (°C)
- b. Push Up/Down temperature switch simultaneously more than
   5 second displayed temperature unit change (°C → °F)

## (6) Fan speed switch



- ① Fan speed is controlled automatically by setted temperature.
- 2 This switch controls fan speed manually.
  - · There are 8 up/down steps to control fan speed.
  - · The maximum step or the minimum step beeps 5 times.

#### (7) Fan speed



① Steps 1 through 8 to display the amount of wind.

#### (8) Fresh air/air recirculation switch



- ① It is possible to change the air-inlet method.
- a. Fresh air (🕒)
  Inhaling air from the outside.
- b. Air recirculation (巨)
  It recycles the heated or cooled air to increase the energy efficiency.
- * Change air occasionally when using recirculation for a long time.
- * Check out the fresh air filter and the recirculation filter periodically to keep a good efficiency.

#### (9) Air mode switch



① Operating this switch, it beeps and displays symbol of each mode in order. (Face → Face/Rear → Face/Rear/Foot → Foot → Def/Foot)

Mode switch		Face	Face/Rear	Face/Rear/Foot	Foot	Def/Foot
		رڅ	ريم	رُگُرُ	مُدُكُ	<b>P</b> ),
Outlet	Α	•	•	•		
	В		•	•		
	С			•	•	•
	D					•

② When defroster mode operating, FRESH AIR/AIR RECIRCU-LATION switch turns to FRESH AIR mode and air conditioner switch turns ON.

# 8) SELF DIAGNOSIS FUNCTION

- (1) Diagnostic methods : Diagnostic information window, select
- (2) Diagnostic indication (Displays fault)

Fault code	Description	Fail safe function	
F01	Ambient temperature sensor open	20°C alternate value control	
F02	Ambient temperature sensor short	20 C alternate value control	
F03	Cab inside temperature sensor open	25°C alternate value control	
F04	Cab inside temperature sensor short	25 C alternate value control	
F05	Evaporate temperature sensor open	0°C alternate value control	
F06	Evaporate temperature sensor short	O C alternate value control	
F07	Null	-	
F08	Null	-	
F09	Mode 1 actuator open/short	The alternate value is face	
F10	Mode 1 actuator drive circuit malfunction	If not, the alternate value is Def/Foot	
F11	Intake actuator open/short	The alternate value is air recirculation	
F12	Intake actuator drive circuit malfunction	The alternate fresh air	
F13	Temperature actuator open/short	If opening amount is 0 %, the alternate value is 0 %	
F14	Temperature actuator drive circuit malfunction	If not, the alternate value is 100 %	
F15	Null	-	
F16	Null	-	

# **GROUP 17 FUEL WARMER SYSTEM**

#### 1. SPECIFICATION

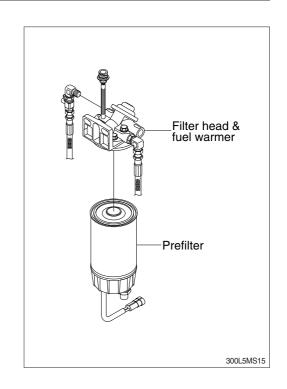
1) Operating voltage :  $24 \pm 4 \text{ V}$ 

2) Power: 350±50 W 3) Current: 15 A

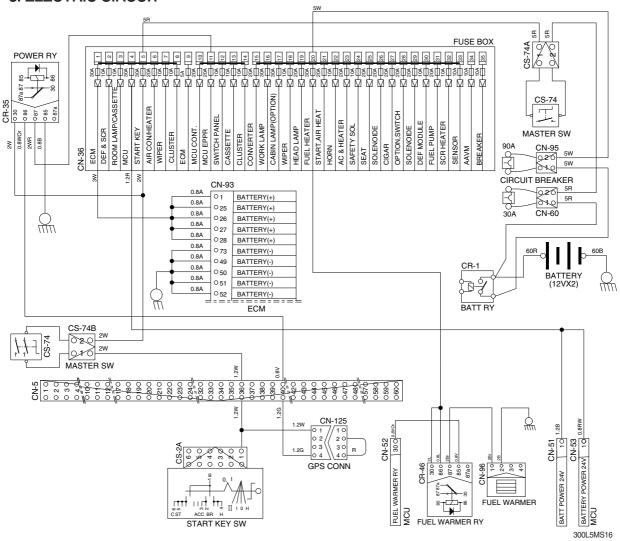
#### 2. OPERATION

- 1) The current of fuel warmer system is automatically controlled without thermostat according to fuel temperature.
- 2) At the first state, the 15 A current flows to the fuel warmer and engine may be started in 1~2 minutes.
- If the fuel starts to flow, ceramic-disk in the fuel warmer heater senses the fuel temperature to reduce the current as low as 1.5 A.

So, fuel is protected from overheating by this mechanism.



#### 3. ELECTRIC CIRCUIT



# SECTION 6 TROUBLESHOOTING

Group	1	Before Troubleshooting	6-1
Group	2	Hydraulic and Mechanical System	6-4
Group	3	Electrical System	6-24
Group	4	Mechatronics System ·····	6-40

# SECTION 6 TROUBLESHOOTING

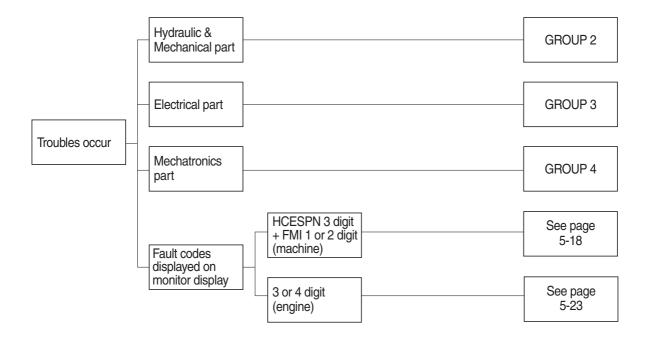
# GROUP 1 BEFORE TROUBLESHOOTING

#### 1. INTRODUCTION

When a trouble is occurred in the machine, this section will help an service man to repair the machine with easy.

The trouble of machine is parted Hydraulic & Mechanical system, Electrical system and Mechatronics system (fault codes displayed on monitor display). At each system part, a service man can check the machine according to the troubleshooting process diagram.

* Before carring out troubleshooting procedure, check monitoring menu in the cluster.



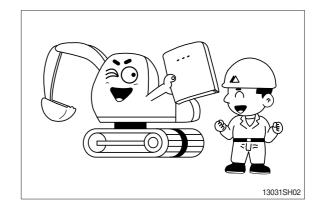
#### 2. DIAGNOSING PROCEDURE

To carry out troubleshooting efficiently, the following steps must be observed.

#### STEP 1. Study the machine system

Study and know how the machine is operating, how the system is composing, what kinds of function are installed in the machine and what are specifications of the system components by the machine service manual.

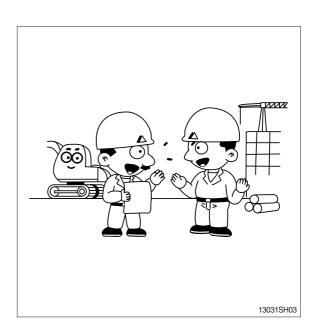
Especially, deepen the knowledge for the related parts of the trouble.



#### STEP 2. Ask the operator

Before inspecting, get the full story of malfunctions from a witness --- the operator.

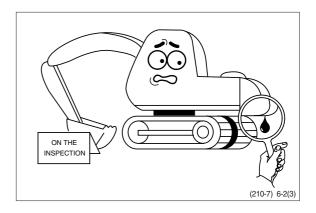
- 1) How the machine is used and when it is serviced?
- 2) When the trouble was noticed and what work the machine was doing at that time?
- 3) What is the phenomenon of the trouble? Was the trouble getting worse, or did it come out suddenly for the first time?
- 4) Did the machine have any troubles previously? If so, which parts were repaired before.



#### STEP 3. Inspect the machine

Before starting troubleshooting, check the machine for the daily maintenance points as shown in the operator's manual.

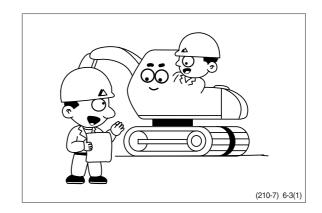
And also check the electrical system including batteries, as the troubles in the electrical system such as low battery voltage, loose connections and blown out fuses will result in malfunction of the controllers causing total operational failures of the machine.



# STEP 4. Inspect the trouble actually on the machine

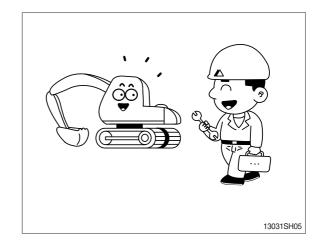
In case that some trouble cannot be confirmed, obtain the details of the malfunction from the operator.

Also, check if there are any in complete connections of the wire harnesses are or not.



# STEP 5. Perform troubleshooting

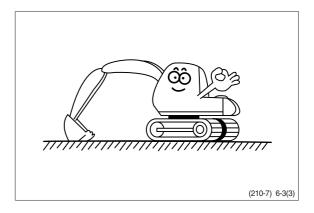
According to where the trouble parts are located, hydraulic & mechanical system part or electrical system part or mechatronics system part, perform troubleshooting the machine refer to the each system part's troubleshooting process diagram.



#### STEP 6. Trace a cause

Before reaching a conclusion, check the most suspectible causes again. Try to trace what the real cause of the trouble is.

Make a plan of the appropriate repairing procedure to avoid consequential malfunctions.



# **GROUP 2 HYDRAULIC AND MECHANICAL SYSTEM**

#### 1. INTRODUCTION

#### 1) MACHINE IN GENERAL

- (1) If even a minor fault is left intact and operation is continued, a fatal failure may be caused, entailing a large sum of expenses and long hours of restoration.
  - Therefore when even a small trouble occurs, do not rely on your intuition and experience, but look for the cause based on the troubleshooting principle and perform maintenance and adjustment to prevent major failure from occurring. Keep in mind that a fault results from a combination of different causes.
- (2) The following lists up commonly occurring faults and possible causes with this machine. For the troubleshooting of the engine, refer to the coming troubleshooting and repair.
- (3) When carrying out troubleshooting, do not hurry to disassemble the components. It will become impossible to find the cause of the problem.
- (4) Ask user or operator the following.
- ① Was there any strange thing about machine before failure occurred?
- ② Under what conditions did the failure occur?
- 3 Have any repairs been carried out before the failure?
- (5) Check before troubleshooting.
- ① Check oil and fuel level.
- ② Check for any external leakage of oil from components.
- ③ Check for loose or damage of wiring and connections.

#### 2) MACHINE STATUS MONITORING ON THE CLUSTER

(1) The machine status such as the engine rpm, oil temperature, voltage and pressure etc. can be checked by this menu.



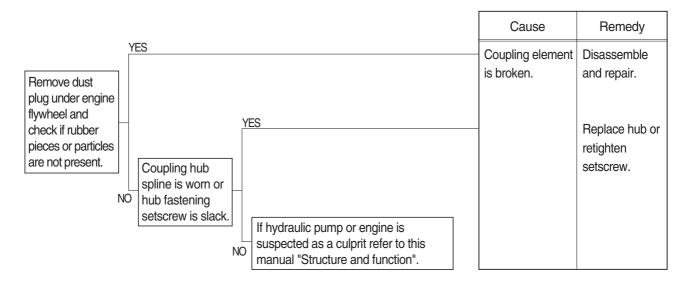


(2) Specification

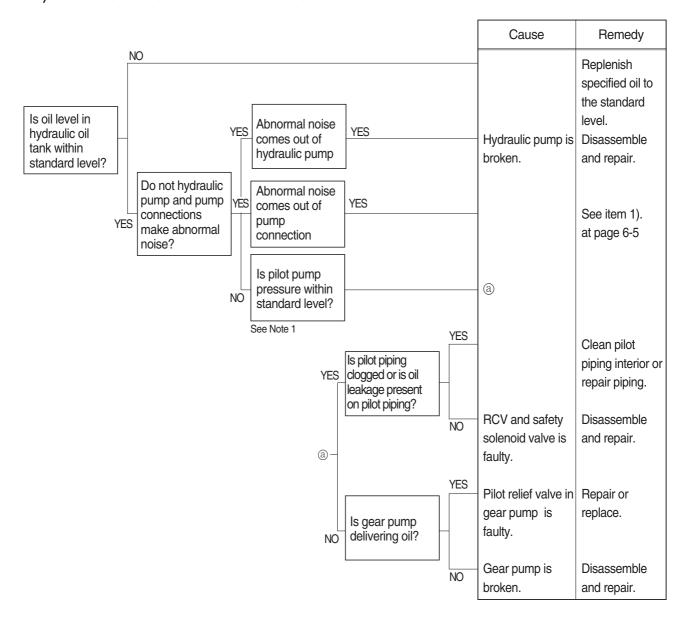
. , .		
No.	Description	Specification
Note 1	Work pilot pressure	40 ⁺² ₀ bar
Note 2	Swing pilot pressure	0~40 bar
Note 3	Boom up pilot pressure	0~40 bar
Note 4	Arm/bucket pilot pressure	0~40 bar
Note 5	Pump 1 regulator pressure	0~50 bar
Note 6	Pump 2 regulator pressure	0~50 bar
Note 7	Pump 1 pressure	350 bar

# 2. DRIVE SYSTEM

# 1) UNUSUAL NOISE COMES OUT OF PUMP CONNECTION

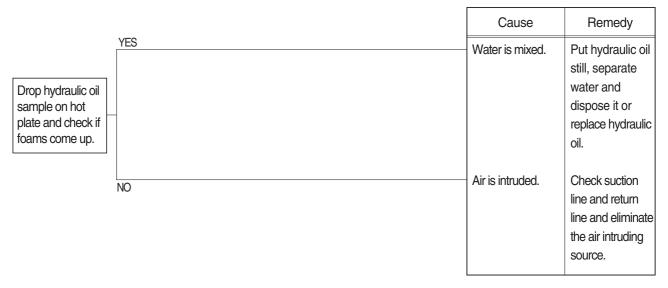


#### 2) ENGINE STARTS BUT MACHINE DOES NOT OPERATE AT ALL

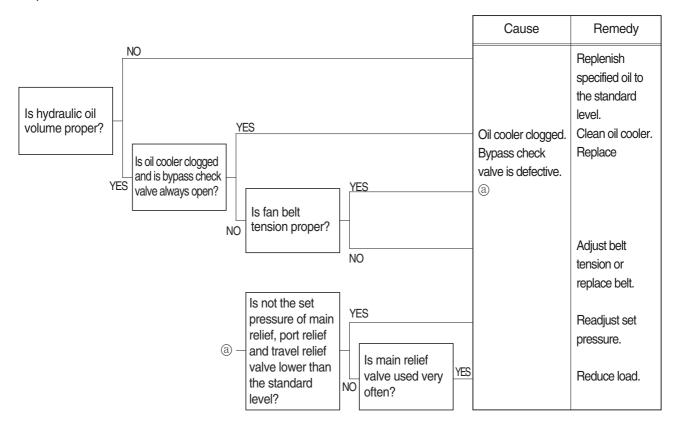


#### 3. HYDRAULIC SYSTEM

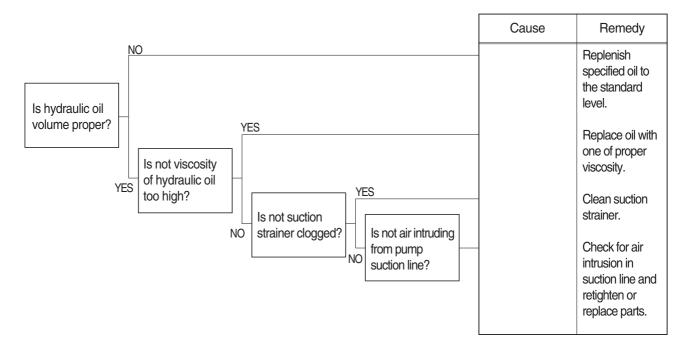
# 1) HYDRAULIC OIL IS CLOUDY



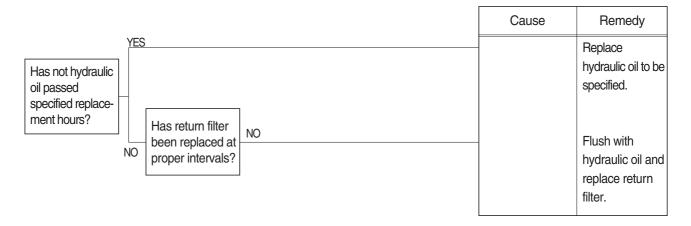
#### 2) HYDRAULIC OIL TEMPERATURE HAS RISEN ABNORMALLY



# 3) CAVITATION OCCURS WITH PUMP

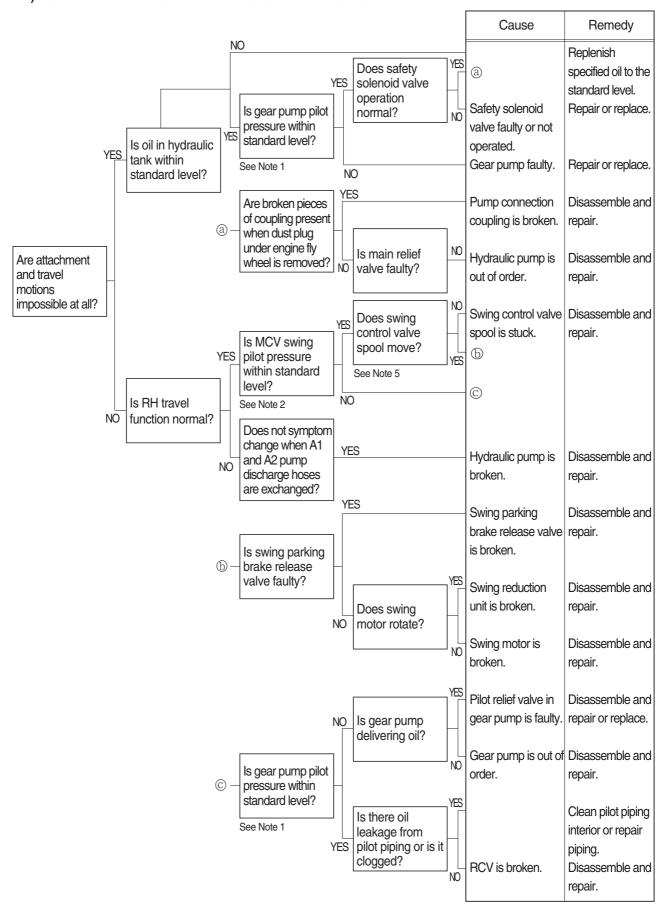


### 4) HYDRAULIC OIL IS CONTAMINATED

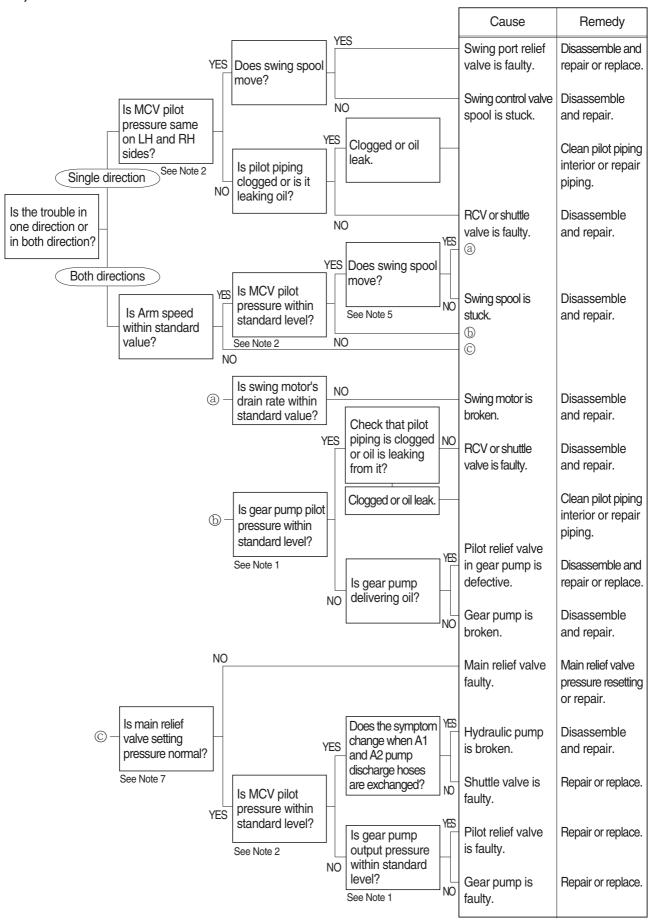


#### 4. SWING SYSTEM

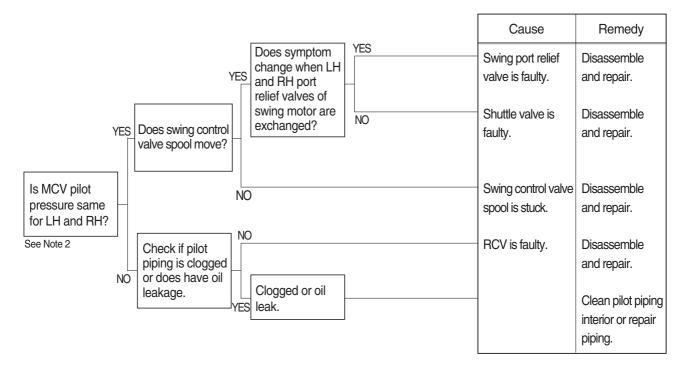
### 1) BOTH LH AND RH SWING ACTIONS ARE IMPOSSIBLE



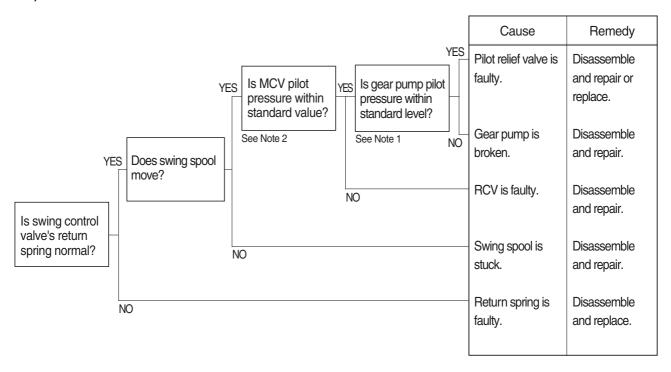
#### 2) SWING SPEED IS LOW



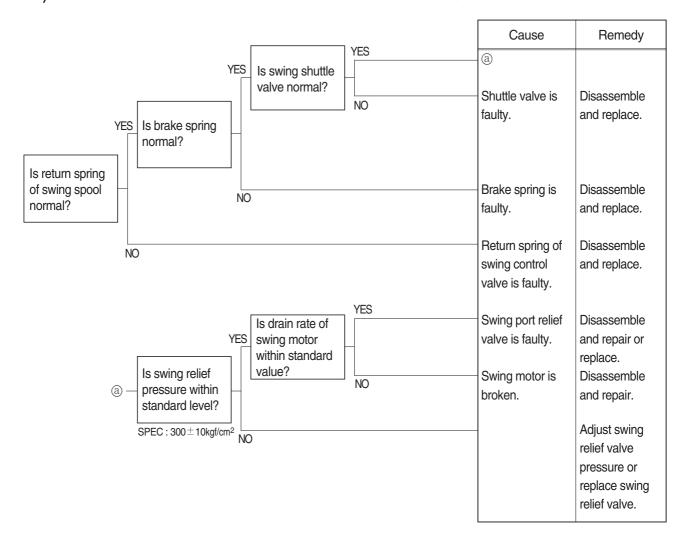
### 3) SWING MOTION IS IMPOSSIBLE IN ONE DIRECTION



#### 4) MACHINE SWINGS BUT DOES NOT STOP

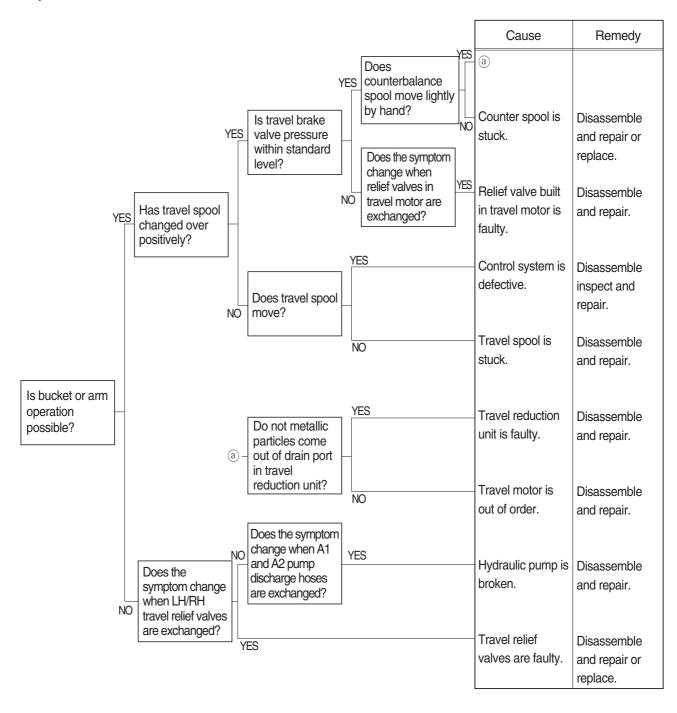


# 5) THE SWING UNIT DRIFTS WHEN THE MACHINE IS AT REST ON A SLOPE

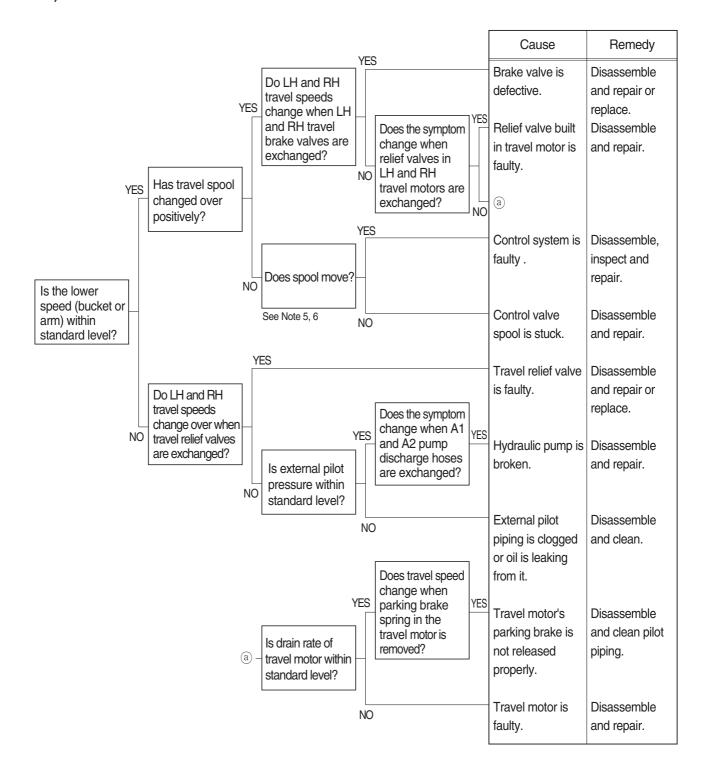


#### 5. TRAVEL SYSTEM

### 1) TRAVEL DOES NOT FUNCTION AT ALL ON ONE SIDE

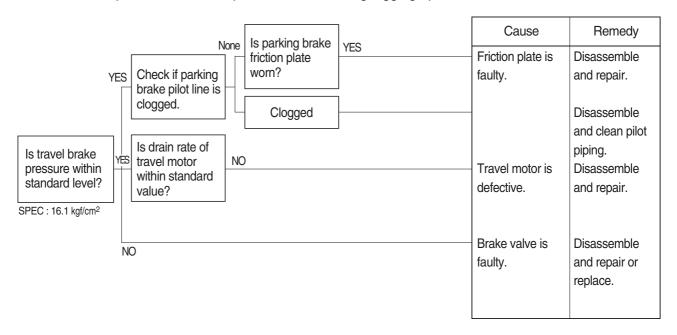


#### 2) SPEED ON ONE SIDE FALLS AND THE MACHINE CURVES

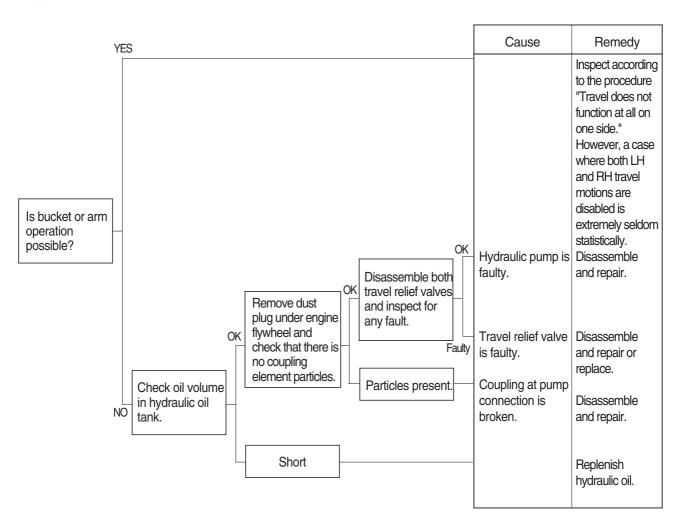


#### 3) MACHINE DOES NOT STOP ON A SLOPE

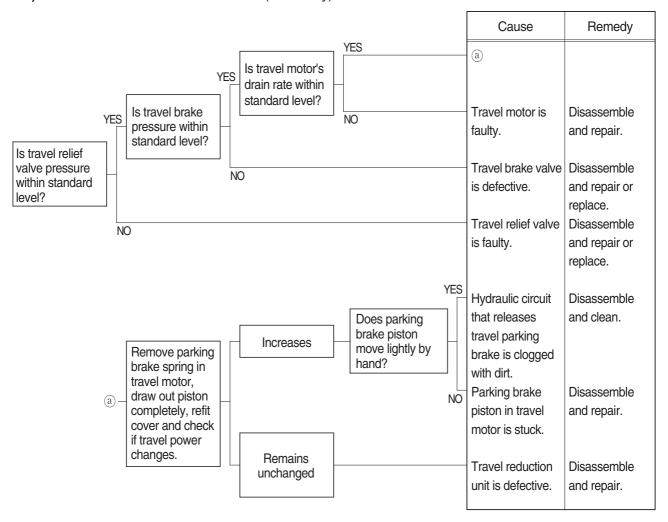
Machine is pulled forward as sprocket rotates during digging operation.



### 4) LH AND RH TRAVEL MOTIONS ARE IMPOSSIBLE



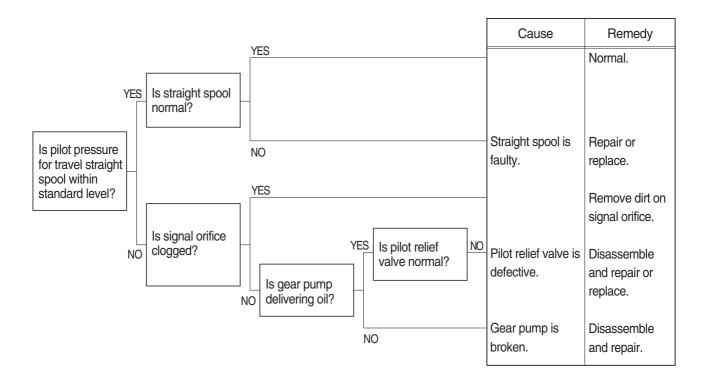
# 5) TRAVEL ACTION IS POWERLESS (travel only)



#### 6) MACHINE RUNS RECKLESSLY ON A SLOPE

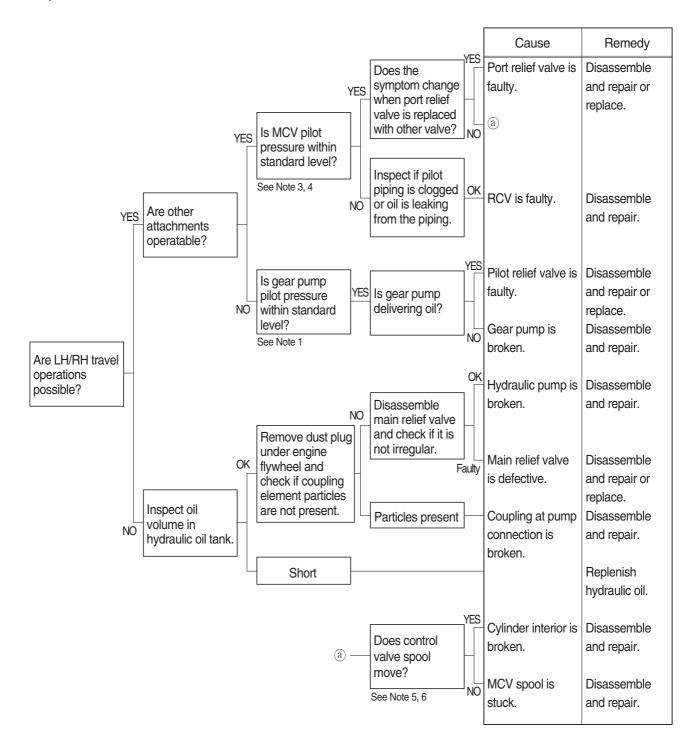
Travel brake valve	Cause	Remedy
(counterbalance valve) is faulty.		Disassemble and repair or replace.

# 7) MACHINE MAKES A CURVED TRAVEL OR DOES NOT TRAVEL AT ALL WHEN TRAVEL AND ATTACHMENT OPERATIONS ARE EXECUTED AT THE SAME TIME

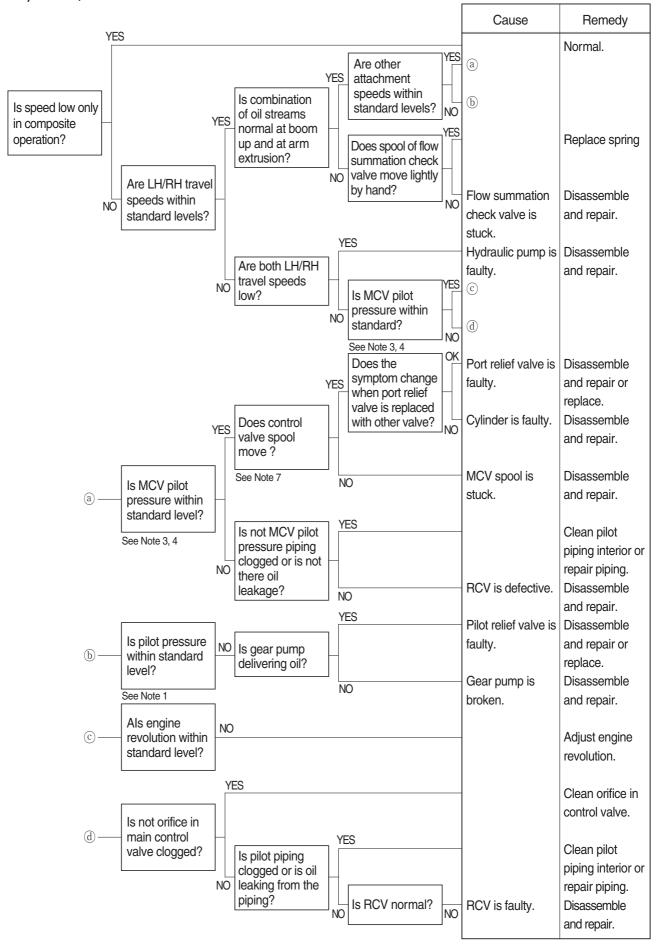


#### 6. ATTACHMENT SYSTEM

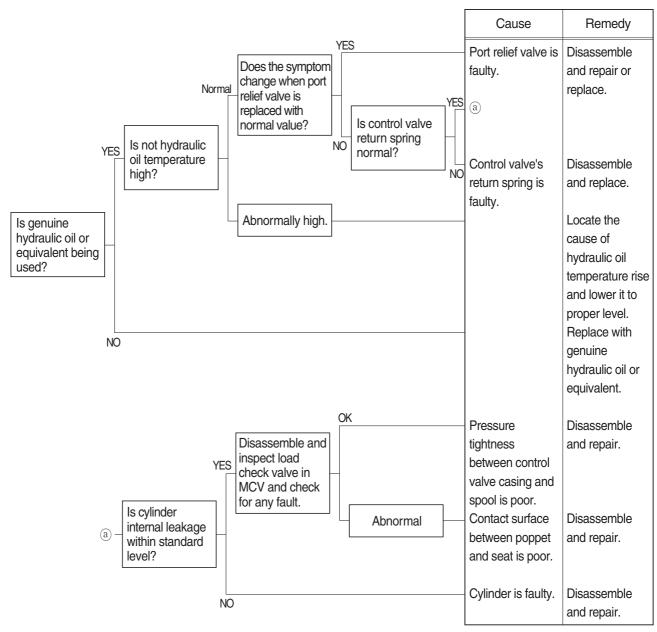
### 1) BOOM OR ARM ACTION IS IMPOSSIBLE AT ALL



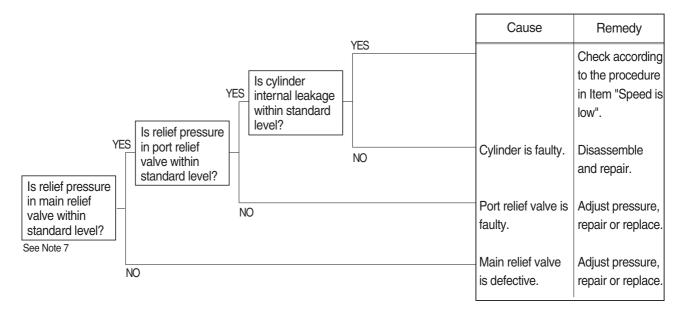
# 2) BOOM, ARM OR BUCKET SPEED IS LOW



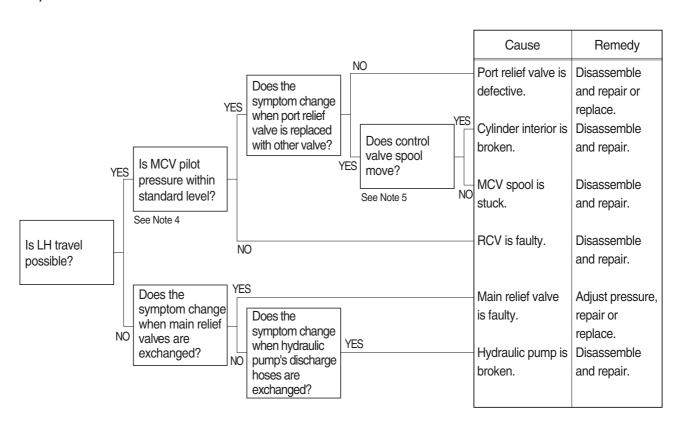
# 3) BOOM, ARM OR BUCKET CYLINDER EXTENDS OR CONTRACTS ITSELF AND ATTACHMENT FALLS



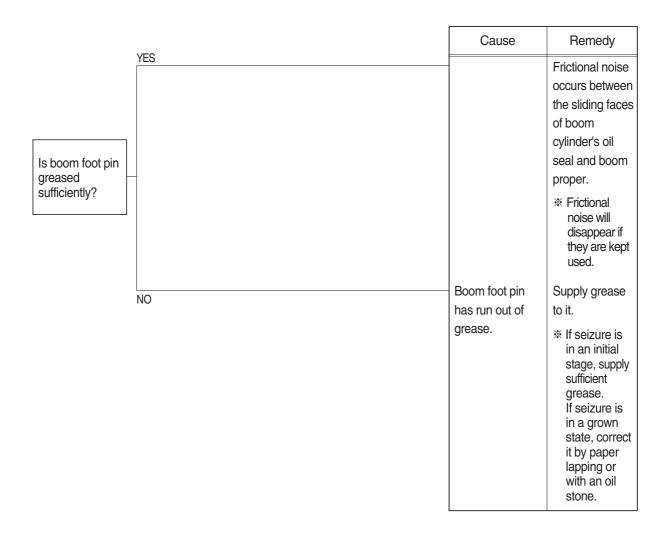
#### 4) BOOM, ARM OR BUCKET POWER IS WEAK



#### 5) ONLY BUCKET OPERATION IS TOTALLY IMPOSSIBLE

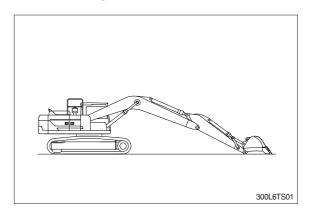


# 6) BOOM MAKES A SQUEAKING NOISE WHEN BOOM IS OPERATED

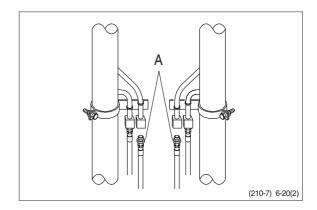


#### **** HOW TO CHECK INTERNAL BOOM CYLINDER LEAKAGE**

1. Lower the bucket teeth to the ground with bucket cylinder fully retracted and arm cylinder rod retracted almost in full.



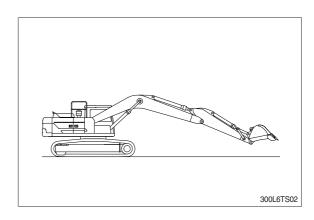
2. Disconnect hose (A) from rod side of boom cylinder and drain oil from cylinders and hose. (put cups on piping and hose ends)



3. Raise bucket OFF the ground by retracting the arm cylinder rod.

If oil leaks from piping side and boom cylinder rod is retracted there is an internal leak in the cylinder.

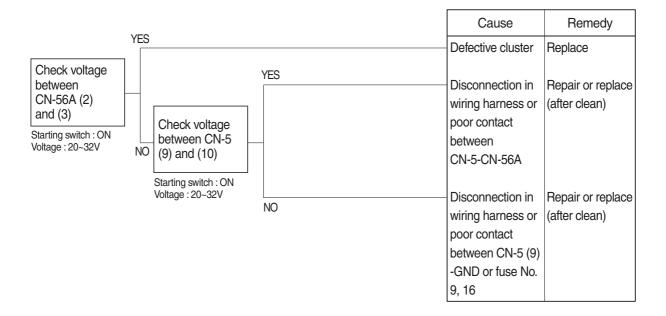
If no oil leaks from piping side and boom cylinder rod is retracted, there is an internal leak in the control valve.



# **GROUP 3 ELECTRICAL SYSTEM**

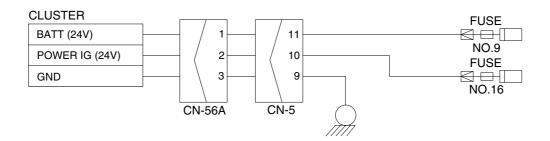
# 1. WHEN STARTING SWITCH IS TURNED ON, MONITOR PANEL DISPLAY DOES NOT APPEAR

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No. 9, 16.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.



#### Check voltage

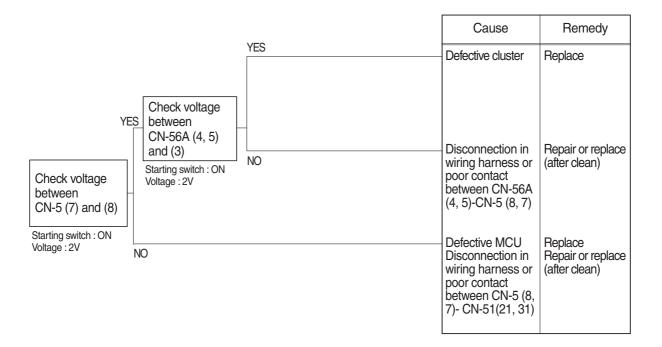
YES	20~32V	
NO	0V	



220NL6ES01

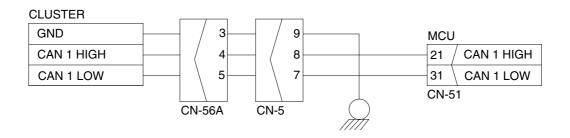
# 2. COMMUNICATION ERROR FLASHES ON THE CLUSTER (HCESPN 840, FMI 2)

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.



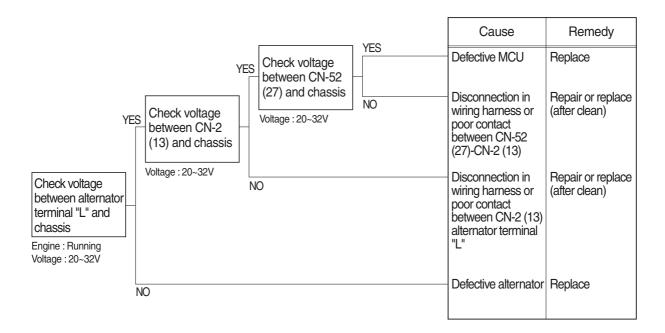
#### Check voltage

YES	2V
NO	0V



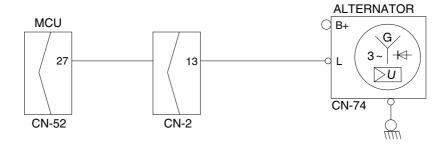
# 3. Fig. BATTERY CHARGING WARNING LAMP LIGHTS UP (Starting switch : ON)

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.



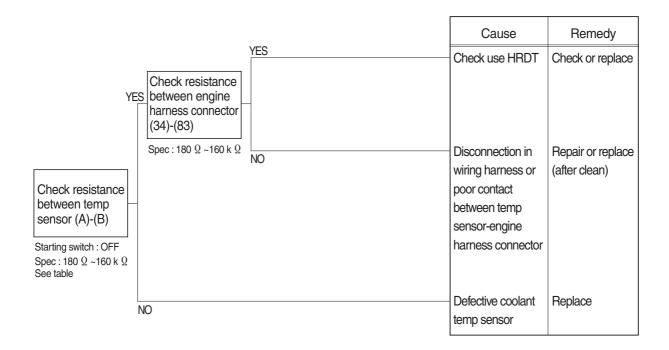
#### Check voltage

YES	20~32V		
NO	0V		



# 4. WHEN COOLANT OVERHEAT WARNING LAMP LIGHTS UP (engine is started)

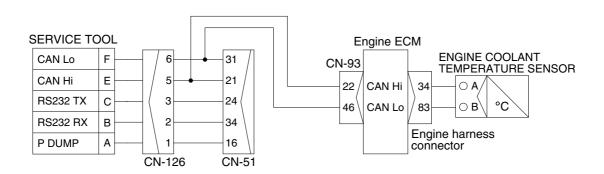
- · Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.





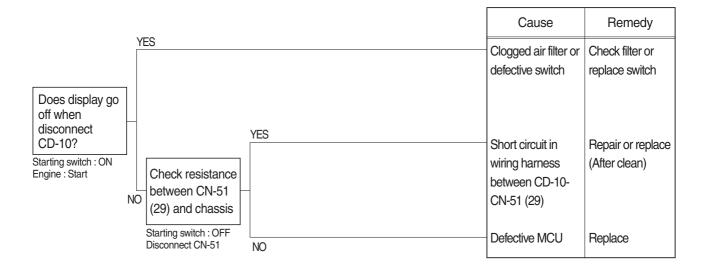
# **Check Table**

Temperature (°C)	0	25	50	80	95	
Resistance (k $\Omega$ )	30~37	9.3~10.7	3.2~3.8	1.0~1.3	0.7~0.8	



# 5. WHEN AIR CLEANER WARNING LAMP LIGHTS UP (engine is started)

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

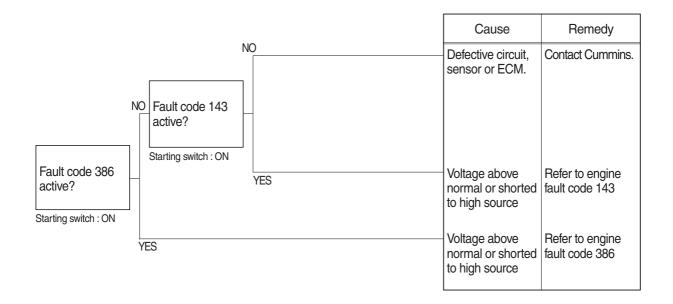


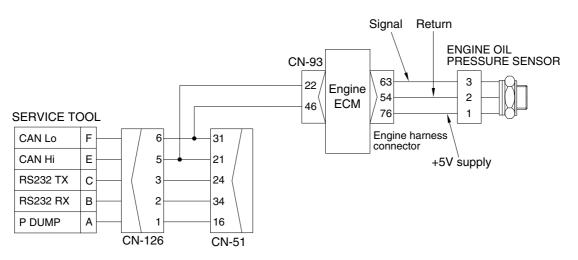
#### Check resistance

YES	MAX 1Ω			
NO	MIN 1MΩ		,,,,,	
		MCU		AIR CLEANER SWITCH
				Pa _
		/ 29		
				CD-10
		CN-51		

# 6. WHEN ENGINE OIL PRESSURE WARNING LAMP LIGHTS UP (engine is started)

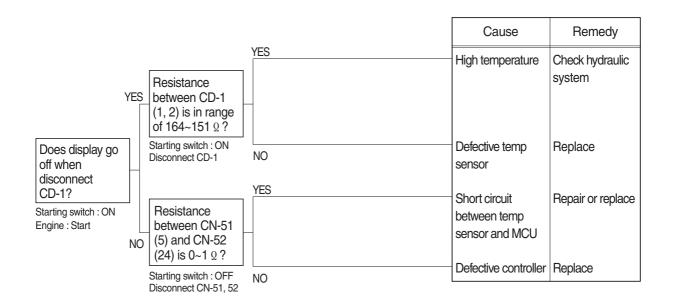
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.





# 7. WHEN HYDRAULIC OIL TEMPERATURE WARNING LAMP LIGHTS UP (engine is started)

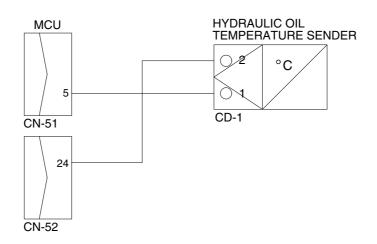
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.



#### **Check Table**

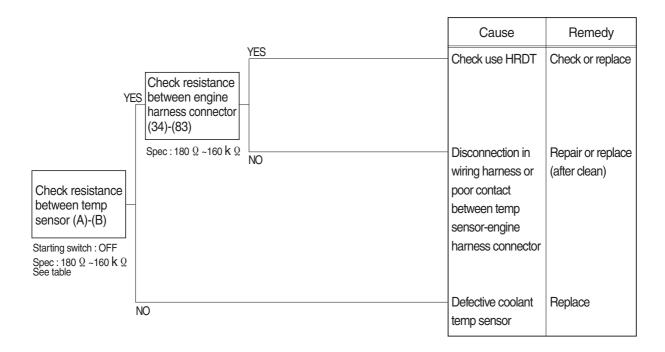


Temperature (°C)	~ -30	~ -10	~ 0	~ 40	~ 70	~ 80	~ 90	~ 100	105~
Resistance (k $\Omega$ )		8.16 ~10.74							



#### 8. WHEN COOLANT TEMPERATURE GAUGE DOES NOT OPERATE

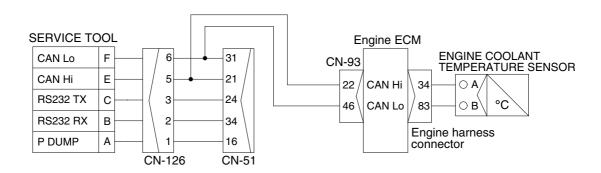
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.





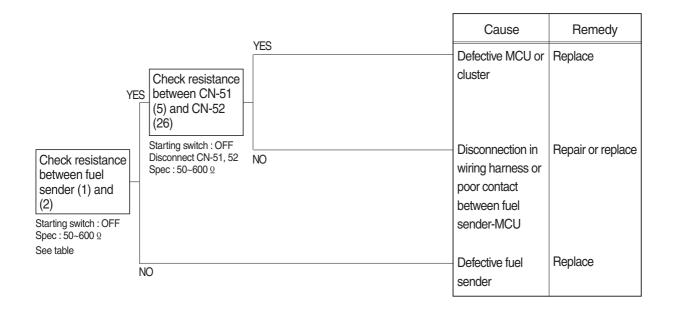
#### **Check Table**

Temperature (°C)	0	25	50	80	95
Resistance (k $\Omega$ )	30~37	9.3~10.7	3.2~3.8	1.0~1.3	0.7~0.8



# 9. WHEN FUEL GAUGE DOES NOT OPERATE (HCESPN 301, FMI 3 or 4)

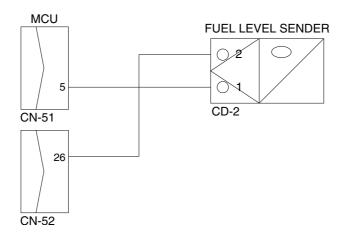
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.





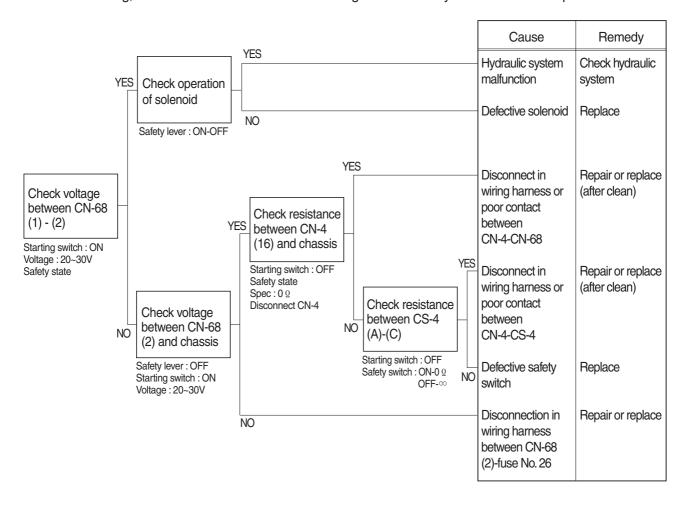
#### **Check Table**

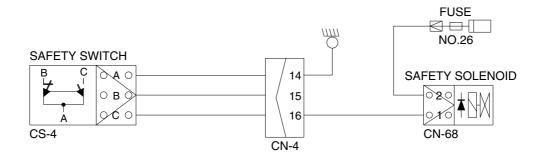
Range Resistance ( $\Omega$ )		Range	Resistance ( $\Omega$ )				
Full	Full 50		400				
11/12	100	4/12	450				
10/12	150	3/12	500				
9/12	200	2/12	550				
8/12	250	1/12	600				
7/12 300		Empty warning	700				
6/12	350	-	-				



#### 10. WHEN SAFETY SOLENOID DOES NOT OPERATE

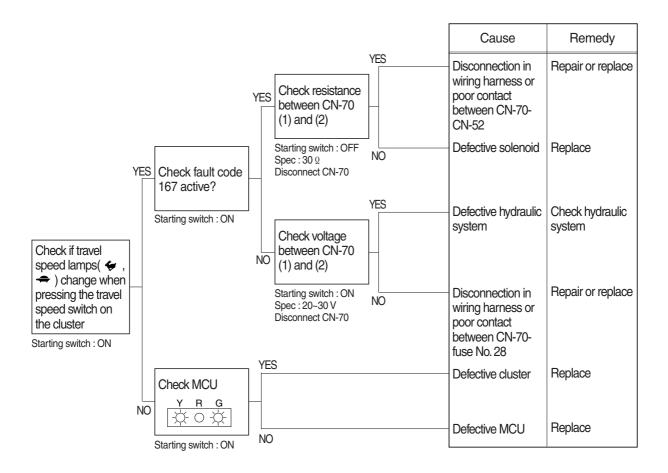
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No. 26.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

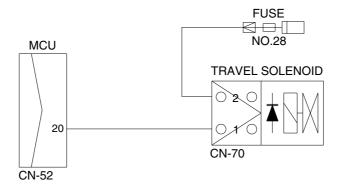




# 11. WHEN TRAVEL SPEED 1, 2 DOES NOT OPERATE (HCESPN 167, FMI 4 or 6)

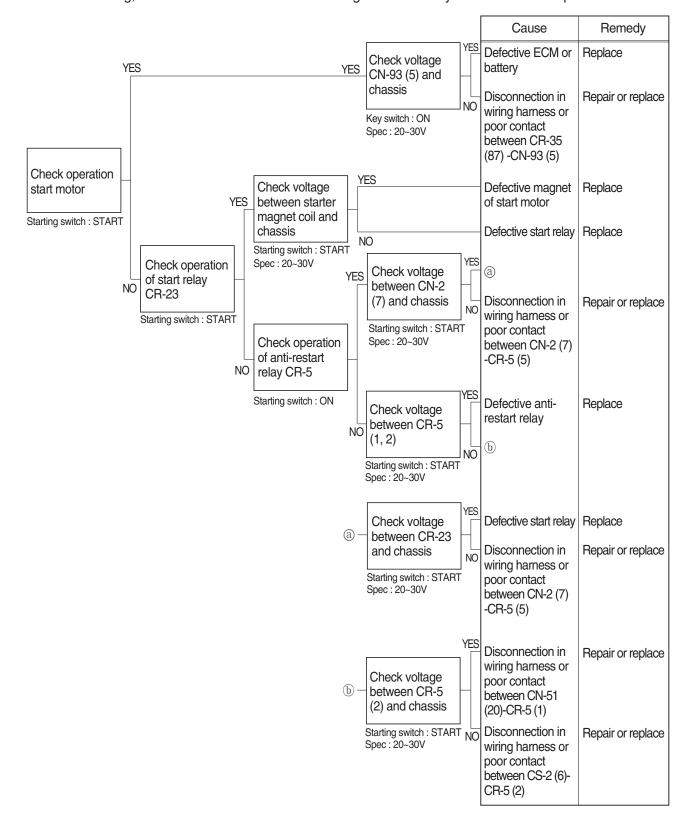
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No. 28.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

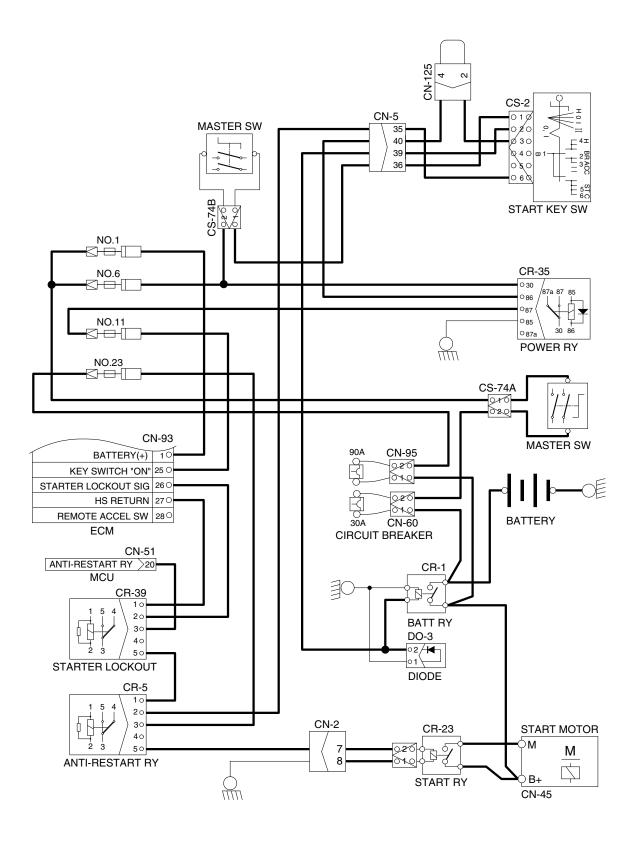




# 12. WHEN ENGINE DOES NOT START ( | lights up condition)

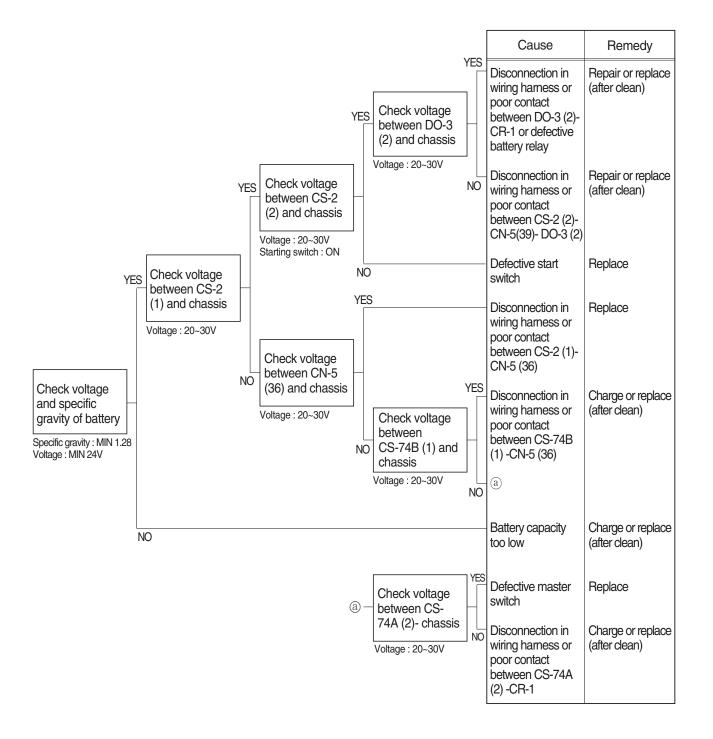
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No. 1, 6, 11, 23.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

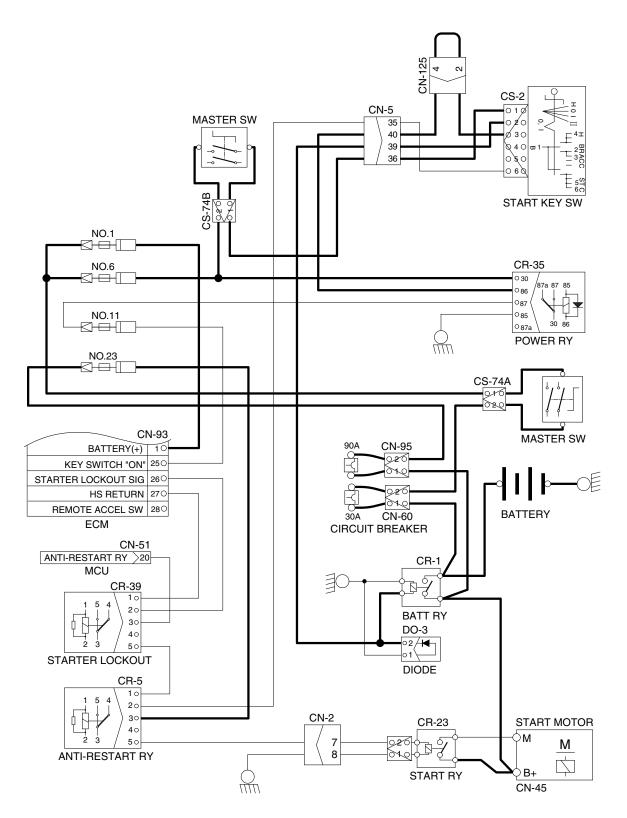




#### 13. WHEN STARTING SWITCH ON DOES NOT OPERATE

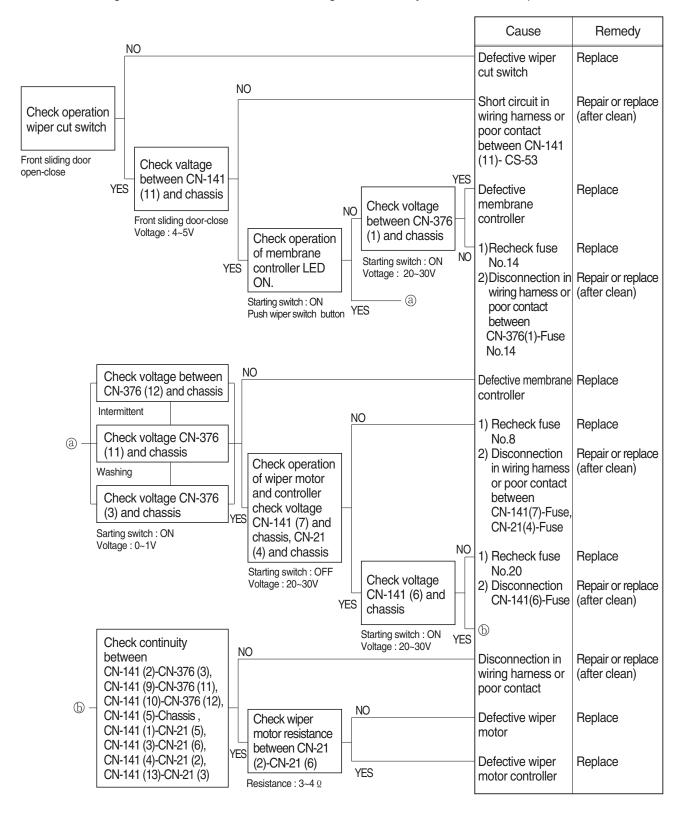
- · Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted, master switch ON and check open circuit of circuit breaker (CN-60).
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

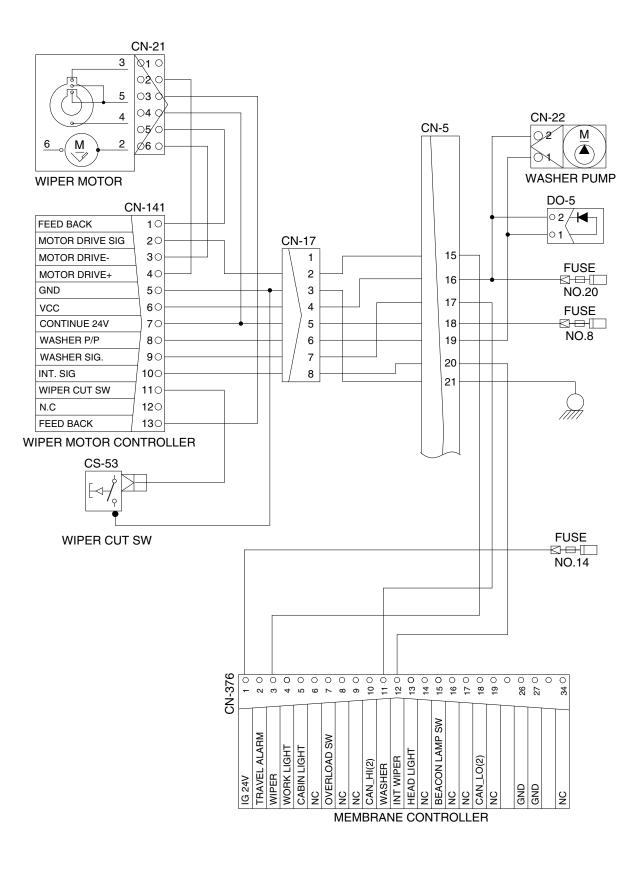




## 14. WHEN STARTING SWITCH IS TURNED ON, WIPER MOTOR DOES NOT OPERATE

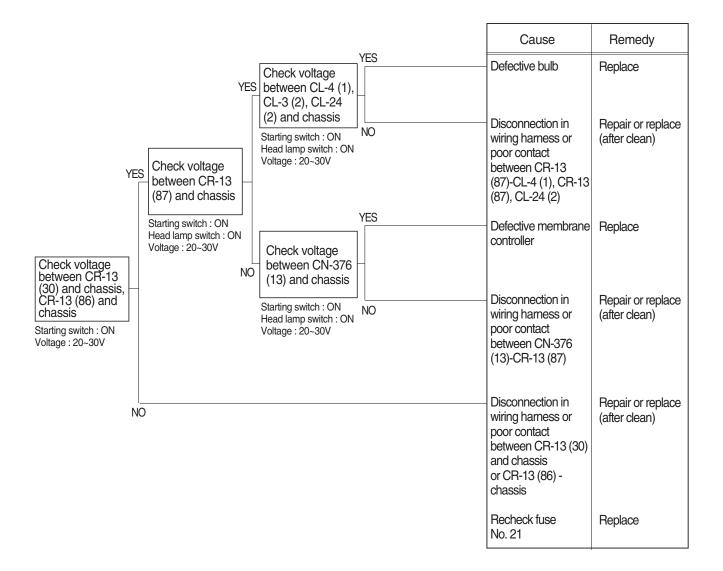
- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No. 8, 14 and 20 are not blown out.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.

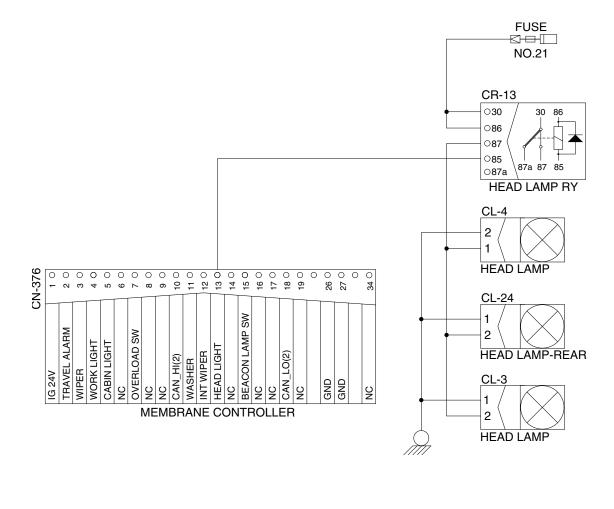




## 15. WHEN STARTING SWITCH IS TURNED ON, HEAD LAMP DOES NOT LIGHTS UP

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.21.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.



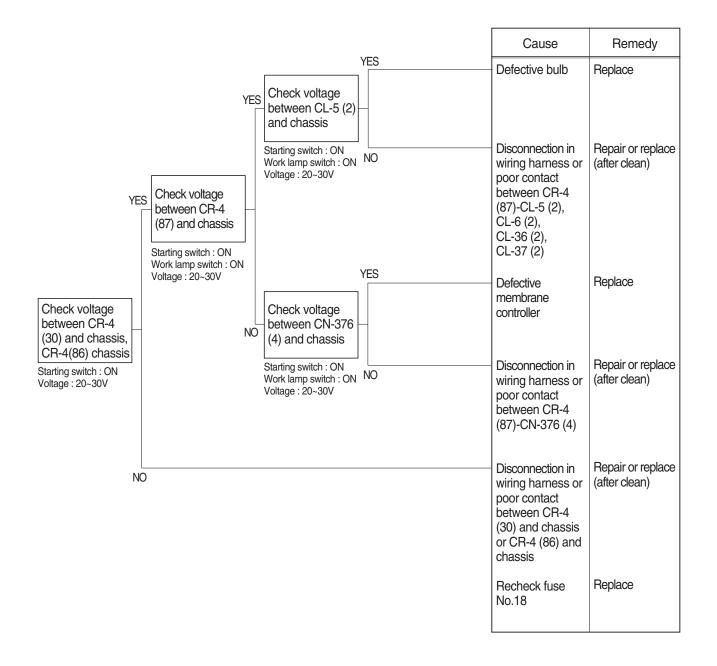


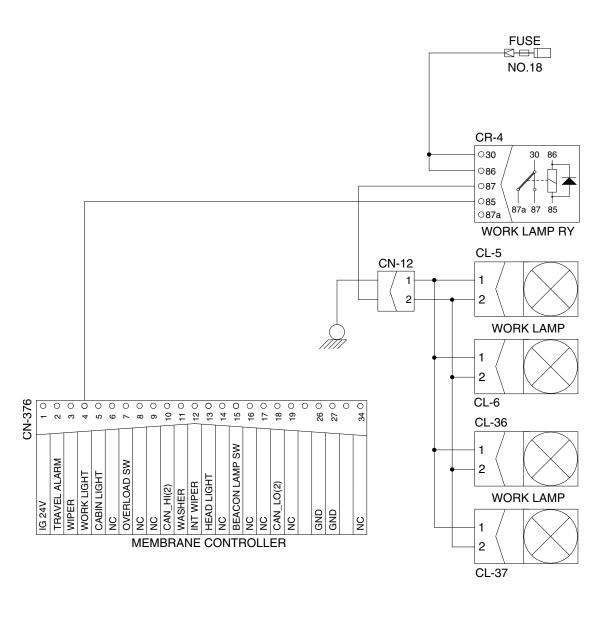
220NL6ES17

6-38

## 16. WHEN STARTING SWITCH IS TURNED ON, WORK LAMP DOES NOT LIGHTS UP

- · Before disconnecting the connector, always turn the starting switch OFF.
- · Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.18.
- · After checking, insert the disconnected connectors again immediately unless otherwise specified.





220NL6ES18

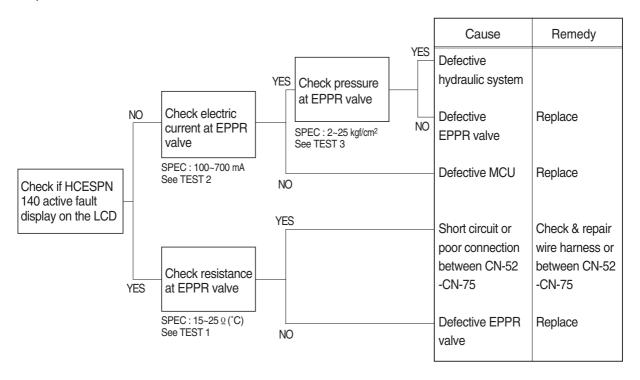
6-39

# **GROUP 4 MECHATRONICS SYSTEM**

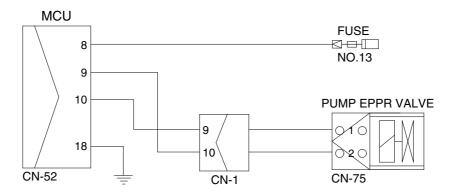
#### 1. ALL ACTUATORS SPEED ARE SLOW

- * Boom, Arm, Bucket, Swing and travel speed are slow, but engine speed is good.
- $\divideontimes$  Spec : P-mode 1800  $\pm$  50 rpm S -mode 1700  $\pm$  50 rpm E-mode 1600  $\pm$  50 rpm
- * Before carrying out below procedure, check all the related connectors are properly inserted and fault code on the cluster.

## 1) INSPECTION PROCEDURE

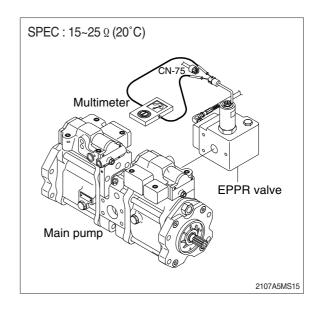


## Wiring diagram

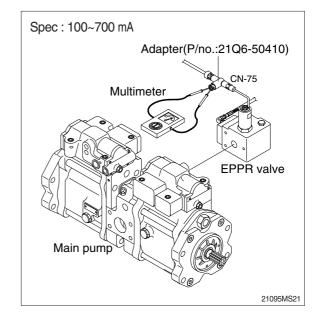


220NL6MS01

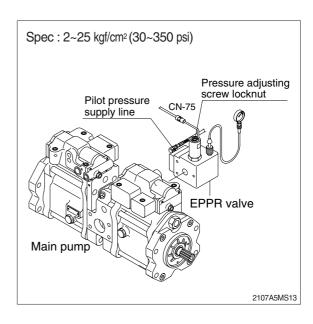
- (1) **Test 1**: Check resistance at connector CN-75.
- ① Starting key OFF.
- ② Disconnect connector CN-75 from EPPR valve at main hydraulic pump.
- ③ Check resistance between 2 lines as figure.



- (2) **Test 2**: Check electric current at EPPR valve.
- ① Disconnect connector CN-75 from EPPR valve.
- ② Insert the adapter to CN-75 and install multimeter as figure.
- ③ Start engine.
- 4 Set S-mode and cancel auto decel mode.
- (5) Position the multimodal dial at 10.
- ⑥ If tachometer show approx 1700±50 rpm disconnect one wire harness from EPPR valve.
- Theck electric current at bucket circuit relief position.



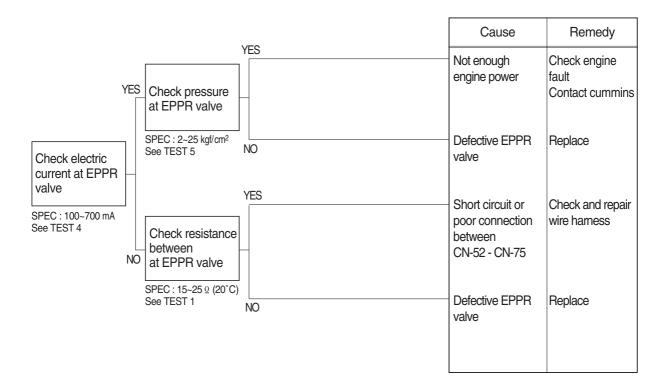
- (3) Test 3: Check pressure at EPPR valve.
  - ① Remove plug and connect pressure gauge as figure.
    - Gauge capacity: 0 to 50 kgf/cm² (0 to 725 psi)
  - ② Start engine.
  - ③ Set S-mode and cancel auto decel mode.
  - 4 Position the multimodal dial at 10.
  - ⑤ If tachometer show approx 1700±50 rpm check pressure at relief position of bucket circuit by operating bucket control lever.
  - 6 If pressure is not correct, adjust it.
  - 7 After adjust, test the machine.



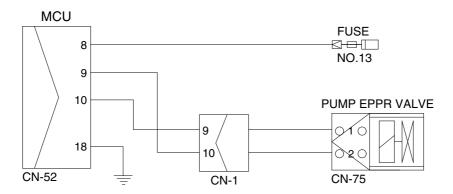
#### 2. ENGINE STALL

* Before carrying out below procedure, check all the related connectors are properly inserted.

# 1) INSPECTION PROCEDURE

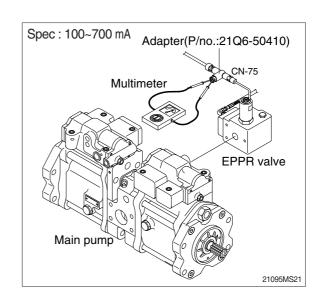


# Wiring diagram



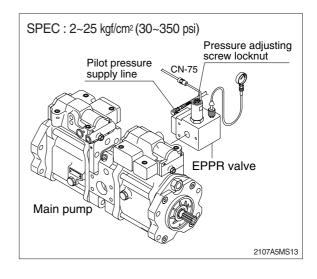
220NL6MS01

- (1) Test 4 : Check electric current at EPPR valve.
  - ① Disconnect connector CN-75 from EPPR valve.
  - ② Insert the adapter to CN-75 and install multimeter as figure.
  - ③ Start engine.
  - Set S-mode and cancel auto decel mode.
  - 5 Position the multimodal dial at 10.
  - ⑥ If rpm show approx 1700±50 rpm disconnect one wire harness from EPPR valve.
  - Theck electric current at bucket circuit relief position.



## (2) Test 5: Check pressure at EPPR valve.

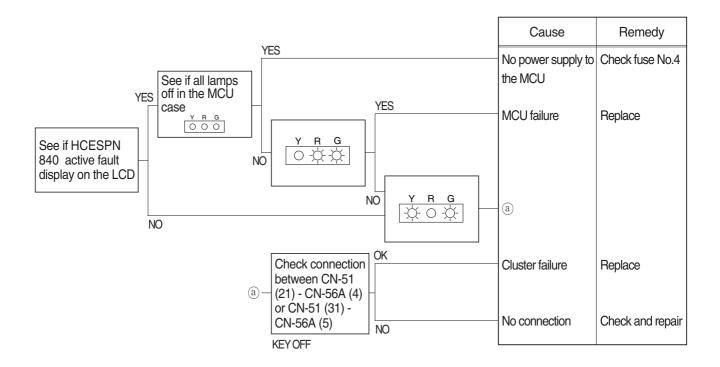
- ① Remove plug and connect pressure gauge as figure.
  - Gauge capacity: 0 to 50 kgf/cm² (0 to 725 psi)
- 2 Start engine.
- ③ Set S-mode and cancel auto decel mode.
- 4 Position the multimodal dial at 10.
- ⑤ If rpm show approx 1700±50 rpm check pressure at relief position of bucket circuit by operating bucket control lever.
- 6 If pressure is not correct, adjust it.
- 7 After adjust, test the machine.



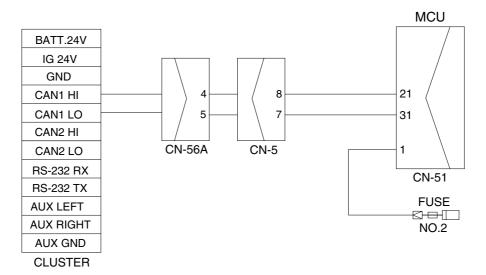
## 3. MALFUNCTION OF CLUSTER OR MODE SELECTION SYSTEM

* Before carrying out below procedure, check all the related connectors are properly inserted.

## 1) INSPECTION PROCEDURE



### Wiring diagram

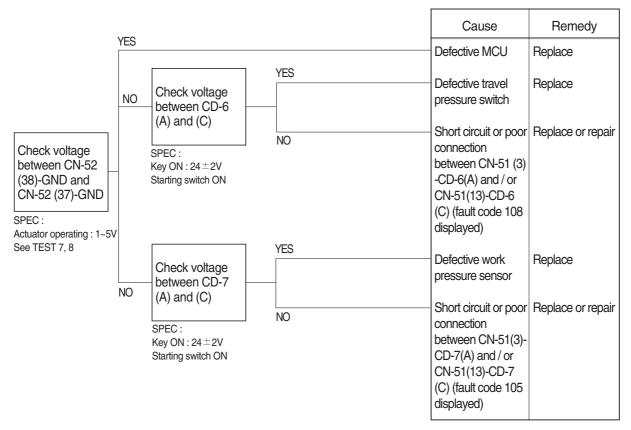


220NL6MS02

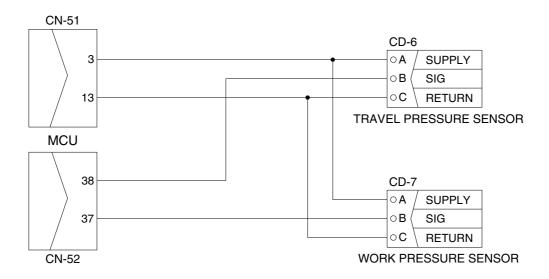
#### 4. AUTO DECEL SYSTEM DOES NOT WORK

- Fault code: HCESPN 105, FMI 0~4 (work pressure sensor)
   HCESPN 108, FMI 0~4 (travel oil pressure sensor)
- * Before carrying out below procedure, check all the related connectors are properly inserted.

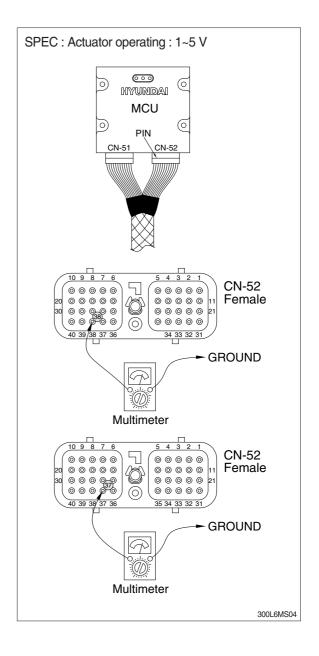
## 1) INSPECTION PROCEDURE



#### Wiring diagram



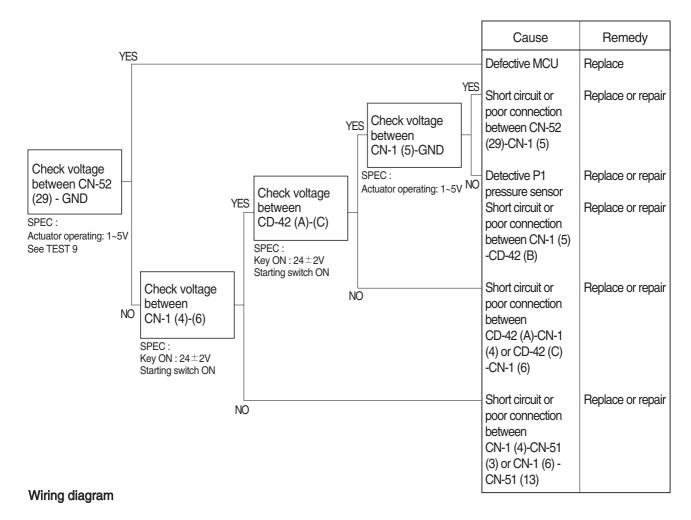
- (1) Test 7: Check voltage at CN-52 (38) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (38) of CN-52.
- ③ Starting switch ON.
- ④ Check voltage as figure.
- (2) Test 8: Check voltage at CN-52 (37) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper
- ② Insert prepared pin to rear side of connectors: One pin to (37) of CN-52.
- ③ Starting switch ON.
- ④ Check voltage as figure.

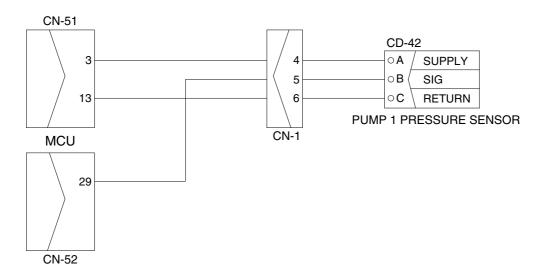


### 5. MALFUNCTION OF PUMP 1 PRESSURE SENSOR

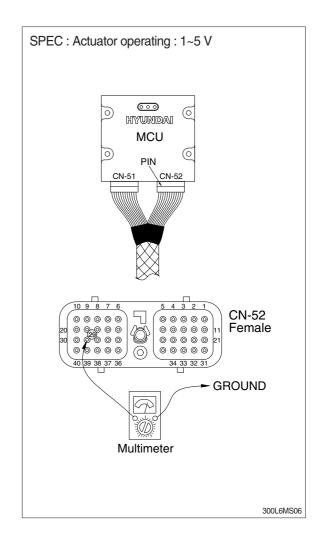
- · Fault code: HCESPN 120, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

# 1) INSPECTION PROCEDURE





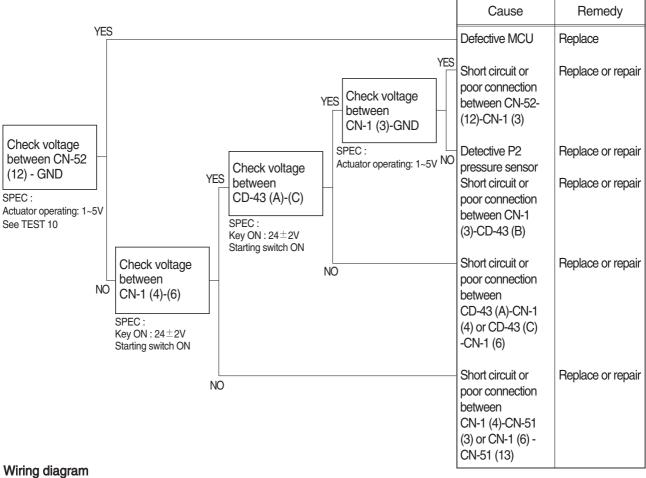
- (1) Test 9: Check voltage at CN-52 (29) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (29) of CN-52.
- ③ Starting switch ON.
- ④ Check voltage as figure.



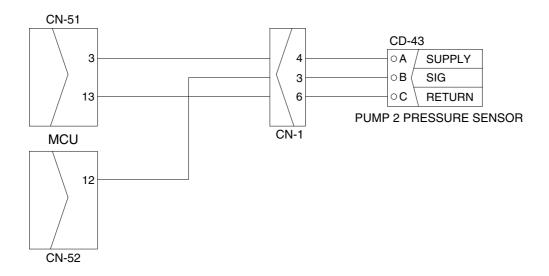
#### 6. MALFUNCTION OF PUMP 2 PRESSURE SENSOR

- · Fault code: HCESPN 121, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

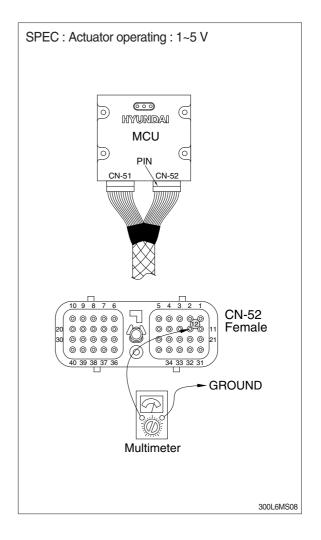
# 1) INSPECTION PROCEDURE



# willing diagram



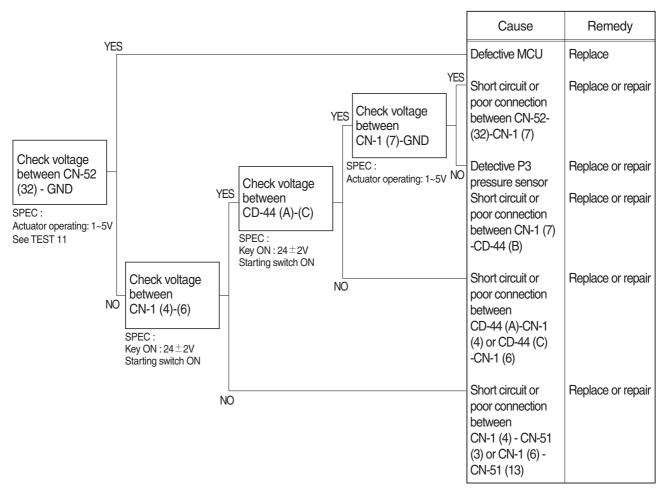
- (1) Test 10 : Check voltage at CN-52 (12) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (12) of CN-52.
- ③ Starting switch ON.
- ④ Check voltage as figure.



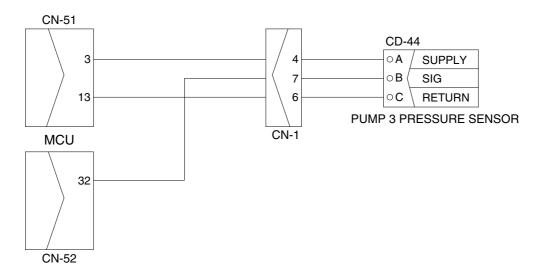
### 7. MALFUNCTION OF PUMP 3 PRESSURE SENSOR

* Before carrying out below procedure, check all the related connectors are properly inserted.

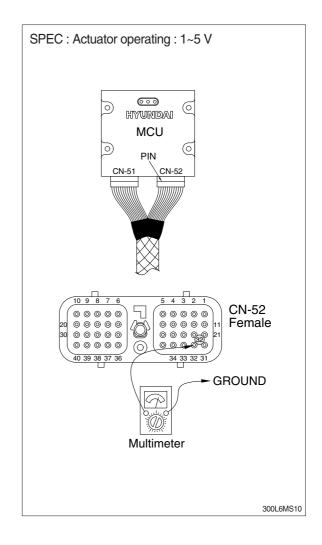
#### 1) INSPECTION PROCEDURE



#### Wiring diagram



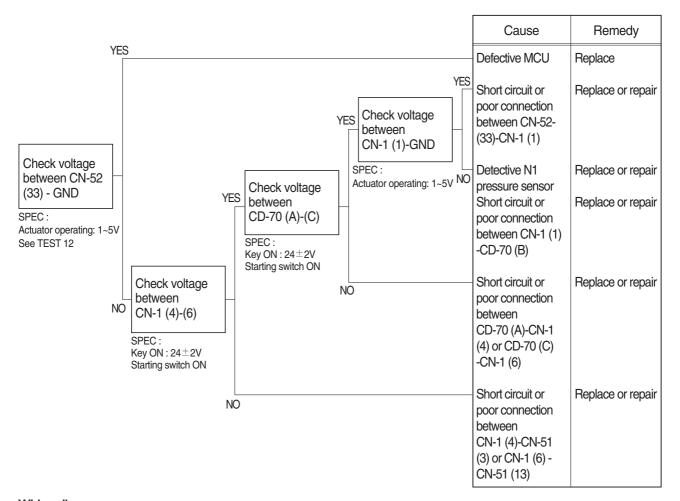
- (1) Test 11: Check voltage at CN-52 (32) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (32) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



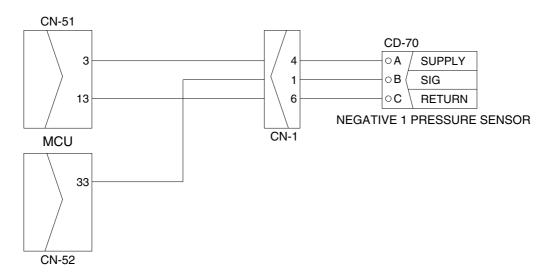
### 8. MALFUNCTION OF NEGATIVE 1 PRESSURE SENSOR

- · Fault code: HCESPN 123, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

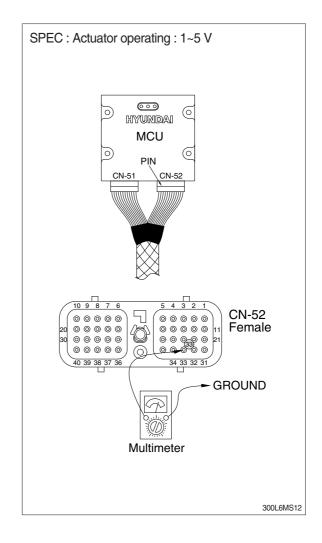
## 1) INSPECTION PROCEDURE



## Wiring diagram



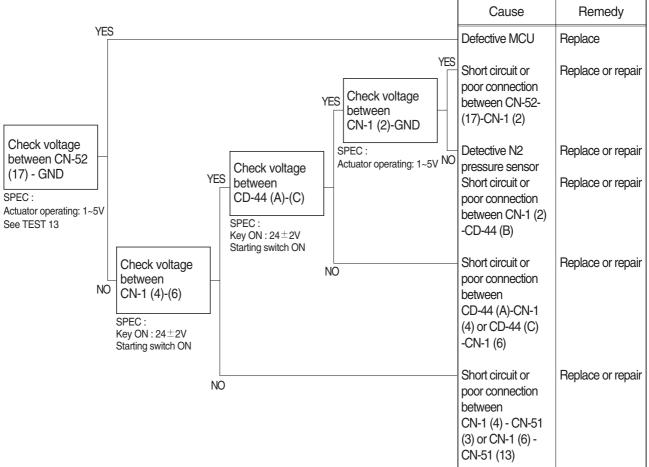
- (1) Test 12: Check voltage at CN-52 (33) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (33) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



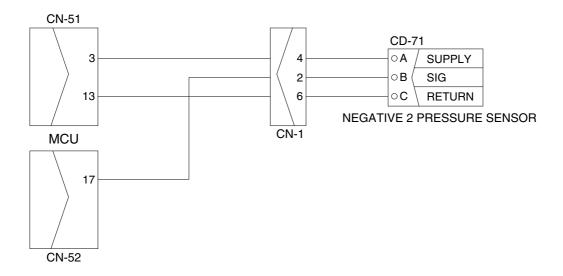
#### 9. MALFUNCTION OF NEGATIVE 2 PRESSURE SENSOR

- · Fault code: HCESPN 124, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

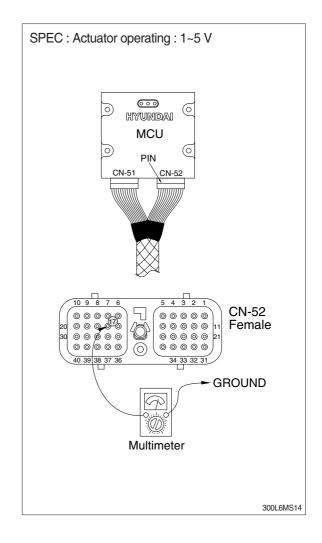
## 1) INSPECTION PROCEDURE



### Wiring diagram



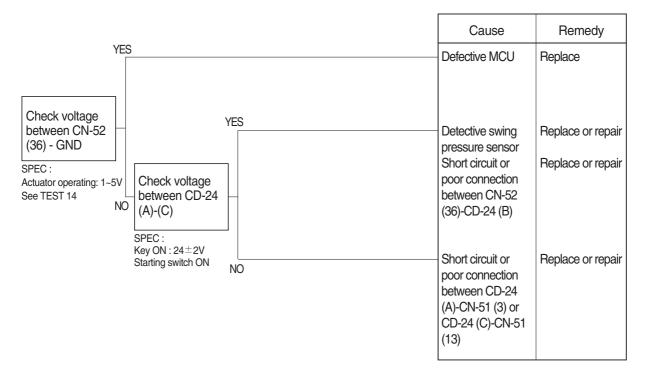
- (1) Test 13: Check voltage at CN-52 (17) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (17) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



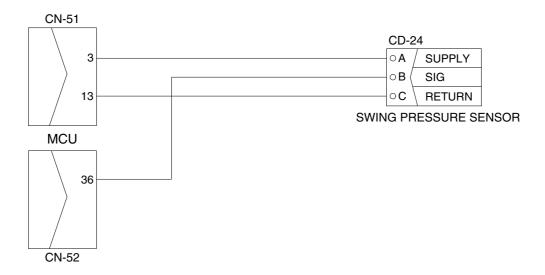
#### 10. MALFUNCTION OF SWING PRESSURE SENSOR

- · Fault code: HCESPN 135, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

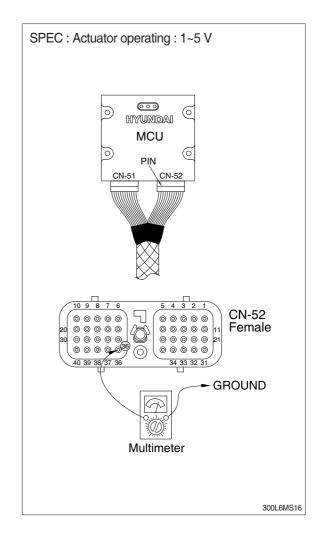
# 1) INSPECTION PROCEDURE



## Wiring diagram



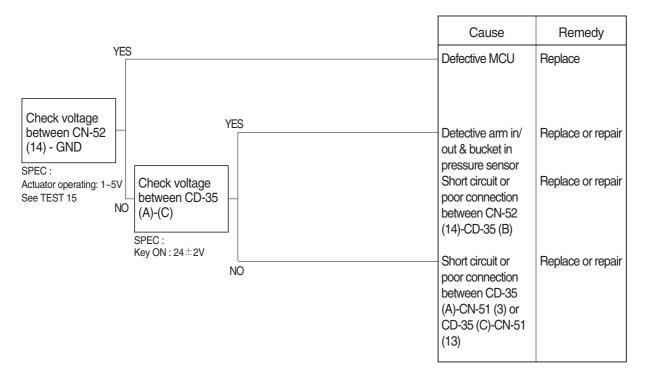
- (1) Test 14: Check voltage at CN-52 (36) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (36) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



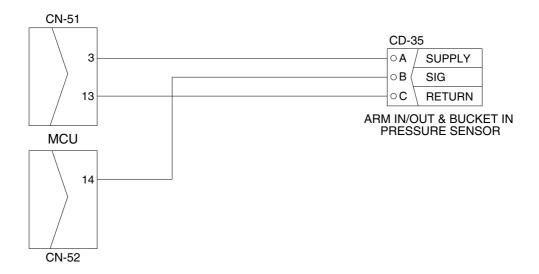
#### 11. MALFUNCTION OF ARM IN/OUT & BUCKET IN PRESSURE SENSOR

- · Fault code: HCESPN 133, FMI 0~4
- ** Before carrying out below procedure, check all the related connectors are properly inserted.

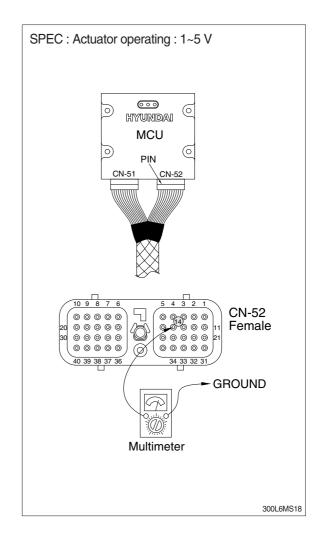
# 1) INSPECTION PROCEDURE



## Wiring diagram



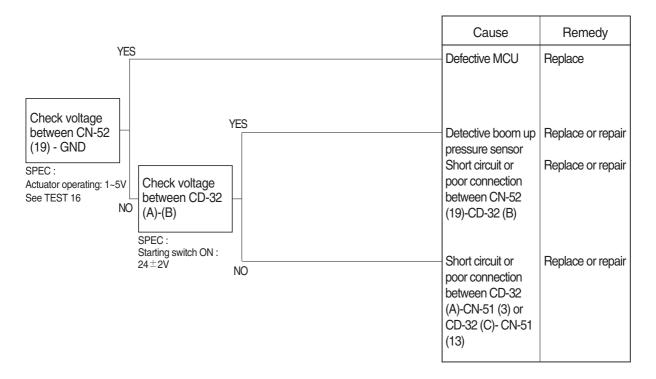
- (1) Test 15: Check voltage at CN-52 (14) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (14) of CN-52.
- ③ Starting switch ON.
- ④ Check voltage as figure.



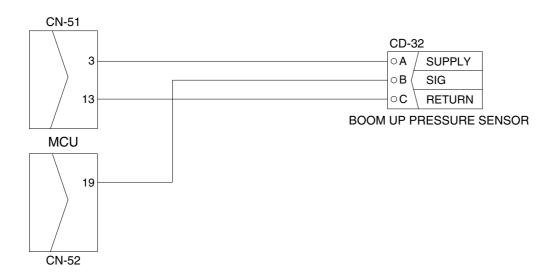
#### 12. MALFUNCTION OF BOOM UP PRESSURE SENSOR

- · Fault code: HCESPN 127, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE



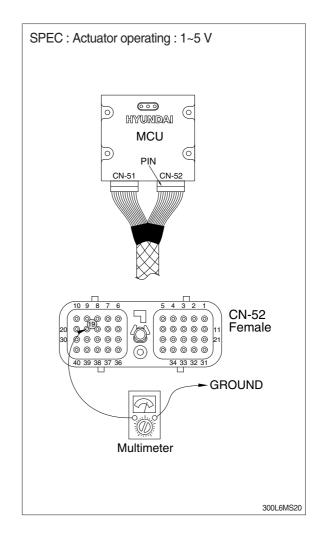
#### Wiring diagram



300L6MS19

#### 2) TEST PROCEDURE

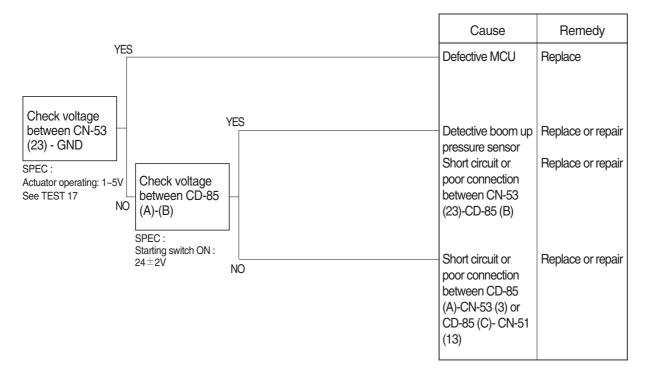
- (1) Test 16: Check voltage at CN-52 (19) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (19) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



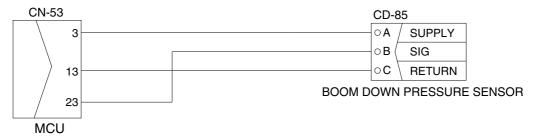
#### 13. MALFUNCTION OF BOOM DOWN PRESSURE SENSOR

- · Fault code: HCESPN 128, FMI 0~4
- * Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE



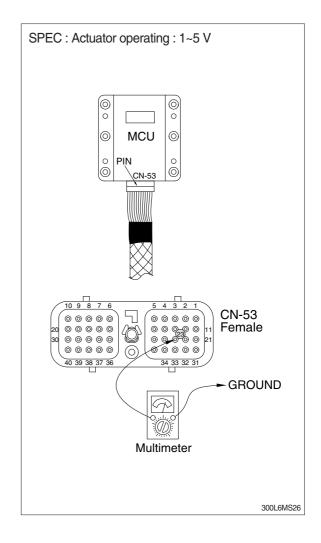
#### Wiring diagram



300L6MS25

#### 2) TEST PROCEDURE

- (1) Test 17: Check voltage at CN-53 (23) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (23) of CN-53.
- ③ Starting switch ON.
- 4 Check voltage as figure.

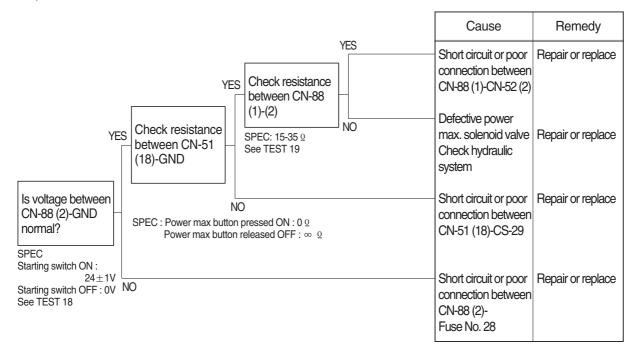


#### 14. MALFUNCTION OF POWER MAX

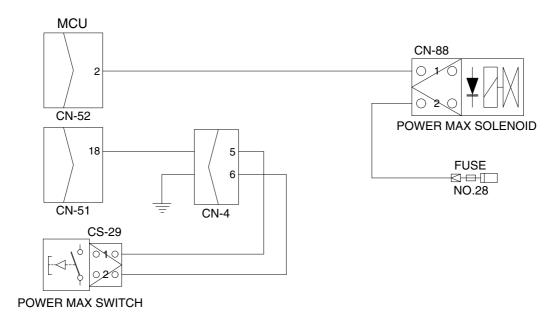
· Fault code: HCESPN 166, FMI 4 or 6

* Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE



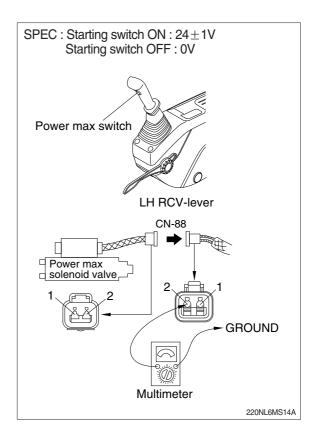
#### Wiring diagram



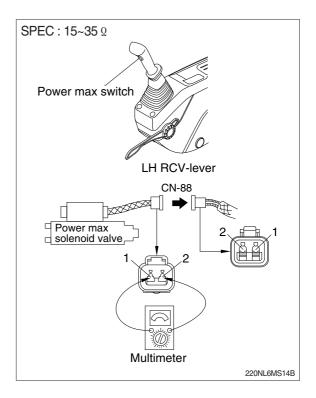
220NL6MS21

#### 2) TEST PROCEDURE

- (1) **Test 18**: Check voltage between connector CN-88 (2) GND.
- ① Disconnect connector CN-88 from power max solenoid valve.
- ② Starting switch ON.
- ③ Check voltage as figure.



- (2) Test 19: Check resistance of the solenoid valve between CN-88 (1)-(2).
- ① Starting switch OFF.
- ② Disconnect connector CN-88 from power max solenoid valve.
- 3 Check resistance as figure.

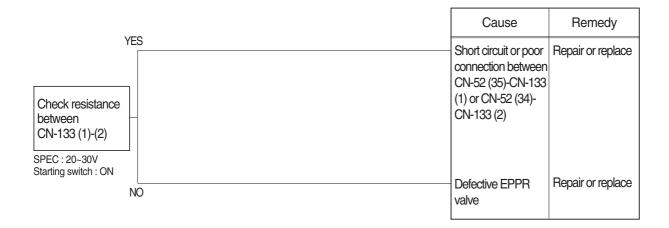


#### 15. MALFUNCTION OF BOOM PRIORITY EPPR VALVE

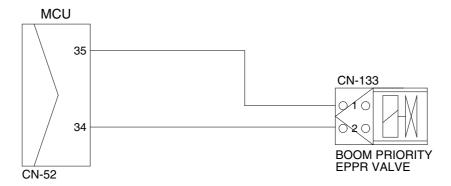
· Fault code: HCESPN 141, FMI 5 or 6

* Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE



#### Wiring diagram



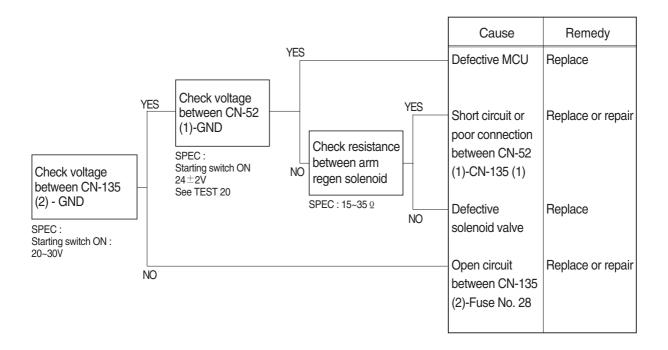
300L6MS23

#### 16. MALFUNCTION OF ARM REGENERATION SOLENOID

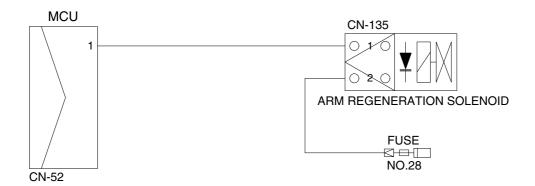
· Fault code: HCESPN 170, FMI 4 or 6

* Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE



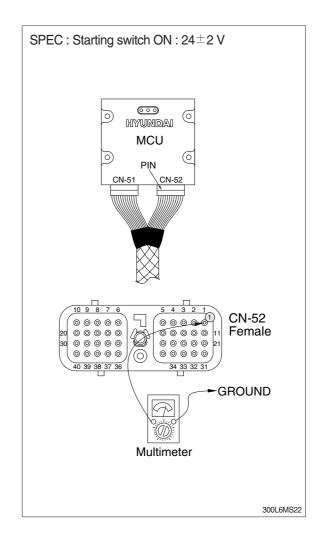
#### Wiring diagram



220NL6MS24

#### 2) TEST PROCEDURE

- (1) Test 20 : Check voltage at CN-52 (1) and ground.
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Insert prepared pin to rear side of connectors: One pin to (1) of CN-52.
- ③ Starting switch ON.
- 4 Check voltage as figure.



## SECTION 7 MAINTENANCE STANDARD

Group	1	Operational Performance Test ·····	7-1
Group	2	Major Components	7-21
Group	3	Track and Work Equipment	7-29

### 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.

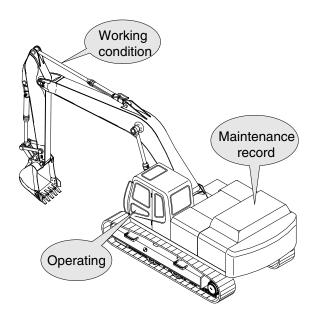
## 2) OPERATIONAL PERFORMANCE OF A WORKING MACHINE

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.

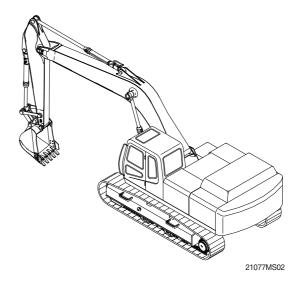


21077MS01

#### 2. TERMINOLOGY

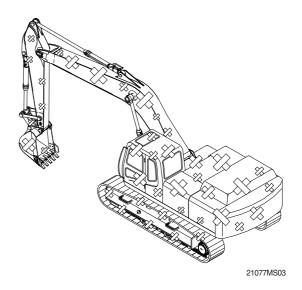
#### 1) STANDARD

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



#### 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.



#### 3. OPERATION FOR PERFORMANCE TESTS

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

#### The machine

(1) 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

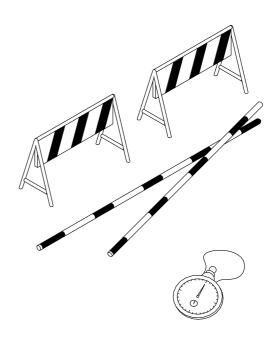
- ① Select a hard, flat surface.
- ② Secure enough space to allow the machine to run straight more than 20m, and to make a full swing with the front attachment extended.
- ③ If required, rope off the test area and provide signboards to keep unauthorized personnel away.

#### (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.

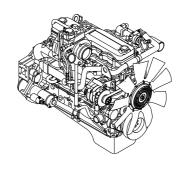
#### (2) Preparation

- 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.
- ① 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
	Start idle	850±100	
	P mode	1800±50	
HX220 NL	S mode	1700±50	
TIAZZU NL	E mode	1600±50	
	Auto decel	1000±100	
	One touch decel	850±100	

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

#### 3) TRAVEL SPEED

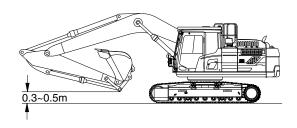
(1) Measure the time required for the excavator to travel a 20 m test track.

#### (2) Preparation

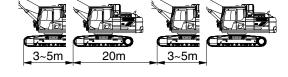
- ① Adjust the tension of both tracks to be equal.
- ② Prepare a flat and solid test track 20 m in length, with extra length of 3 to 5 m on both ends for machine acceleration and deceleration.
- ③ Hold the bucket 0.3 to 0.5 m above the ground with the arm and bucket rolled in.
- 4 Keep the hydraulic oil temperature at  $50\pm5^{\circ}\text{C}$ .



- 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.
- S 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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260A7MS03

#### (4) Evaluation

The average measured time should meet the following specifications.

Unit: Seconds / 20 m

Model	Travel speed	Standard	Maximum allowable	Remarks
LIVOOO NII	1 Speed	20±2.0	25	
HX220 NL	2 Speed	13±1.0	16.3	

#### 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  $50\pm5^{\circ}\text{C}$ .



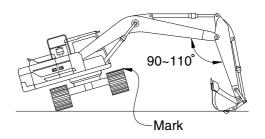
- ① Select the following switch positions.
- · Travel mode switch : 1 or 2 speed
- · Power mode switch : P mode
- · Auto idle switch : OFF
- ② Operate the travel control lever of the raised track in full forward and reverse.
- 3 Rotate 1 turn, then measure time taken for next 3 revolutions.
- ④ Raise the other side of machine and repeat the procedure.
- S 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
HA330 VII	1 Speed	28±2.0	35.0
HX220 NL	2 Speed	18±2.0	22.5



300L7MS04

#### 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.

#### (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.

#### (4) Evaluation

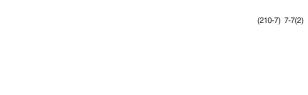
Model

HX220 NL

Mistrack should be within the following specifications.

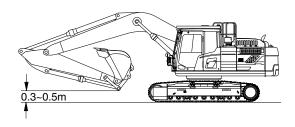
Standard

200 below

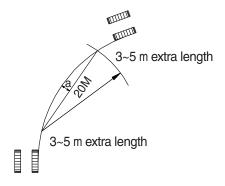


Maximum allowable

240



260A7MS02



Unit: mm/20 m

#### 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.
- 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  $50\pm5^{\circ}\text{C}$ .



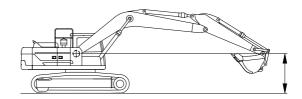
- ① Select the following switch positions.
- · Power mode switch : P mode
- ② Operate swing control lever fully.
- ③ Swing 1 turn and measure time taken to swing next 3 revolutions.
- ④ Repeat steps ② and ③ three time and calculate the average values.

#### (4) Evaluation

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

Unit: Seconds / 3 revolutions

Model Power mode switch		Standard	Maximum allowable
HX220 NL	P mode	16.6±1.5	21



300L7MS05

#### 7) SWING FUNCTION DRIFT CHECK

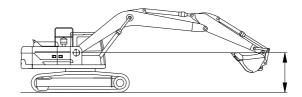
(1) Measure the swing drift on the bearing outer circumference when stopping after a 360° full speed swing.

#### (2) Preparation

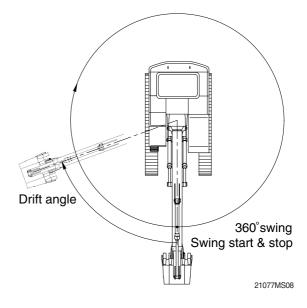
- ① Check the lubrication of the swing gear and swing bearing.
- ② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
- ③ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin. The bucket must be empty.
- 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  $50\pm5^{\circ}$ C.

#### (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.



300L7MS05



#### (4) Evaluation

The measured drift angle should be within the following specifications.

Unit : Degree

Model	Power mode switch	Standard	Maximum allowable	Remarks
HX220 NL	P mode	90 below	157.5	

#### 8) SWING BEARING PLAY

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

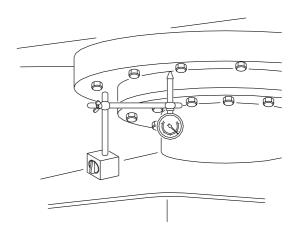
#### (2) Preparation

- 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.

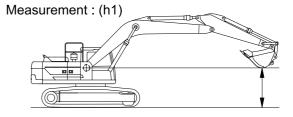
#### (3) Measurement

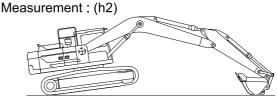
- ① With the arm rolled out and bucket rolled in, hold the bottom face of the bucket to the same height of the boom foot pin.

  Record the dial gauge reading (h1).
- ② Lower the bucket to the ground and use it to raise the front idler 50 cm. Record the dial gauge reading (h2).
- ③ Calculate bearing play (H) from this data (h1 and h2) as follows.
  H=h2-h1



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300L7MS06

#### (4) Evaluation

The measured drift should be within the following specifications.

Unit: mm

Model Standard		Maximum allowable	Remarks
HX220 NL	0.5 ~ 1.5	3.0	

#### 9) HYDRAULIC CYLINDER CYCLE TIME

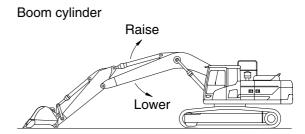
(1) Measure the cycle time of the boom, standard arm, and standard bucket cylinders.

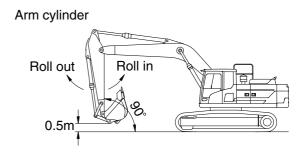
#### (2) Preparation

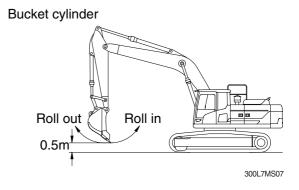
- ① To measure the cycle time of the boom cylinders:
  - With the arm rolled out and the empty bucket rolled out, lower the bucket to the ground, as shown.
- ② To measure the cycle time of the arm cylinder.
  - With the empty bucket rolled in, position the arm so that it is vertical to the ground. Lower 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  $50\pm5^{\circ}\text{C}$ .

#### (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.







#### - 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
	Boom raise		3.3±0.4	4.1	
	Boom lower		2.5±0.4	3.1	
	Arm in	Regen ON	2.9±0.4	3.6	
HX220 NL		Regen OFF	3.2±0.4	4.0	
	Arm out		2.8±0.3	3.5	
	Bucket in		2.3±0.4	2.9	
	Bucket out		2.1±0.3	2.6	_

#### 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= $M^3 \times 1.5$ 

Where:

M³ = Bucket heaped capacity (m³)

1.5 = Soil specific gravity

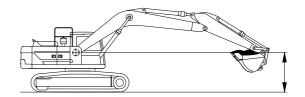
- ② Position the arm cylinder with the rod 20 to 30 mm extended from the fully retracted position.
- ③ Position the bucket cylinder with the rod 20 to 30 mm retracted from the fully extended position.
- With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin.

#### (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: mm/5 min

Model	Drift to be measured	Standard	Maximum allowable	Remarks
	Boom cylinder	10 below	20	
HX220 NL	Arm cylinder	10 below	20	
	Bucket cylinder	40 below	60	



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#### 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  $50\pm5^{\circ}$ 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
	Boom lever	1.7 or below	2.0	
	Arm lever	1.7 or below	2.0	
HX220 NL	Bucket lever	1.4 or below	2.0	
	Swing lever	1.4 or below	2.0	
	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  $50\pm5^{\circ}\text{C}$ .

#### (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
	Boom lever	90±10	112	
	Arm lever	90±10	112	
HX220 NL	Bucket lever	90±10	112	
	Swing lever	90±10	112	
	Travel lever	139±10	178	

#### 13) PILOT PRIMARY PRESSURE

#### (1) Preparation

① Keep the hydraulic oil temperature at  $50\pm5^{\circ}$ C.

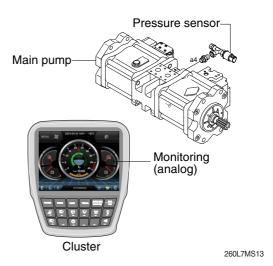
#### (2) Measurement

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.



#### (3) Evaluation

The average measured pressure should meet the following specifications:

Unit: kgf/cm2

Model	Engine speed	Standard	Allowable limits	Remarks
HX220 NL	. P mode	40 +2	-	

#### 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.
- $\bigcirc$  Keep the hydraulic oil temperature at  $50\pm5^{\circ}$ C.

#### (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.

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#### (3) Evaluation

The average measured pressure should be within the following specifications.

Unit: kgf/cm²

Model	Travel speed mode	Standard	Maximum allowable	Remarks
LIVOO NII	1 Speed	0	-	
HX220 NL	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  $50\pm5^{\circ}\text{C}$ .



- 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.

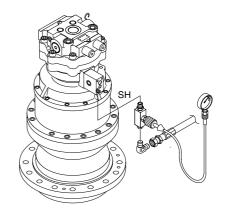
Repeat step ② three times and calculate the average values.



The average measured pressure should be within the following specifications.

Unit: kgf/cm2

Model	Description	Standard	Allowable limits	Remarks
LIVOOO NII	Brake disengaged	30	Over 4	
HX220 NL	Brake applied	0	-	



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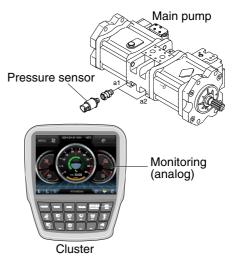
#### 16) MAIN PUMP DELIVERY PRESSURE

#### (1) Preparation

① Keep the hydraulic oil temperature at  $50\pm5^{\circ}$ 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).



260L7MS16

#### (3) Evaluation

The average measured pressure should meet the following specifications.

Unit: kgf/cm²

Model	Engine speed	Standard	Allowable limits	Remarks
HX220 NL	High idle	40±5	-	

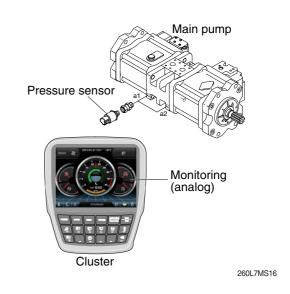
#### 17) SYSTEM PRESSURE REGULATOR RELIEF SETTING

#### (1) Preparation

① Keep the hydraulic oil temperature at  $50\pm5^{\circ}$ 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.



#### (3) Evaluation

The average measured pressure should be within the following specifications.

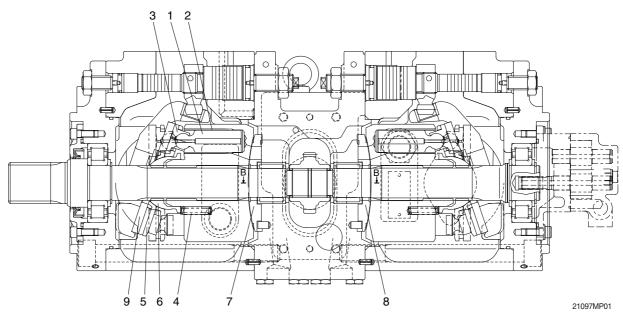
Unit: kgf/cm²

Model	Function to be tested	Standard	Port relief setting
	Boom, Arm, Bucket	350 (380)±10	400±10
HX220 NL	Travel	$350\pm10$	-
	Swing	$265\pm10$	-

( ): Power boost

## **GROUP 2 MAJOR COMPONENT**

#### 1. MAIN PUMP



Part name &	inspection item	Standard dimension	Recommended replacement value	Counter measures
Clearance between piston (1) & cylinder bore (2) (D-d)	d D	0.039	0.067	Replace piston or cylinder.
Play between piston (1) & shoe caulking section (3)		0-0.1	0.3	Replace assembly of
Thickness of shoe (t)	t A	4.9	4.7	piston & shoe.
Free height of cylinder spring (4)		41.1	40.3	Replace cylinder spring.
Combined height of set plate (5) & spherical bushing (6) (H-h)	h H	23.0	22.0	Replace retainer or set plate.
Surface roughness for valve plate (sliding face) (7,8),	Surface roughness necessary to be corrected	3	3z	Laurina
swash plate (shoe plate area) (9), & cylinder (2) (sliding face)	Standard surface roughness (corrected value)	0.4z c	or lower	Lapping

#### 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.
		<ul> <li>Sliding sections of casing hole and spool, especially land sections applied with held pressure.</li> <li>Seal pocket section where spool is inserted.</li> <li>Sealing section of port where O-ring contacts.</li> <li>Sealing section of each relief valve for main and port.</li> <li>Sealing section of plug.</li> <li>Other damages that may damage normal function.</li> </ul>
Spool	Existence of scratch, gnawing, rusting or corrosion.	Replacement when its outside sliding section has scratch (especially on seals-contacting section).
	· O-ring seal sections at both ends.	Replacement when its sliding section has scratch.
	Insert spool into casing hole, rotate and reciprocate it.	Correction or replacement when O-ring is damaged or when spool does not move smoothly.
Poppet	· Damage of spring	· Replacement.
	· Damage of poppet	Correction or replacement when sealing is incomplete.
	· Insert poppet into casing and function it.	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	· External oil leakage.	· Correction or replacement.
for spool	Rusting, corrosion or deformation of seal plate.	Correction or replacement.
Main relief valve,	· External rusting or damage.	· Replacement.
port relief valve & posi-nega	· Contacting face of valve seat.	· Replacement when damaged.
conversion valve	· Contacting face of poppet.	· Replacement when damaged.
	· O-rings and back up rings.	· Replacement in principle.

### 3. SWING DEVICE (TYPE 1, 2)

### 1) WEARING PARTS

Inspection item	Standard dimension	Recommended replacement value	Counter measures
Clearance between piston and cylinder block bore	0.041	0.060	Replace piston or cylinder block
Thickness of valve plate	6	5.88	Replace
Play between piston and shoe caulking section ( $\delta$ )	0.025	0.1	Replace assembly of piston and shoe
Thickness of shoe (t)	6.6	6.5	Replace assembly of piston and shoe
Combined height of retainer plate and spherical bushing (H-h)	17.6	17.3	Replace set of retainer plate and sperical bushing
Thickness of friction plate	2.94	2.7	Replace
t #		Temporal Property of the Control of	↓ ↓h H ↑ ↑
T 140W77MS12			2609A7MS01

## 2) SLIDING PARTS

Part name	Standard roughness	Allowable roughness	Remark
Shoe	Rmax=1S (Ra=0.2a) (LAPPING)	4S (Ra=0.1a)	
Shoe plate	Rmax=0.4S (Ra=0.1a) (LAPPING)	3S (Ra=0.8a)	
Cylinder	Rmax=0.4S (Ra=0.1a) (LAPPING)	3S (Ra=0.8a)	
Valve plate	Rmax=0.4S (Ra=0.1a) (LAPPING)	2S (Ra=0.5a)	

### 4. TRAVEL MOTOR (TYPE 1, 2)

Pr	oblem	Cause	Remedy
Does not start	Pressure is not developed	Pump failure     Control valve malfunction	<ul> <li>Check if action other than traveling is available. If faulty, repair.</li> <li>Check if spool moves correctly. Repair if necessary.</li> </ul>
	Pressure in developed	<ul> <li>Brake valve failure</li> <li>-Sleeve stick</li> <li>-Check valve stick</li> <li>Motor failure</li> <li>-Valve seat seizure</li> <li>Gear broken and fragment locked</li> <li>Overloaded</li> </ul>	<ul> <li>Replace brake valve</li> <li>Replace    <ul> <li>Check hydraulic oil for contamination</li> <li>Replace reduction gear</li> <li>Reduce load</li> </ul> </li> </ul>
Oil leakage	Leakage from engaging surfaces	<ul><li>Scratch on engaging surfaces</li><li>Loosening by poor bolt tightening</li></ul>	<ul><li>Correct surfaces by oilstone or sandpaper or replace</li><li>Check after retightening</li></ul>
	Leakage from casing	· Plug loosened · Crack formed by stone	· Retighten · Replace reduction gear
	Leakage from floating seal	· Sliding surfaces worn · Creep on O-ring	Replace reduction gear     Replace floating seal
	Leakage from hydraulic motor	Bolt loosened     O-ring damaged     Sealing surface scratched	<ul><li>Tighten properly</li><li>Replace O-ring</li><li>Correct by oilstone or sandpaper</li></ul>
Coasts on s	lope excessively	<ul> <li>Poor volumetric efficiency of hydraulic motor</li> <li>Increase of internal leakage of brake valve</li> <li>Parking brake not actuated</li> <li>Spring breakage</li> <li>Wear of friction plate</li> </ul>	
Excessive to reduction ge	emperature on ear case	<ul><li>Pitting on bearing</li><li>Lack of gear oil</li><li>Hydraulic oil introduced to gear case</li></ul>	<ul><li>Replace reduction gear</li><li>Supply gear oil properly</li><li>Check motor and replace oil seal</li></ul>
Meanders	Meanders at low pressure	<ul> <li>Delivery rate is different between right and left</li> <li>Motor drain rate is different between right and left</li> </ul>	
	Meanders at high pressure	<ul> <li>Delivery rate is different between right and left</li> <li>Motor drain rate is different between right and left</li> </ul>	, ,
	Meanders at high pressure	<ul> <li>Relief pressure dropped at right and left brake valve</li> <li>Main relief pressure dropped at right or left of control valve</li> </ul>	
Pump delivery is poor		Regulator operation poor     External leakage of pump is excessive	· Repair regulator · Repair pump
External leakage of motor is excessive		-	· Replace motor

#### 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 : 40 kgf/cm² Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than 10 $\mu$ m, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	1 mm	
	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 : 40 kgf/cm² Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than $10\mu$ m, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	1 mm	
	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

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

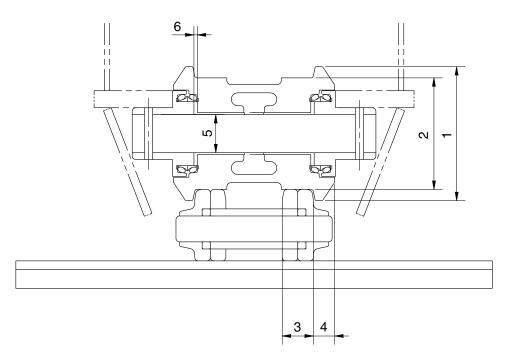
### 8. CYLINDER

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

# **GROUP 3 TRACK AND WORK EQUIPMENT**

#### 1. TRACK

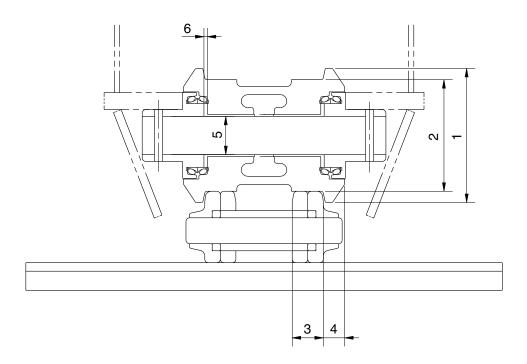
### 1) TRACK ROLLER (-#0133)



Unit:mm

No.	Check item		Criteria				
4	Outside dispersion of florers	Standard size		Repair limit			
'	Outside diameter of flange	Ø1	95	_			
2	Outside diameter of tread	Ø1	60	Ø.	Ø148		
3	Width of tread	44		50		replace	
4	Width of flange	33.3		-			
		Standard size	e & tolerance	Standard	Clearance		
5	Clearance between shaft	Shaft	Hole	clearance	limit	Replace	
	and bushing		Ø70 +0.35 +0.3	0.32 ~ 0.38	2.0	bushing	
6	Side clearance of roller	Standard clearance		Clearance limit		Doploso	
0	(both side)	0.26 ~	0.26 ~ 1.22		.0	Replace	

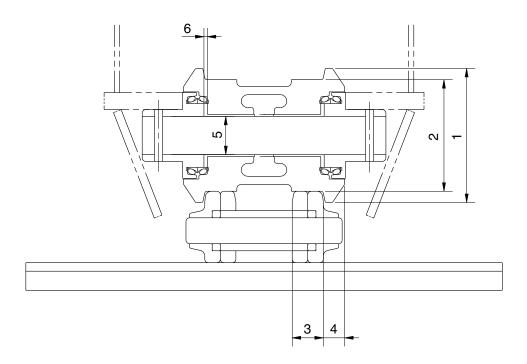
# TRACK ROLLER (#0134-)



Unit: mm

No.	Check item		Criteria				
4	Outside dismeter of flance	Standa	Standard size		Repair limit		
	Outside diameter of flange	Ø1	85	-	_		
2	Outside diameter of tread	Ø1	50	Ø138		Rebuild or replace	
3	Width of tread	45		51		Toplado	
4	Width of flange	29		-			
		Standard size	e & tolerance	Standard	Clearance		
5	Clearance between shaft	Shaft	Hole	clearance	limit	Replace	
	and bushing	Ø65 0 -0.03	Ø65 +0.37 +0.32	0.32 ~ 0.4	2.0	bushing	
6	Side clearance of roller	Standard clearance		Clearance limit		Doploos	
0	(both side)	0.23 ~	0.23 ~ 1.32		.0	Replace	

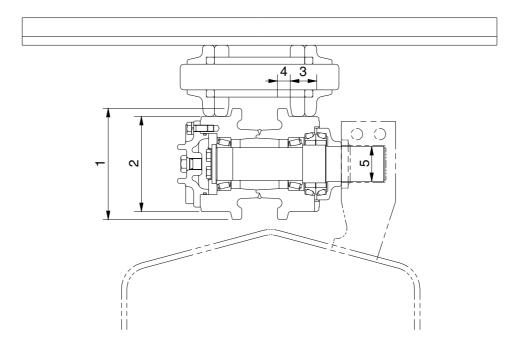
# TRACK ROLLER (#0134-)



Unit: mm

No.	Check item		Criteria				
4	Outside dismeter of flores	Standa	rd size	Repair limit			
	Outside diameter of flange	Ø1	85	-	_		
2	Outside diameter of tread	Ø1	50	Ø.	138	Rebuild or replace	
3	Width of tread	45		51			
4	Width of flange	29		-			
		Standard size	e & tolerance	Standard	Clearance		
5	Clearance between shaft	Shaft	Hole	clearance	limit	Replace	
	and bushing	Ø65 0 -0.03	Ø65 +0.37 +0.32	0.32 ~ 0.4	2.0	bushing	
6	Side clearance of roller	Standard clearance		Clearance limit		Doploos	
0	(both side)	0.23 ~	- 1.32	2	.0	Replace	

# 2) CARRIER ROLLER

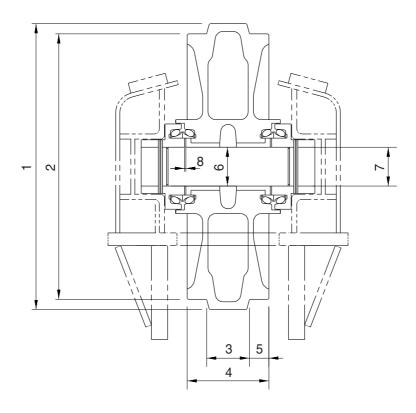


21037MS02

Unit: mm

No.	Check item		Criteria				
_	Outside diameter of flance	Standa	Standard size			Repair limit	
'	Outside diameter of flange	Ø	ø 169		-		D.J. T.L.
2	Outside diameter of tread	ø 144			ø 134		Rebuild or replace
3	Width of tread	4	14		49		'
4	Width of flange	•	17			-	
	Standard size Toleran		Tolerance		Standard	Clearance	
5	Clearance between shaft	Stariuaru Size	Shaft	Hole	clearance	limit	Replace
	and bushing	ø 55	-0.05 -0.1	+0.3 +0.1	0.15 to 0.4	1.2	bushing

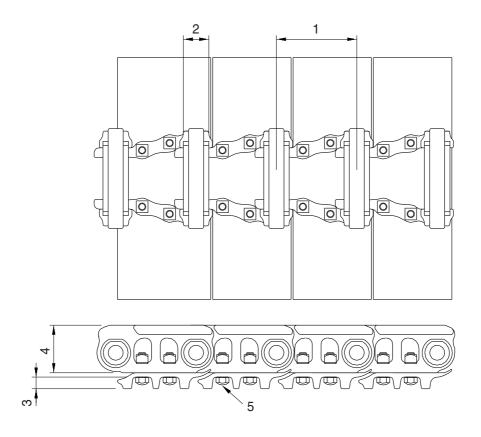
# 3) IDLER



Unit: mm

No.	Check item		Criteria			
_	Outside disposits a function	Standa	Standard size		Repair limit	
1	Outside diameter of protrusion	Ø	560		-	
2	Outside diameter of tread	Ø	520	ø.	ø 510	
3	Width of protrusion	3	34		-	replace
4	Total width	160		-		
5	Width of tread	3	38	43		
		Standard siz	e & tolerance	Standard	Clearance	
6	Clearance between shaft	Shaft	Hole	clearance	limit	Replace
	and bushing	ø 75 _{-0.03}	ø 75.35 ^{+0.05}	0.35 to 0.43	2.0	bushing
7	Clearance between shaft and support	ø 75 _{-0.03}		0.03 to 0.1	1.2	Replace
8	Side clearance of idler	Standard	clearance	Clearance limit		Replace
8	(both side)	0.25	to 1.2	2.	0	bushing

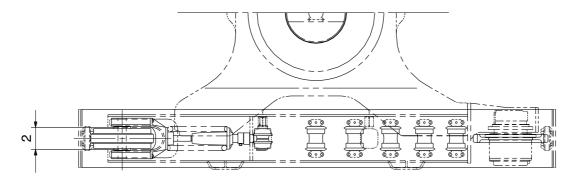
# 4) TRACK

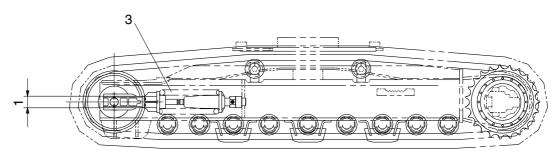


Unit: mm

No.	Check item	Crit	Remedy			
1	Link nitch	Standard size	Repair limit	Turn or		
'	1 Link pitch	190	194.4	replace		
2	Outside diameter of bushing	ø 59	ø 59 ø 51			
3	Height of grouser	26	16	Rebuild or replace		
4	Height of link	105	97	'		
5	Tightening torque	Initial tightening torque : $78\pm$	Retighten			

### 5) TRACK FRAME AND RECOIL SPRING

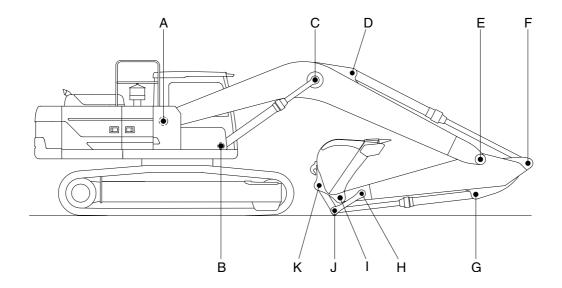




Unit: mm

No.	Check item		Criteria					Remedy
			Standar	d size	Tole	erance	Repair limit	
1	Vertical width of idler guide	Track frame	e 110	3		+2	117	
		Idler suppo	rt 110	0	- 0.5 - 1.0		106	Rebuild or replace
2	Harizantal width of idlar quida	Track fram	e 272	2		+2	276	Торіасс
2	Horizontal width of idler guide	Idler suppo	rt 270	)		-	267	
		Standard size			Repair limit			
3	Recoil spring	Free length	Installation length	Installa loa		Free length	Installation load	Replace
		ø 235×515	431	1371	6kg	-	10973kg	

### 2. WORK EQUIPMENT



260L7MS20

Unit: mm

			Р	in	Bus	hing	Deved
Mark	Measuring point (Pin and Bushing)	Normal value	Recomm. service limit	Limit of use	Recomm. service limit	Limit of use	Remedy & Remark
Α	Boom Rear	90	89	88.5	90.5	91	Replace
В	Boom Cylinder Head	80	79	78.5	80.5	81	"
С	Boom Cylinder Rod	80	79	78.5	80.5	81	"
D	Arm Cylinder Head	80	79	78.5	80.5	81	"
Е	Boom Front	90	89	88.5	90.5	91	"
F	Arm Cylinder Rod	80	79	78.5	80.5	81	"
G	Bucket Cylinder Head	80	79	78.5	80.5	81	"
Н	Arm Link	70	69	68.5	70.5	71	"
I	Bucket and Arm Link	80	79	78.5	80.5	81	"
J	Bucket Cylinder Rod	80	79	78.5	80.5	81	"
K	Bucket Link	80	79	78.5	80.5	81	"

# SECTION 8 DISASSEMBLY AND ASSEMBLY

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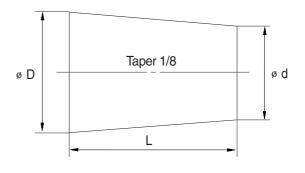
### SECTION 8 DISASSEMBLY AND ASSEMBLY

#### **GROUP 1 PRECAUTIONS**

#### 1. REMOVAL WORK

- Lower the work equipment completely to the ground.
   If the coolant contains antifreeze, dispose of it correctly.
- 2) After disconnecting hoses or tubes, cover them or fit blind plugs to prevent dirt or dust from entering.
- 3) When draining oil, prepare a container of adequate size to catch the oil.
- 4) Confirm the match marks showing the installation position, and make match marks in the necessary places before removal to prevent any mistake when assembling.
- 5) To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors.
- 6) Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
- 7) Check the number and thickness of the shims, and keep in a safe place.
- 8) When raising components, be sure to use lifting equipment of ample strength.
- 9) When using forcing screws to remove any components, tighten the forcing screws alternately.
- 10) Before removing any unit, clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.
- 11) When removing hydraulic equipment, first release the remaining pressure inside the hydraulic tank and the hydraulic piping.
- 12) If the part is not under hydraulic pressure, the following corks can be used.

Nominal		Dimensions			
number	D	d	L		
06	6	5	8		
08	8	6.5	11		
10	10	8.5	12		
12	12	10	15		
14	14	11.5	18		
16	16	13.5	20		
18	18	15	22		
20	20	17	25		
22	22	18.5	28		
24	24	20	30		
27	27	27 22.5			



#### 2. INSTALL WORK

- 1) Tighten all bolts and nuts (sleeve nuts) to the specified torque.
- 2) Install the hoses without twisting or interference.
- 3) Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
- 4) Bend the cotter pin or lock plate securely.
- 5) When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2-3 drops of adhesive.
- 6) When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
- 7) Clean all parts, and correct any damage, dents, burrs, or rust.
- 8) Coat rotating parts and sliding parts with engine oil.
- 9) When press fitting parts, coat the surface with antifriction compound (LM-P).
- 10) After installing snap rings, check that the snap ring is fitted securely in the ring groove (Check that the snap ring moves in the direction of rotation).
- 11) When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
- 12) When using eyebolts, check that there is no deformation or deterioration, and screw them in fully.
- 13) When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.
- 14) When operating the hydraulic cylinders for the first time after repairing and reassembling the hydraulic cylinders, pumps, or other hydraulic equipment or piping, always bleed the air from the hydraulic cylinders as follows:
- (1) Start the engine and run at low idling.
- (2) Operate the control lever and actuate the hydraulic cylinder 4-5 times, stopping 100mm before the end of the stroke.
- (3) Next, operate the piston rod to the end of its stroke to relieve the circuit. (The air bleed valve is actuated to bleed the air.)
- (4) After completing this operation, raise the engine speed to the normal operating condition.
- * If the hydraulic cylinder has been replaced, carry out this procedure before assembling the rod to the work equipment.
- * Carry out the same operation on machines that have been in storage for a long time after completion of repairs.

#### 3. COMPLETING WORK

- 1) If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.
- 2) If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
- 3) If the piping or hydraulic equipment, such as hydraulic cylinders, pumps, or motors, have been removed for repair, always bleed the air from the system after reassembling the parts.
- 4) Add the specified amount of grease (molybdenum disulphied grease) to the work equipment related parts.

# GROUP 2 TIGHTENING TORQUE

#### 1. MAJOR COMPONENTS

NI.		Provide trans	Delta's	Tor	que
No.		Descriptions	Bolt size	kgf · m	lbf ⋅ ft
1		Engine mounting bolt (engine-bracket)	M12 × 1.75	11.5± 1.0	82.8 ± 7.2
2		Engine mounting bolt (bracket-frame)	M20 × 2.5	52.1 ± 5.0	377 ± 36.2
3	Engine	Radiator mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
4		Coupling mounting socket bolt	M18 × 2.5	32 ±1.0	231 ± 7.2
5		Fuel tank mounting bolt	M20 × 2.5	46 $\pm$ 5.1	333 ± 36.9
6		Main pump housing mounting bolt	M10 × 1.5	6.9 ± 0.5	50 ± 3.6
7		Main pump mounting socket bolt	M20 × 2.5	52.1 $\pm$ 5	377 ± 36.1
8	Hydraulic system	Main control valve mounting bolt	M12 × 1.75	12.3 $\pm$ 1.3	89.0 ± 9.4
9	- cyclom	Hydraulic oil tank mounting bolt	M20 × 2.5	46 ± 5.1	333 ± 36.9
10		Turning joint mounting bolt, nut	M12 × 1.75	12.3 $\pm$ 1.3	89.0 ± 9.4
11		Swing motor mounting bolt	M20 × 2.5	57.9 ± 5.8	419 ± 42
12	Power	Swing bearing upper part mounting bolt	M20 × 2.5	$57.9 \pm 6.0$	419 ± 43.3
13	train	Swing bearing lower part mounting bolt	M20 × 2.5	$57.9 \pm 6.0$	419 ± 43.3
14	system	Travel motor mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
15		Sprocket mounting bolt	M16 × 2.0	$29.7\pm3.0$	215 ± 21.7
16		Carrier roller mounting bolt, nut	M16 × 2.0	$29.7\pm3.0$	215 ± 21.7
17		Track roller mounting bolt	M20 × 2.5	$57.9 \pm 6.0$	419 ± 43.4
18	Under carriage	Track tension cylinder mounting bolt	M16 × 2.0	$29.7\pm4.5$	215 ± 32.5
19	camago	Track shoe mounting bolt, nut	M20 × 1.5	57.9 ± 5.8	419 ± 41.9
20		Track guard mounting bolt	M20 × 2.5	57.9 ± 5.8	419 ± 41.9
21		Counterweight mounting bolt	M36 × 3.0	377 ± 33	2727 ± 239
22	Others	Cab mounting bolt	M12 × 1.75	12.3 $\pm$ 1.3	88.9 ± 9.4
23		Operator's seat mounting bolt	M10 × 1.5	$6.9\pm0.5$	49.9 ± 3.6

^{*} For tightening torque of engine and hydraulic components, see engine maintenance guide and service manual.

### 2. TORQUE CHART

Use following table for unspecified torque.

# 1) BOLT AND NUT

### (1) Coarse thread

Dolt size	8.8T		10	.9T	12.9T		
Bolt size	kgf⋅m	lbf∙ft	kgf⋅m	lbf∙ft	kgf⋅m	lbf∙ft	
M 6×1.0	0.8 ~ 1.2	5.8 ~ 8.6	1.2 ~ 1.8	8.7 ~ 13.0	1.5 ~ 2.1	10.9 ~ 15.1	
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.6	2.8 ~ 4.2	20.3 ~ 30.4	3.4 ~ 5.0	24.6 ~ 36.1	
M10 × 1.5	4.0 ~ 6.0	29.0 ~ 43.3	5.6 ~ 8.4	40.5 ~ 60.8	6.8 ~ 10.0	49.2 ~ 72.3	
M12 × 1.75	6.8 ~ 10.2	50.0 ~ 73.7	9.6 ~ 14.4	69.5 ~ 104	12.3 ~ 16.5	89.0 ~ 119	
M14 × 2.0	10.9 ~ 16.3	78.9 ~ 117	16.3 ~ 21.9	118 ~ 158	19.5 ~ 26.3	141 ~ 190	
M16 × 2.0	17.9 ~ 24.1	130 ~ 174	25.1 ~ 33.9	182 ~ 245	30.2 ~ 40.8	141 ~ 295	
M18 × 2.5	24.8 ~ 33.4	180 ~ 241	34.8 ~ 47.0	252 ~ 340	41.8 ~ 56.4	302 ~ 407	
M20 × 2.5	34.9 ~ 47.1	253 ~ 340	49.1 ~ 66.3	355 ~ 479	58.9 ~ 79.5	426 ~ 575	
M22 × 2.5	46.8 ~ 63.2	339 ~ 457	65.8 ~ 88.8	476 ~ 642	78.9 ~ 106	570 ~ 766	
M24 × 3.0	60.2 ~ 81.4	436 ~ 588	84.6 ~ 114	612 ~ 824	102 ~ 137	738 ~ 991	
M30 × 3.5	120 ~ 161	868 ~ 1164	168 ~ 227	1216 ~ 1641	202 ~ 272	1461 ~ 1967	

### (2) Fine thread

Dolt size	8.8	ВТ	10	.9T	12.9T		
Bolt size	kgf · m	lbf ⋅ ft	kgf · m	lbf ⋅ ft	kgf · m	lbf · ft	
M 8 × 1.0	2.1 ~ 3.1	15.2 ~ 22.4	3.0 ~ 4.4	21.7 ~ 31.8	3.6 ~ 5.4	26.1 ~ 39.0	
M10 × 1.25	4.2 ~ 6.2	30.4 ~ 44.9	5.9 ~ 8.7	42.7 ~ 62.9	7.0 ~ 10.4	50.1 ~ 75.2	
M12 × 1.25	7.3 ~ 10.9	52.8 ~ 78.8	10.3 ~ 15.3	74.5 ~ 110	13.1 ~ 17.7	94.8 ~ 128	
M14 × 1.5	12.4 ~ 16.6	89.7 ~ 120	17.4 ~ 23.4	126 ~ 169	20.8 ~ 28.0	151 ~ 202	
M16 × 1.5	18.7 ~ 25.3	136 ~ 182	26.3 ~ 35.5	191 ~ 256	31.6 ~ 42.6	229 ~ 308	
M18 × 1.5	27.1 ~ 36.5	196 ~ 264	38.0 ~ 51.4	275 ~ 371	45.7 ~ 61.7	331 ~ 446	
M20 × 1.5	37.7 ~ 50.9	273 ~ 368	53.1 ~ 71.7	384 ~ 518	63.6 ~ 86.0	460 ~ 622	
M22 × 1.5	51.2 ~ 69.2	370 ~ 500	72.0 ~ 97.2	521 ~ 703	86.4 ~ 116	625 ~ 839	
M24 × 2.0	64.1 ~ 86.5	464 ~ 625	90.1 ~ 121	652 ~ 875	108 ~ 146	782 ~ 1056	
M30 × 2.0	129 ~ 174	933 ~ 1258	181 ~ 245	1310 ~ 1772	217 ~ 294	1570 ~ 2126	

# 2) PIPE AND HOSE (FLARE TYPE)

Thread size (PF)	Width across flat (mm)	kgf ⋅ m	lbf ⋅ ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130.2
1"	41	21	151.9
1-1/4"	50	35	253.2

### 3) PIPE AND HOSE (ORFS TYPE)

Thread size (UNF)	Width across flat (mm)	kgf ⋅ m	lbf ⋅ ft
9/16-18	19	4	28.9
11/16-16	22	5	36.2
13/16-16	27	9.5	68.7
1-3/16-12	36	18	130.2
1-7/16-12	41	21	151.9
1-11/16-12	50	35	253.2

### 4) FITTING

Thread size	Width across flat (mm)	kgf ⋅ m	lbf ⋅ ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130.2
1"	41	21	151.9
1-1/4"	50	35	253.2

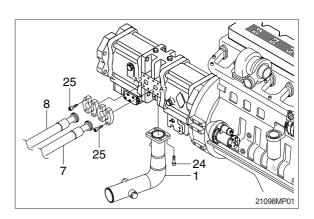
#### **GROUP 3 PUMP DEVICE**

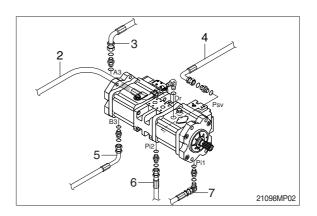
#### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
- (4) Remove the wirings for the pressure sensors and so on.
- (5) Loosen the drain plug under the hydraulic tank and drain the oil from the hydraulic tank.
  - Hydraulic tank quantity: 160 l
- (6) Remove socket bolts (25) and disconnect pipe (7, 8).
- (7) Disconnect pilot line hoses (2, 3, 4, 5, 6, 7).
- (8) Remove socket bolts (24) and disconnect pump suction tube (1).
- When pump suction tube is disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (9) Sling the pump assembly and remove the pump mounting bolts.
  - Weight: 140 kg (310 lb)
- ** Pull out the pump assembly from housing. When removing the pump assembly, check that all the hoses have been disconnected.





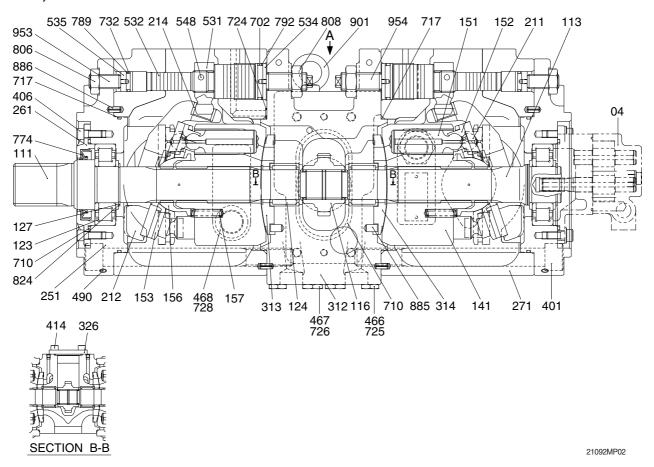


#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Remove the suction strainer and clean it.
- (3) Replace return filter with new one.
- (4) Remove breather and clean it.
- (5) After adding oil to the hydraulic tank to the specified level.
- (6) Bleed the air from the hydraulic pump.
- ① Remove the air vent plug (2EA).
- ② Tighten plug lightly.
- ③ Start the engine, run at low idling, and check oil come out from plug.
- 4 Tighten plug.
- (7) Start the engine, run at low idling (3~5 minutes) to circulate the oil through the system.
- (8) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

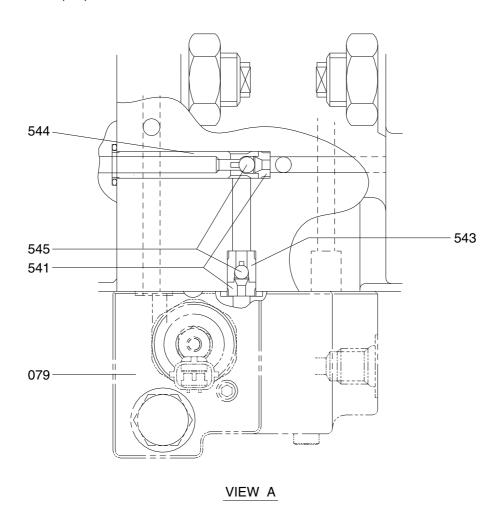
### 2. MAIN PUMP (1/2)

#### 1) STRUCTURE



04	Gear pump	271	Pump casing	710	O-ring
111	Drive shaft (F)	312	Valve block	717	O-ring
113	Drive shaft (R)	313	Valve plate (R)	724	O-ring
116	Gear	314	Valve plate (L)	725	O-ring
123	Roller bearing	326	Cover	726	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Bearing spacer	406	Hexagon socket bolt	732	O-ring
141	Cylinder block	414	Hexagon socket bolt	774	Oil seal
151	Piston	466	VP Plug	789	Back up ring
152	Shoe	467	VP plug	792	Back up ring
153	Set plate	468	VP Plug	806	Hexagon head nut
156	Bushing	490	Plug	808	Hexagon head nut
157	Cylinder spring	531	Tilting pin	824	Snap ring
211	Shoe plate	532	Servo piston	885	Pin
212	Swash plate	534	Stopper (L)	886	Spring pin
214	Bushing	535	Stopper (S)	901	Eye bolt
251	Support	548	Pin	953	Set screw
261	Seal cover (F)	702	O-ring	954	Set screw

# MAIN PUMP (2/2)



541 Seat
542 Stopper 2
543 Stopper 1
544 Stopper 2
545 Steel ball

21092MP08

### 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

The tools necessary to disassemble/reassemble the pump are shown in the follow list.

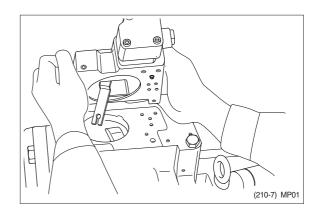
Tool name & size		Part name						
Name	В	Hexagon socket head bolt		PT plug T thread)	PO plug (PF thread)		Hexagon socket head setscrew	
Allen wrench	4	M 5	Е	3P-1/16	-		M 8	
	5	M 6	Е	3P-1/8	-		M10	
	6	M 8	Е	3P-1/4	PO-1/4	ŀ	M12, M14	
- B -	8	M10	Е	3P-3/8	PO-3/8	3	M16, M18	
	17	M20, M22	Е	3P-1	PO-1, 1 1/4,	1 1/2	-	
Double ring spanner, socket wrench, double (single)	-	Hexagon socket head bolt		Hexagon nut			VP plug (PF thread)	
open end spanner	19	M12		M12		VP-1/4		
D.	24	M16		M16		-		
- B	27	M18		M18		VP-1/2		
	30	M20		M	120	-		
	36	-		-		VP-3/4		
Adjustable angle wrench		Medium size, 1 set						
Screw driver		Minus type screw driver, Medium size, 2 sets						
Hammer		Plastic hammer, 1 set						
Pliers		For snap ring, TSR-160						
Steel bar		Steel bar of key material approx. 10 × 8 × 200						
Torque wrench		Capable of tightening with the specified torques						

# (2) Tightening torque

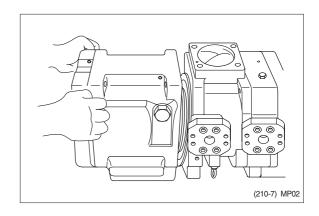
Part name	Dolt size	Tor	que	Wrench size		
Part name	Bolt size	kgf⋅m	lbf ⋅ ft	in	mm	
Hexagon socket head bolt	M 5	0.7	5.1	0.16	4	
(Material : SCM435)	M 6	1.2	8.7	0.20	5	
	M 8	3.0	21.7	0.24	6	
	M10	5.8	42.0	0.31	8	
	M12	10.0	72.3	0.39	10	
	M14	16.0	116	0.47	12	
	M16	24.0	174	0.55	14	
	M18	34.0	246	0.55	14	
	M20	44.0	318	0.67	17	
PT Plug (Material : S45C)	PT1/16	0.7	5.1	0.16	4	
Wind a seal tape 1 1/2 to	PT 1/8	1.05	7.59	0.20	5	
2 turns round the plug	PT 1/4	1.75	12.7	0.24	6	
	PT 3/8	3.5	25.3	0.31	8	
	PT 1/2	5.0	36.2	0.39	10	
PF Plug (Material : S45C)	PF 1/4	3.0	21.7	0.24	6	
	PF 1/2	10.0	72.3	0.39	10	
	PF 3/4	15.0	109	0.55	14	
	PF 1	19.0	137	0.67	17	
	PF 1 1/4	27.0	195	0.67	17	
	PF 1 1/2	28.0	203	0.67	17	

#### 3) DISASSEMBLY

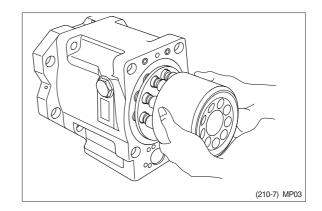
- (1) Select place suitable to disassembling.
- * Select clean place.
- Spread rubber sheet, cloth or so on on overhaul workbench top to prevent parts from being damaged.
- (2) Remove dust, rust, etc, from pump surfaces with cleaning oil or so on.
- (3) Remove drain port plug (468) and let oil out of pump casing (front and rear pump).
- (4) Remove hexagon socket head bolts (412, 413) and remove regulator.



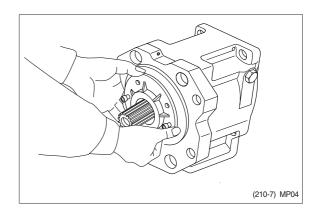
- (5) Loosen hexagon socket head bolts (401) which tighten swash plate support (251), pump casing (271) and valve block (312).
- * If gear pump and so on are fitted to rear face of pump, remove them before starting this work.
- (6) Place pump horizontally on workbench with its regulator-fitting surface down and separate pump casing (271) from valve block (312).
- ** Before bringing this surface down, spread rubber sheet on workbench without fail to prevent this surface from being damaged.

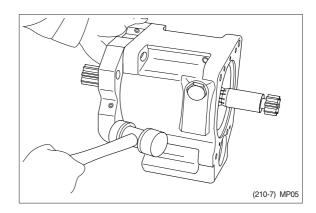


- (7) Pull cylinder block (141) out of pump casing (271) straightly over drive shaft (111). Pull out also pistons (151), set plate (153), spherical bush (156) and cylinder springs (157) simultaneously.
- * Take care not to damage sliding surfaces of cylinder, spherical bushing, shoes, swash plate, etc.

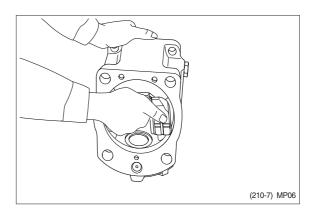


- (8) Remove hexagon socket head bolts (406) and then seal cover (F, 261).
- Fit bolt into pulling out tapped hole of seal cover (F), and cover can be removed easily.
- Since oil seal is fitted on seal cover (F), take care not to damage it in removing cover.
- (9) Remove hexagon socket head bolts (408) and then seal cover (R, 262).In case fitting a gear pump, first, remove gear pump.
- (10) Tapping lightly fitting flange section of swash plate support (251) on its pump casing side, separate swash plate support from pump casing.

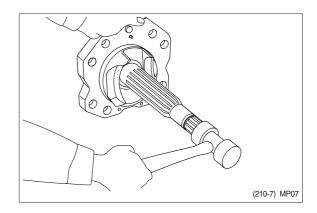




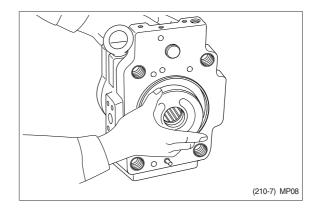
(11) Remove shoe plate (211) and swash plate (212) from pump casing (271).



(12) Tapping lightly shaft ends of drive shafts (111, 113) with plastic hammer, take out drive shafts from swash plate supports.



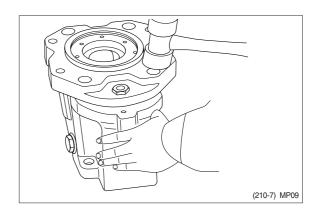
- (13) Remove valve plates (313, 314) from valve block (312).
- * These may be removed in work (6).



- (14) If necessary, remove stopper (L, 534), stopper (S, 535), servo piston (532) and tilting pin (531) from pump casing (271), and needle bearing (124) and splined coupling (114) from valve block (312).
- In removing tilting pin, use a protector to prevent pin head from being damaged.
- Since loctite is applied to fitting areas of tilting pin and servo piston, take care not to damage servo piston.
- ** Do not remove needle bearing as far as possible, except when it is considered to be out of its life span.
- ** Do not loosen hexagon nuts of valve block and swash plate support.
  If loosened, flow setting will be changed.

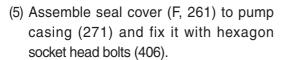
#### 4) ASSEMBLY

- (1) For reassembling reverse the disassembling procedures, paying attention to the following items.
- ① Do not fail to repair the parts damaged during disassembling, and prepare replacement parts in advance.
- ② Clean each part fully with cleaning oil and dry it with compressed air.
- ③ Do not fail to apply clean working oil to sliding sections, bearings, etc. before assembling them.
- ④ In principle, replace seal parts, such as O-rings, oil seals, etc.
- ⑤ For fitting bolts, plug, etc., prepare a torque wrench or so on, and tighten them with torques shown in page 8-11, 12.
- ⑤ For the double-pump, take care not to mix up parts of the front pump with those of the rear pump.
- (2) Fit swash plate support (251) to pump casing (271), tapping the former lightly with a hammer.
- ** After servo piston, tilting pin, stopper (L) and stopper (S) are removed, fit them soon to pump casing in advance for reassembling.
- In tightening servo piston and tilting pin, use a protector to prevent tilting pin head and feedback pin from being damaged. In addition, apply loctite (Medium strength) to their threaded sections.



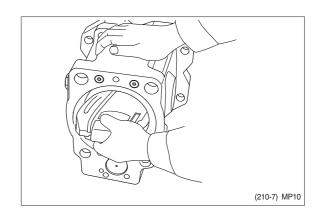
- (3) Place pump casing with its regulator fitting surface down, fit tilting bush of swash plate to tilting pin (531) and fit swash plate (212) to swash plate support (251) correctly.
- * Confirm with fingers of both hands that swash plate can be removed smoothly.
- * Apply grease to sliding sections of swash plate and swash plate support, and drive shaft can be fitted easily.
- (4) To swash plate support (251), fit drive shaft (111) set with bearing (123), bearing spacer (127) and snap ring (824).
- * Do not tap drive shaft with hammer or so on.
- * Assemble them into support, tapping outer race of bearing lightly with plastic hammer.

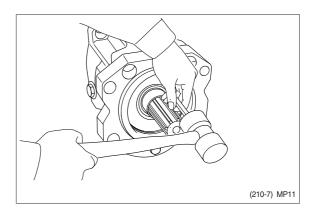
Fit them fully, using steel bar or so on.

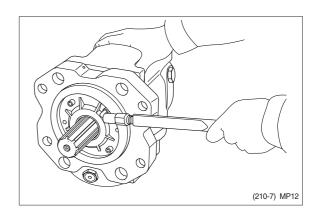


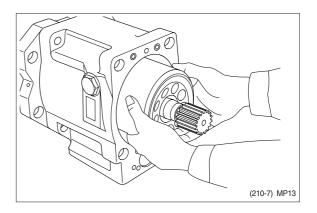
- * Apply grease lightly to oil seal in seal cover (F).
- * Assemble oil seal, taking full care not to damage it.
- For tandem type pump, fit rear cover (263) and seal cover (262) similarly.
- (6) Assemble piston cylinder subassembly (cylinder block (141), piston subassembly (151, 152), set plate (153), spherical bush (156), spacer (158) and cylinder spring (157)).

Fit spline phases of retainer and cylinder. Then, insert piston cylinder subassembly into pump casing.

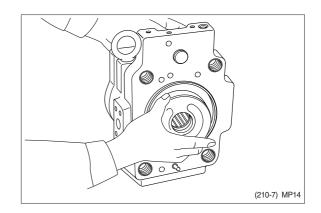




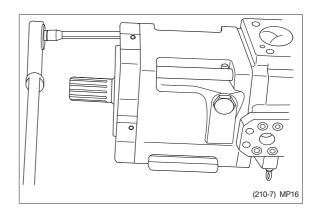


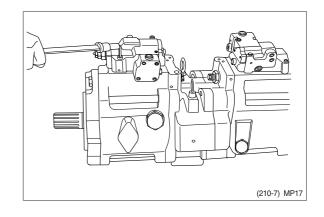


- (7) Fit valve plate (313) to valve block (312), entering pin into pin hole.
- * Take care not to mistake suction / delivery directions of valve plate.



- (8) Fit valve block (312) to pump casing (271) and tighten hexagon socket head bolts (401).
- * At first assemble this at rear pump side, and this work will be easy.
- * Take care not to mistake direction of valve block.
- ** Clockwise rotation (Viewed from input shaft side) - Fit block with regulator up and with delivery flange left, viewed from front side.
- ** Counter clockwise rotation (Viewed from input shaft side) - Fit block with delivery flange right, viewed from front side.
- (9) Putting feedback pin of tilting pin into feedback lever of regulator, fit regulator and tighten hexagon socket head bolts (412, 413).
- * Take care not to mistake regulator of front pump for that of rear pump.



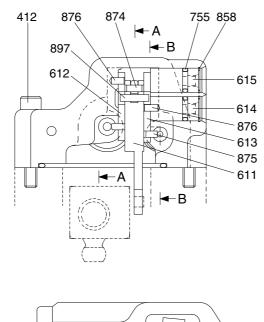


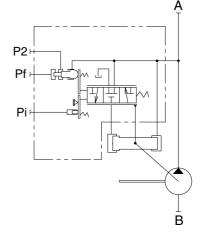
(10) Fit drain port plug (468).

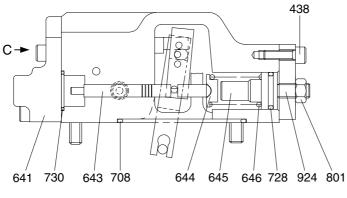
This is the end of reassembling procedures.

#### 3. REGULATOR

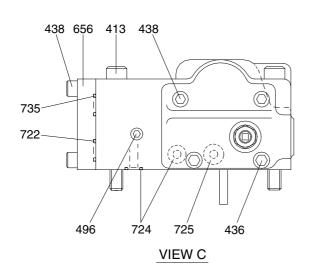
# **1) STRUCTURE** (1/2)





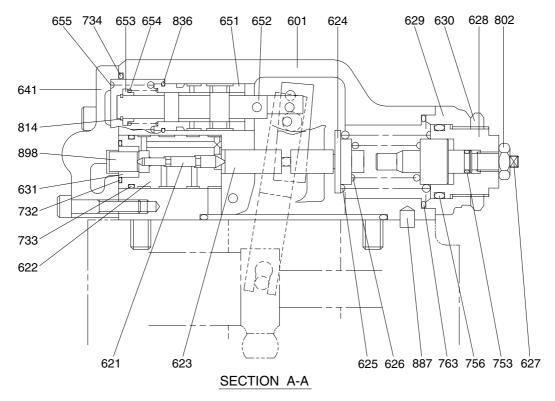


SECTION B-B



21092MP03

#### REGULATOR (2/2)



21092MP04

412 413	Hexagon socket screw Hexagon socket screw	630 631	Lock nut Sleeve, pf	733 734	O-ring O-ring
436	Hexagon socket screw	641	Pilot cover	735	O-ring
438	Hexagon socket screw	643	Pilot piston	753	O-ring
496	Plug	644	Spring seat (Q)	755	O-ring
601	Casing	645	Adjust stem (Q)	756	O-ring
611	Feed back lever	646	Pilot spring	763	O-ring
612	Lever (1)	651	Sleeve	801	Nut
613	Lever (2)	652	Spool	802	Nut
614	Fulcrum plug	653	Spring seat	814	Snap ring
615	Adjust plug	654	Return spring	836	Snap ring
621	Compensator piston	655	Set spring	858	Snap ring
622	Piston case	656	Block cover	874	Pin
623	Compensator rod	708	O-ring	875	Pin
624	Spring seat (C)	722	O-ring	876	Pin
625	Outer spring	724	O-ring	887	Pin
626	Inner spring	725	O-ring	897	Pin
627	Adjust stem (C)	728	O-ring	898	Pin
628	Adjust screw (C)	730	O-ring	924	Set screw
629	Cover (C)	732	O-ring		

### 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

The tools necessary to disassemble/reassemble the pump are shown in the follow list.

Tool name & size			Part name					
В	Hexagon socket head bolt			PO pluç (PF threa				
4	M 5	E	3P-1/16	-	M 8			
5	M 6	Е	3P-1/8	-	M10			
6	M 8	Е	3P-1/4	PO-1/4	M12, M14			
_	Hexagon head bolt		Hexagon nut		VP plug (PF thread)			
6	M 8		М	8	-			
	Small size, Max 36mm							
	Minus type screw driver, Medium size, 2 sets							
	Plastic hammer, 1 set							
	For snap ring, TSR-160							
Steel bar		4×100 mm						
Torque wrench		Capable of tightening with the specified torques						
	-							
	M4, Length: 50 mm							
		head bolt  4 M 5  5 M 6  6 M 8  Hexagon hear bolt  6 M 8  Small size, Max 3  Minus type screw Plastic hammer, 1  For snap ring, TS  4×100 mm  Capable of tighter  -	Head bolt (P  4 M 5 E  5 M 6 E  6 M 8 E  Hexagon head bolt  6 M 8  Small size, Max 36mm  Minus type screw driver  Plastic hammer, 1 set  For snap ring, TSR-160  4×100 mm  Capable of tightening w  -	B Hexagon socket head bolt (PT thread)  4 M 5 BP-1/16  5 M 6 BP-1/8  6 M 8 BP-1/4  Hexagon head bolt Hexagon  6 M 8 M  Small size, Max 36mm  Minus type screw driver, Medium size Plastic hammer, 1 set  For snap ring, TSR-160  4×100 mm  Capable of tightening with the specification.	B Hexagon socket head bolt (PT thread) (PF thread)  4 M 5 BP-1/16 -  5 M 6 BP-1/8 -  6 M 8 BP-1/4 PO-1/4  - Hexagon head bolt Hexagon nut  6 M 8 M 8  Small size, Max 36mm  Minus type screw driver, Medium size, 2 sets  Plastic hammer, 1 set  For snap ring, TSR-160  4×100 mm  Capable of tightening with the specified torques  -			

### (2) Tightening torque

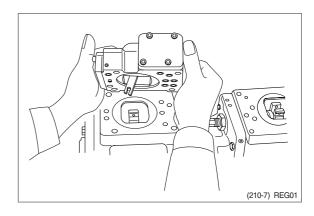
Deden	<b>5</b>	Tor	que	Wrench size		
Part name	Bolt size	kgf ⋅ m	lbf ⋅ ft	in	mm	
Hexagon socket head bolt	M 5	0.7	5.1	0.16	4	
(Material : SCM435)	M 6	1.2	8.7	0.20	5	
	M 8	3.0	21.7	0.24	6	
	M10	5.8	42.0	0.31	8	
	M12	10.0	72.3	0.39	10	
	M14	16.0	116	0.47	12	
	M16	24.0	174	0.55	14	
	M18	34.0	246	0.55	14	
	M20	44.0	318	0.67	17	
PT Plug (Material : S45C)	PT1/16	0.7	5.1	0.16	4	
Wind a seal tape 1 1/2 to	PT 1/8	1.05	7.59	0.20	5	
2 turns round the plug	PT 1/4	1.75	12.7	0.24	6	
	PT 3/8	3.5	25.3	0.31	8	
	PT 1/2	5.0	36.2	0.39	10	
PF Plug (Material : S35C)	PF 1/4	3.0	21.7	0.24	6	
	PF 1/2	10.0	72.3	0.39	10	
	PF 3/4	15.0	109	0.55	14	
	PF 1	19.0	137	0.67	17	
	PF 1 1/4	27.0	195	0.67	17	
	PF 1 1/2	28.0	203	0.67	17	

#### 3) DISASSEMBLY

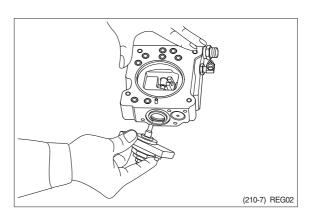
Since the regulator consists of small precision finished parts, disassembly and assembly are rather complicated.

For this reason, replacement of a regulator assembly is recommended, unless there is a special reason, but in case disassembly is necessary for an unavoidable reason, read through this manual to the end before starting disassembly.

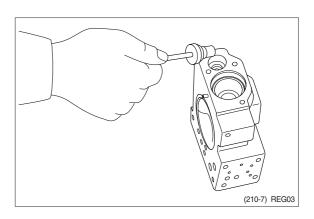
- (1) Choose a place for disassembly.
- * Choose a clean place.
- Spread rubber sheet, cloth, or so on on top of work-bench to prevent parts from being damaged.
- (2) Remove dust, rust, etc. from surfaces of regulator with clean oil.
- (3) Remove hexagon socket head screw (412, 413) and remove regulator main body from pump main body.
- * Take care not to lose O-ring.

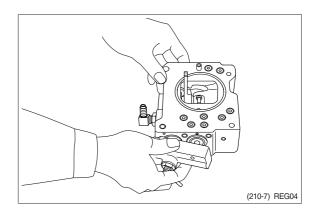


- (4) Remove hexagon socket head screw (438) and remove cover (C, 629)
- ** Cover (C) is fitted with adjusting screw (C, 628), adjusting ring (C, 627), lock nut (630), hexagon nut (801) and adjusting screw (924).
- ** Do not loosen these screws and nuts.
  If they are loosened, adjusted pressure-flow setting will vary.

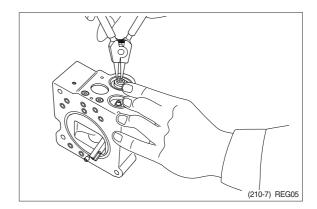


- (5) After removing cover (C, 629) subassembly, take out outer spring (625), inner spring (626) and spring seat (C, 624) from compensating section.
  - Then draw out adjusting ring (Q, 645), pilot spring (646) and spring seat (644) from pilot section.
- * Adjusting ring (Q,645) can easily be drawn out with M4 bolt.
- (6) Remove hexagon socket head screws (436, 438) and remove pilot cover (641). After removing pilot cover, take out set spring (655) from pilot section.

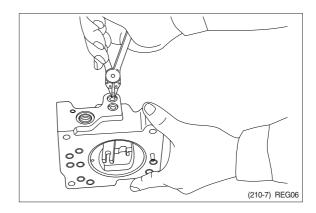


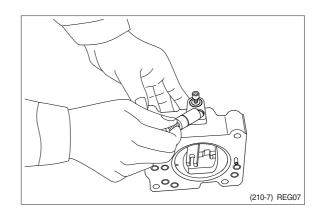


- (7) Remove snap ring (814) and take out spring seat (653), return spring (654) and sleeve (651).
- * Sleeve (651) is fitted with snap ring (836).
- When removing snap ring (814), return spring (654) may pop out.
   Take care not to lose it.

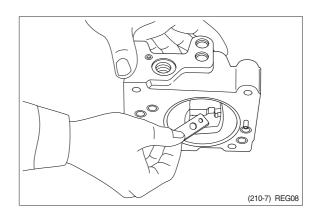


- (8) Remove locking ring (858) and take out fulcrum plug (614) and adjusting plug (615).
- Fulcrum plug (614) and adjusting plug (615) can easily be taken out with M6 bolt.



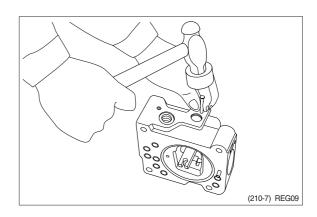


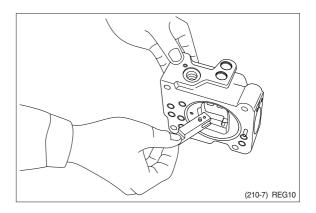
- (9) Remove lever (2, 613). Do not draw out pin (875).
- Work will be promoted by using pincers or so on.



(10) Draw out pin (874) and remove feedback lever (611).

Push out pin (874, 4 mm in dia.) from above with slender steel bar so that it may not interfere with lever (1, 612).



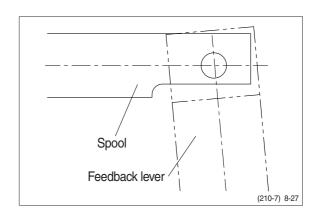


- (11) Remove lever (1, 612). Do not draw out pin (875).
- (12) Draw out pilot piston (643) and spool (652).
- (13) Draw out piston case (622), compensating piston (621) and compensating rod (623).
- * Piston case (622) can be taken out by pushing compensating rod (623) at opposite side of piston case.

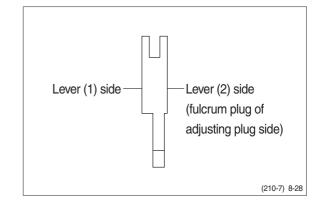
This completes disassembly.

#### 4) ASSEMBLY

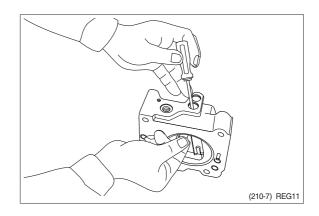
- For assembly, reverse disassembly procedures, but pay attention to the following items.
- ① Always repair parts that were scored at disassembly.
- ② Get replacement parts ready beforehand. Mixing of foreign matter will cause malfunction.
  - Therefore, wash parts well with cleaning oil, let them dry with jet air and handle them in clean place.
- 3 Always tighten bolts, plugs, etc. to their specified torques.
- ④ Do not fail to coat sliding surfaces with clean hydraulic oil before assembly.
- ⑤ Replace seals such as O-ring with new ones as a rule.
- (2) Put compensating rod (623) into compensating hole of casing (601).
- (3) Put pin force-fitted in lever (1, 612) into groove of compensating rod and fit lever (1) to pin force-fitted in casing.
- (4) Fit spool (652) and sleeve (651) into hole in spool of casing.
- * Confirm that spool and sleeve slide smoothly in casing without binding.
- * Pay attention to orientation of spool.



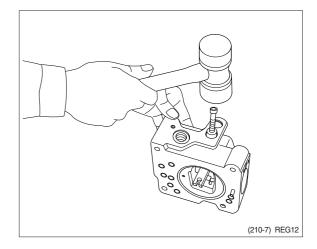
- (5) Fit feedback lever (611), matching its pin hole with pin hole in spool. Then insert pin (874).
- * Insert pin in feedback lever a little to ease operation.
- * Take care not to mistake direction of feedback lever.

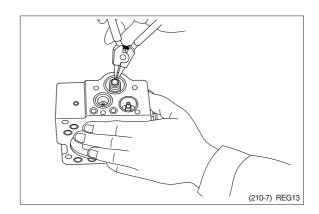


- (6) Put pilot piston (643) into pilot hole of casing.
- * Confirm that pilot piston slides smoothly without binding.
- (7) Put pin force-fitted in lever (2, 613) into groove of pilot piston. Then fix lever (2).



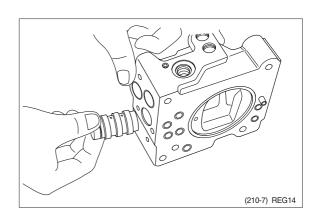
- (8) Fit fulcrum plug (614) so that pin forcefitted in fulcrum plug (614) can be put into pin hole of lever (2).
  - Then fix locking ring (858).
- (9) Insert adjusting plug (615) and fit locking ring.
- * Take care not to mistake inserting holes for fulcrum plug and adjusting plug. At this point in time move feedback lever to confirm that it has no large play and is free from binding.
- (10) Fit return spring (654) and spring seat (653) into spool hole and attach snap ring (814).



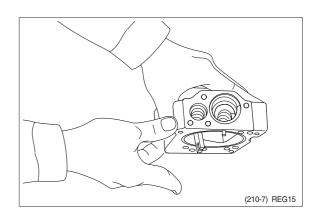


compensating piston (621) and piston case (622) into compensating hole. Fit pilot cover (641) and tighten it with hexagonal socket head screws (436, 438).

(11) Fit set spring (655) to spool hole and put

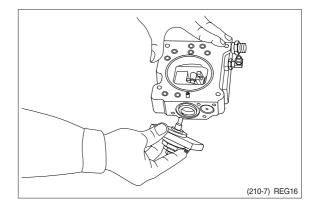


- (12) Put spring seat (644), pilot spring (646) and adjusting ring (Q, 645) into pilot hole. Then fix spring seat (624), inner spring (626) and outer spring (625) into compensating hole.
- When fitting spring seat, take care not to mistake direction of spring seat.



(13) Install cover (C, 629) fitted with adjusting screws (628), adjusting ring (C, 627), lock nut (630), hexagon nut (801) and adjusting screw (924).

Then tighten them with hexagonal socket head screws (438).



This completes assembly.

#### **GROUP 4 MAIN CONTROL VALVE**

#### 1. REMOVAL AND INSTALL OF MOTOR

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

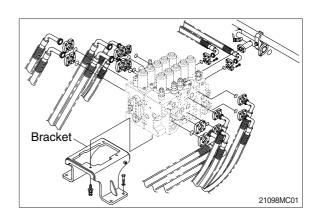
# ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.

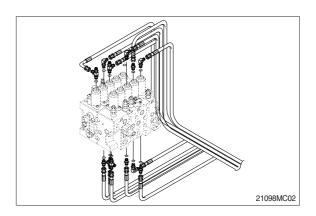
- When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Remove the wirings for the pressure sensor and so on.
- (5) Remove bolts and disconnect pipe.
- (6) Disconnect pilot line hoses.
- (7) Disconnect pilot piping.
- (8) Sling the control valve assembly and remove the control valve mounting bolt and bracket.
  - · Weight: 220kg(485lb)
- (9) Remove the control valve assembly. When removing the control valve assembly, check that all the piping have been disconnected.

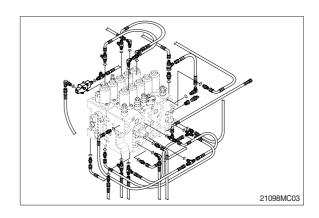
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from below items.
- ① Cylinder (boom, arm, bucket)
- ② Swing motor
- ③ Travel motor
- * See each item removal and install.
- (3) Confirm the hydraulic oil level and recheck the hydraulic oil leak or not.

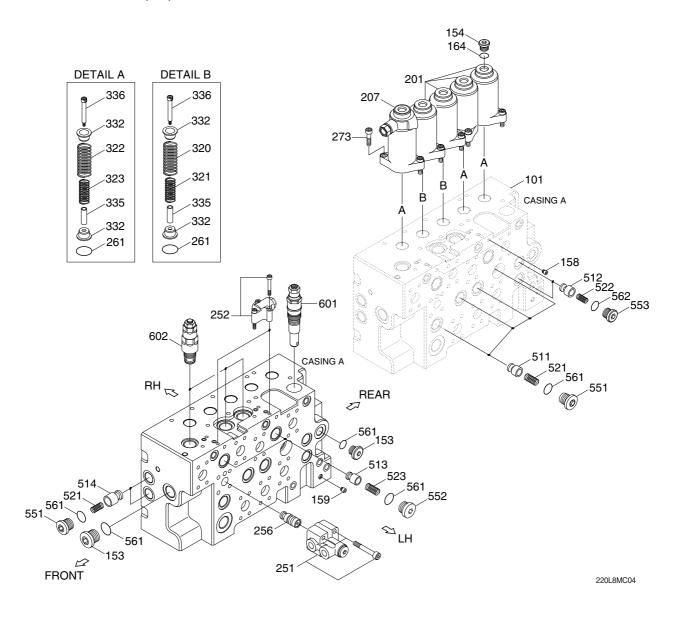






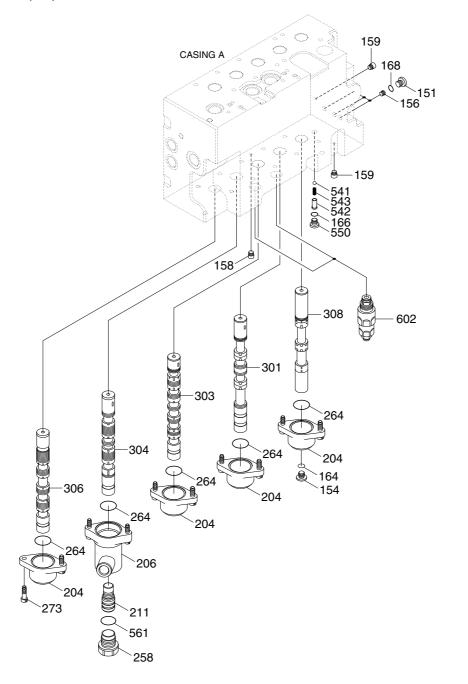


## 2. STRUCTURE (1/4)



101	P2 housing	273	Socket screw	521	Spring
	Plug	320	Spring		Spring
	Plug	321	Spring		Spring
	Plug	322	Spring		Plug
159	Plug		Spring	552	Plug
164	O-ring	332	Seat	553	Plug
201	Spring cover	335	Stopper	561	O-ring
207	Spring cover sub assy	336	Bolt	562	O-ring
251	Logic control valve	511	Poppet	601	Main relief valve
252	Selector lock valve	512	Poppet	602	Port relief valve
256	Logic poppet	513	Poppet		
261	O-ring	514	Poppet		

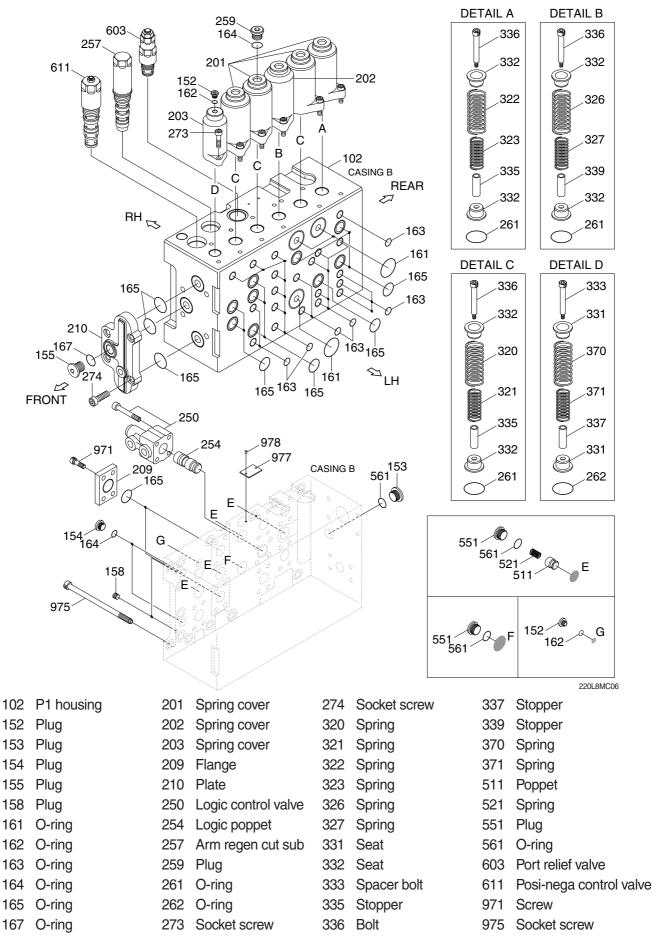
# STRUCTURE (2/4)



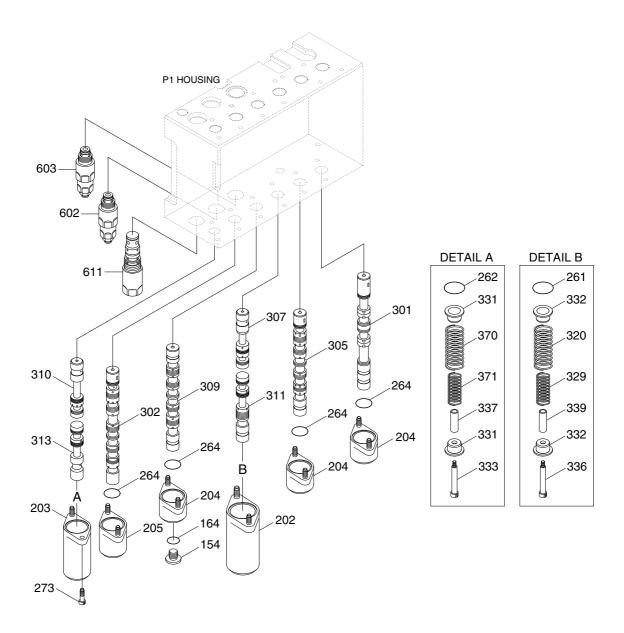
151	Plug	206	Cover	308	Straight travel spool
154	Plug	211	Piston	541	Steel ball
156	Orifice	258	Plug	542	Spring seat
158	Plug	264	O-ring	543	Spring
159	Plug	273	Socket screw	550	Plug
164	O-ring	301	Travel, LH spool	561	O-ring
166	O-ring	303	Boom 1 spool	602	Port relief valve
168	O-ring	304	Bucket spool		
204	Cover	306	Arm 2 spool		

220L8MC05

#### STRUCTURE (3/4)



## STRUCTURE(4/4)



220L8MC07

154	Plug	302	Arm 1 spool	333	Spacer bolt
	•		•		•
164	O-ring	305	Swing spool	336	Bolt
202	Spring cover	307	Boom 2 spool	337	Stopper
203	Spring cover	309	Option spool	339	Stopper
204	Cover	310	Bypass cut spool	370	Spring
205	Cover	311	Swing priority spool	371	Spring
261	O-ring	313	Bypass cut spool	602	Port relief valve
262	O-ring	320	Spring	603	Port relief valve
264	O-ring	329	Spring	611	Posi-nega control valve
273	Socket screw	331	Seat		
301	Travel, LH spool	332	Seat		

#### 3. DISASSEMBLY AND ASSEMBLY

#### 1) GENERAL PRECAUTIONS

- (1) All hydraulic components are manufactured to a high precision. Consequently, before disassembling and assembling them, it is essential to select an especially clean place.
- (2) In handling a control valve, pay full attention to prevent dust, sand, etc. from entering into it.
- (3) When a control valve is to be remove from the machine, apply caps and masking seals to all ports. Before disassembling the valve, recheck that these caps and masking seals are fitted completely, and then clean the outside of the assembly. Use a proper bench for working. Spread a paper or rubber mat on the bench, and disassemble the valve on it.
- (4) Support the body section carefully when carrying or transferring the control valve. Do not lift by the exposed spool, end cover section etc.
- (5) After disassembling and assembling of the component it is desired to carry out various tests (for the relief characteristics, leakage, flow resistance, etc.), but hydraulic test equipment is necessary for these tests. Therefore, even when its disassembling can be carried out technically, do not disassemble such components that cannot be tested, adjusted, and so on. Additionally one should always prepare clean cleaning oil, hydraulic oil, grease, etc. beforehand.

2) TOOLS

Before disassembling the control valve, prepare the following tools beforehand.

Name of tool	Quantity	Size (mm)
Vice mounted on bench (soft jaws)	1 unit	
Box wrench	Each 1 piece	24, 32, 36
Hexagon key wrench	Each 1 piece	4, 5, 6, 8, 10 and 12
Loctite #262	1 piece	-
Spanner	Each 1 piece	32 (main relief valve, 601) 36 (port relief valve, 603)

#### 3) DISASSEMBLY

The figure in ( ) shown after the part name in the explanation sentence shows its number in the structure figures (8-31~34).

- (1) Place control valve on working bench.
- * Disassemble it in clean place and pay attention not to damage flange faces and plate faces.



21098MC37

#### (2) Disassembling of main spools

- · Travel (301), bucket (304), swing (305), option (308), arm 2 (306), boom 2 (307), swing priority (311).
- ① Loosen the hexagon the socket head bolts (273) and remove the spring cover (201, 202) and the O-ring (261).
  - · Hexagon key wrench: 6 mm



- 2 Pull out the spool, spring, spring seats (322), stopper (335 or 339) and spacer bolt (336) in the spool assembly condition from the casing.
- When pulling out the spool assembly from housing, pay attention not to damage the housing.



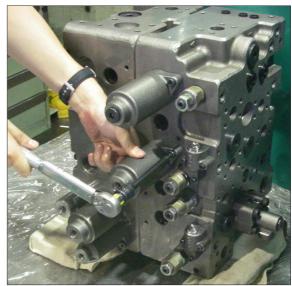
- 3 Hold the spool in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Remove the spacer bolt (336) and disassemble the stopper (335 or 339) and spring seats (332).
  - · Hexagon key wrench: 10 mm



21098MC40

#### (3) Disassembling of boom 1 spool (303):

- ① Loosen the hexagon socket head bolts (273), and remove the spring cover (201) and the O-ring (261).
  - · Hexagon key wrench: 6 mm
- ② Pull out the boom 1 spool (303), spring (320, 321), spring seats (332), stopper (335) and spacer bolt (336) in the spool assembly condition from the P2 housing (101).
- When pulling out the spool assembly from P2 housing (101), pay attention not to damage housing.
- ③ Hold the boom1 spool (303) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Remove the spacer bolt (336), and disassemble the spring (320, 321), spring seats (332) and stopper (335).
  - · Hexagon key wrench: 10 mm
- ④ Do not disassemble the boom1 spool (303) more than these conditions.



21098MC41

#### (4) Disassembling of arm 1 spool (302):

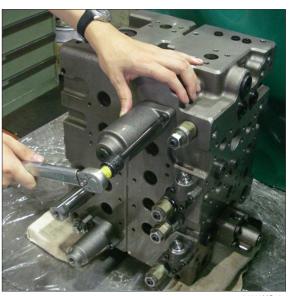
- ① Loosen the hexagon socket head bolts (273), and remove the spring cover (201) and the O-ring (261).
  - · Hexagon key wrench: 6 mm
- ② Pull out the arm 1 spool (302), spring (320, 321), spring seats (332), stopper (335) and spacer bolt (336) in the spool assembly condition from the P1 housing (102).
- When pulling out the spool assembly from P1 housing(102), pay attention not to damage housing.
- ③ Hold the arm 1 spool (302) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Remove the spacer bolt (336), and disassemble the spring (320, 321), spring seats (332) and stopper (335).
  - · Hexagon key wrench: 10 mm
- ④ Do not disassemble the arm 1 spool (302) more than these conditions.



- ① Loosen the hexagon socket head bolts (273), and remove the spring cover (201) and the O-ring (261).
  - · Hexagon key wrench: 6 mm
- ② Pull out the travel straight spool (308), spring (322, 323), spring seat (332), stopper (335) and spacer bolt (336) in the spool assembly condition from the P2 housing (101).
- When pulling out the spool assembly from P2 housing (101), pay attention not to damage housing.



21098MC42



21098MC43

- ③ Hold the travel straight spool (308) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Remove the spacer bolt (336) and disassemble the spring(322, 323), spring seats(332) and stopper (335).
  - · Hexagon key wrench: 10 mm
- ④ Do not disassemble the travel straight spool (308) more than these conditions.

#### (6) Disassembling of bypass cut spool (310, 313):

- ① Loosen the hexagon socket head bolts (273), and remove the spring cover (203) and the O-ring (262).
  - · Hexagon key wrench: 6 mm
- ② Pull out the bypass cut spool (310, 313), spring (370, 371), spring seats (331), stopper (337) and spacer bolt (333) in the spool assembly condition from the P1 housing.
- When pulling out the spool assembly from P1 housing (102), pay attention not to damage housing.
- 3 Hold the bypass cut spool (310,313) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Remove the spacer bolt (333) and disassemble the spring (370, 371), spring seats (331) and stopper (337).
  - · Hexagon key wrench: 10 mm



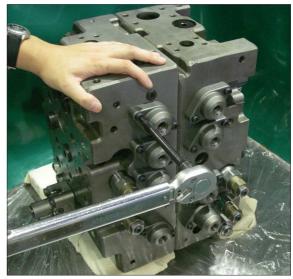
21098MC44



21098MC45

#### (7) Disassembling of spool covers (204, 205, 206):

- ① Remove the hexagon socket head bolts (273), and remove the spool cover (204, 205, 206) and the O-ring (264).
  - · Hexagon key wrench : 6 mm
- ② In removing the bucket spool cover (206), at first loosen the plug (258) before it is removed from the P1 housing (102). After removing the bucket spring cover (206) remove the plug (551), and take out the piston (211).
  - · Box wrench: 32 mm



21098MC46

# (8) Removal of main relief valve (601) port relief valves (602, 603, 604):

① Remove the main relief valve (601) and the port relief valves (602, 603) from the housing.

Main relief valve (601) : spanner 32 mm Port relief valve (602) : spanner or box

wrench 32 mm

Port relief valve (603): spanner 36 mm



21098MC47

② Do not disassemble the relief valves more than these conditions.



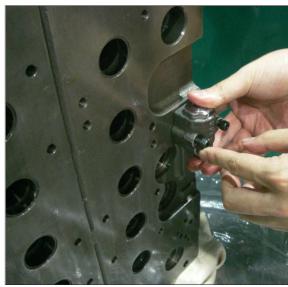
21098MC48



21098MC49

#### (9) Removal of lock valve selector (252):

- ① Loosen the hexagon socket head bolts (252-171) and remove the lock valve selector (252) and the O-rings (252-161).
  - · Hexagon key wrench: 5 mm
- ② Do not disassemble the lock valve selector (252) more than these conditions.



21098MC50

# (10) Removal of posi-nega conversion valve (611):

- ① Remove the posi-nega conversion valve (611) from the P1 housing (102).
  - · Box wrench: 36 mm
- ② Do not disassemble the posi-nega conversion valve (611) more than these conditions.



21098MC51

#### (11) Removal of arm regeneration cut valve (257):

Remove the plug (253), spring (331), spool (211), and sleeve (392) from the P1 housing (102).

· Box wrench: 36 mm



21008MC52

# (12) Disassembly of logic control valve (250, 251) and logic poppet (254, 256):

- ① Loosen the hexagon socket head bolts (250-120, 251-120) and remove the logic control valve (250, 251) and the O-rings (250-112 and 113, 251-112 and 113).
  - · Hexagon key wrench: 8 mm
- ② Pull out the logic poppet (254, 256), spring (254-106, 256-106) and spring seat (254-103, 256-103) from the housing.
- ③ Do not disassemble the logic control valve and the logic poppet more than these condition.



21098MC53



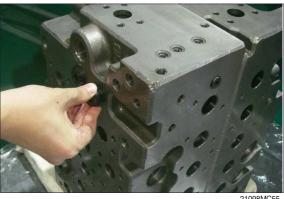
1098MC54

#### (13) Disassembly of check valve:

① CP1, C2, CCb, LCb, LCo, LCk, LCa, LCAT2

Remove the plug (551) and take out the poppet (511) and the spring (521).

- · Hexagon key wrench: 12 mm
- ② CMR1, CMR2
  Remove the plug (553) and take out the poppet (512) and the spring (522).
  - · Hexagon key wrench: 10 mm

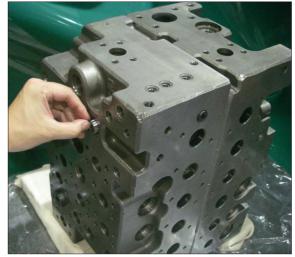


21098MC55

#### ③ CRa, CRb

Remove the plug (552) and take out the poppet (513) and the spring (523).

· Hexagon key wrench: 12 mm

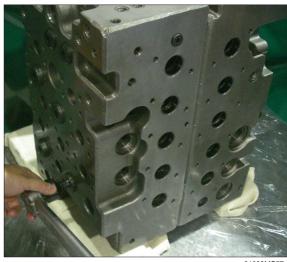


21098MC56

#### 4 CCk, CCo

Remove the plug (551) and take out poppet (514) and the spring (521).

- · Hexagon key wrench: 12 mm
- ⑤ Remove the plug (550) and take out the ball (541), spring (543) and spring seat (542).
  - $\cdot$  Hexagon key wrench : 6 mm



21098MC57

#### (14) Disassembly of flanges (209):

Loosen the hexagon socket head bolts (971) and remove the flange (209) and the O-ring (165).

· Hexagon key wrench: 8 mm

#### (15) Disassembly of plate (210):

Loosen the hexagon socket head bolts (274) and remove the plate (210) and the O-rings (165).

· Hexagon key wrench: 10 mm

#### (16) Disassembly of orifices for signal line:

Do not disassemble the plug (151) and orifice (156) unless required specifically.

### (17) Disassembly of casing:

- ① Except when required specially, do not disassemble the tie bolts of the P1 housing.
- ② Since the plugs not described in above disassembling procedures are the blind plugs for sacrifice holes and the blind plugs for the housing sanitation, do not disassemble them as far as not required specially.



21098MC58

#### (18) Inspection after disassembling

Clean all the disassembled parts with clean mineral oil fully, and dry them with compressed air. Then, place them on clean papers or cloths for inspection.

#### Control valve

- a. Check whole surfaces of all parts for burrs, scratches, notches and other defects.
- Confirm that the seal groove faces of the housing and the covers are smooth and free of dust, dent, rust etc.
- c. Correct dents and damages on check seat faces of housing, if any, by lapping.
- * Pay attention not to leave lapping agent in the housing.
- d. Confirm that all sliding and fitting parts can be moved manually and that all grooves and paths are free from foreign matter.
- e. If any spring is broken or deformed, replace it with new one.
- f. When a relief valve does not function properly, repair it, following its inspection procedures.
- g. Replace all the O-rings with new ones.

#### ② Relief valve

- a. Confirm that all seat faces at ends of all poppets and seats are free of defects and are uniform contact faces.
- b. Confirm manually that main poppet and seat can slide lightly and smoothly.
- c. Confirm that outside face of main poppet and inside face of seat are free from scratches and so on.
- d. Confirm that orifices of the main poppet and seat section are not clogged with foreign matter.
- e. Replace all O-rings with new ones.
- f. When any light damage is found in above inspections, correct it by lapping.
- g. When any abnormal part is found, replace it with a relief valve assembly.

#### 4) ASSEMBLY

- ① In this assembling section, explanation only is shown. Refer to figures and photographs shown in disassembling section.
- ② Figure in () shown after part name in explanation sentence shows number in structure figure.
- ③ Cautions in assembling O-rings
  - a. Pay attention to keep O-rings free from defects in its forming and damages in its handling.
  - b. Apply grease, hydraulic oil or so on to O-rings and seal-fitting sections for full lubrication.
  - c. Do not stretch O-rings so much to deform them permanently.
  - d. In fitting O-ring, pay attention not to roll it into its position. In addition, twisted O-ring cannot remove its twisting naturally with ease after being fitted, and causes oil leakage.
  - e. Tighten fixing the bolts for all sections with a torque wrench to their respective tightening torque.

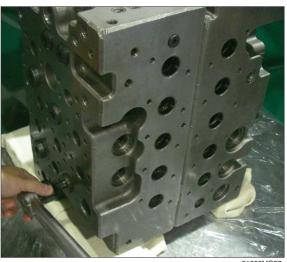
#### (1) Assembly of check valve:

- ① Assemble the poppets (511, 512, 513, 514) and the springs (521, 522, 523): Put the O-rings (561) onto the plugs (551, 552). Put the O-rings (562) onto the plugs (553). Tighten the plugs (551, 552, 553) with their specified torques.
- * Use the poppets, springs and plugs in following groups.

Poppet	Spring	Plug
511	521	551
512	522	553
513	523	552
514	521	551

Remember that 511 in 8 positions 512 in 2 positions 513 in 2 positions 514 in 2 positions

Plug No.	Hexagon key wrench (mm)	Tightening torque (kgf·m)
551	12	23.5 ~ 26.5
552	12	23.5 ~ 26.5
553	10	13.3 ~ 15.3





② Assemble of ball (541), spring Seat (542) and spring (543): Put the O-ring (166) onto the plug (550), and tighten the plug (550) with specified torque.

· Hexagon key wrench: 6 mm

Tightening torque : 2.55 ~ 2.96 kgf⋅m

(18.4~21.4 lbf·ft)



21098MC5

#### (2) Assembly of plate (210):

Fit the O-rings (165) to the P1 housing (102), and tighten the hexagon socket head bolts (274) with specified torque.

· Hexagon key wrench: 10 mm

 Tightening torque : 10.0 ~ 12.2 kgf⋅m (72.3~88.2 lbf⋅ft)

So turn the control valve that the plate face may be directed downward.

#### (3) Assembly of flange (209):

Fit the O-rings (165) to the flange (209), and tighten the hexagon socket head bolts (971) with specified torque.

· Hexagon key wrench: 8 mm

• Tightening torque :  $5.0 \sim 6.6 \text{ kgf-m}$  ( $36.2 \sim 47.7 \text{ lbf-ft}$ )

#### (4) Assemble of logic control valve :

① Put the O-ring (250-115, 251-115) onto the plug (250-111, 251-111).



21098MC5

- ② Assemble the spool (250-102, 251-102), spring seat (250-104, 251-104) and spring (251-105, 251-105) into the casing (250-101, 251-101) of the logic control valve, and tighten the plug (250-111, 251-111) with specified torque.
  - · Hexagon key wrench: 8 mm
  - Tightening torque : 7.0 ~ 8.1 kgf-m (50.6~58.6 lbf-ft)
- ③ Assemble the logic poppet (254; poppet, spring, spring seat) into the housing of the control valve.
- Fit the O-rings (250-112 and 113, 251-112 and 113) to the casing (250-101, 251-101) of the logic control valve, and tighten the hexagon socket head bolts (250-120, 251-120) with specified torque.
  - · Hexagon key wrench: 8 mm
  - Tightening torque : 5.0 ~ 6.6 kgf⋅m

(36.2~47.7 lbf·ft)



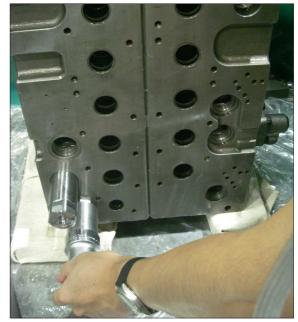
21098MC54

# (5) Assembling of posi-nega conversion valve (611):

Assemble the posi-nega conversion valve (611) into the P2 housing (101), and tighten it with specified torque.

- · Box wrench: 36 mm
- · Tightening torque: 7.0 ~ 8.0 kgf⋅m

(50.6~57.9 lbf·ft)



21098MC51

# (6) Assembly of arm regeneration cut valve (257):

Assemble the sleeve (257-212), spool (257-211), and spring (257-231) into the P1 housing (102). Put the O-ring (265) onto the plug (257-253), and tighten with specified torque.

· Box wrench: 36 mm

· Tightening torque: 7.0 ~ 8.0 kgf⋅m

(50.6~57.9 lbf·ft)



21098MC52

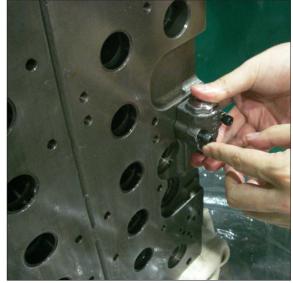
#### (7) Assembling of lock valve selector (252):

Fit the O-rings (252-161) to the lock valve selector (252) and tighten the hexagon socket head bolts (252-171) with specified torque.

· Hexagon key wrench: 5 mm

· Tightening torque : 1.0 ~ 1.4 kgf⋅m

(7.2~10.1 lbf·ft)



21098MC50

# (8) Assembling of main relief valve (601) and port relief valve (602, 603):

Assemble the main relief valve (601) and the port relief valves (602, 603) to the housing, and tighten them with specified torque.

Item	Tool	Tightening torque (kgf·m)
Main relief valve (601)	Spanner 32	7.0 ~ 8.1
Port relief valve (602)	Spanner 32 or box wrench 32	7.0 ~ 8.1
Port relief valve (603)	Spanner 36	12.2 ~14.3



21098MC49



21098MC48



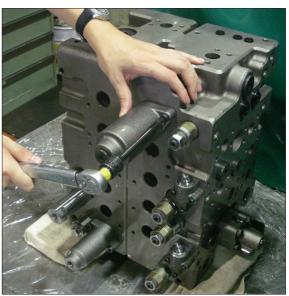
21098MC47

#### (9) Assemble of travel straight spool (308):

- ① Hold the middle of the travel straight spool (308) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Attach the spring seats (332), springs (322, 323) and stopper (335), and tighten the spacer bolt (336) with specified torque.
- Before tightening the spacer bolt (336), apply loctite #262 to it.
  - · Hexagon key wrench: 10 mm
  - · Tightening torque: 1.6 ~ 1.8 kgf⋅m

(11.6~13.0 lbf·ft)

- Pay attention not to fasten the vise excessively to the shape of the travel straight spool (308) is deformed.
- ② Insert the spool assemblies of ① items above into the P2 housing (101).
- Fit spool assemblies into P2 housing (101) carefully and slowly.
- * Do not push them forcibly without fail.



21098MC43

#### (10) Assembling of boom 1 spool (303):

- ① Hold the middle of the boom1 spool (303) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Attach the spring seats (332), springs (320, 321) and stopper (335), and tighten the spacer bolt (336) with specified torque.
- * Before tightening the spacer bolt (336), apply loctite #262 to it.
  - · Hexagon key wrench: 10 mm
  - Tightening torque : 1.6 ~ 1.8 kgf⋅m

(11.6~13.0 lbf·ft)

- * Pay attention not to fasten the vise excessively to the shape of the boom 1 spool (303) is deformed.
- ② Insert the spool assemblies of items ① above into the P2 housing (101).
- Fit spool assemblies into the P2 housing (101) carefully and slowly.
- * Do not push them forcibly without fail.



#### (11) Assembling of arm 1 spool (302):

- ① Hold the middle of the arm1 spool (302) in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Attach the spring seats (332), springs (320, 321) and stopper (335) and tighten the spacer bolt (336) with specified torque.
- Meson Before tightening the spacer bolt (336), apply loctite #262 to it.
  - · Hexagon key wrench: 10 mm
  - Tightening torque: 1.6 ~ 1.8 kgf⋅m

(11.6~13.0 lbf·ft)

- * Pay attention not to fasten the vise excessively to the shape of the arm 1 spool (302) is deformed.
- ② Insert the spool assemblies of items ① above into the P1 housing (102).
- Fit spool assemblies into the P1 housing (102) carefully and slowly.
- Do not push them forcibly without fail.



- (12) Assembling of main spool (travel (301), bucket (304), swing (305), option (309), arm2 (306), boom2 (307), swing priority (311)):
  - ① Hold the middle of each spool in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Attach the spring seats (332), springs and stopper (335 or 339) and tighten the spacer bolt (336) with specified torque.
  - Before tightening the spacer bolt (336), apply loctite #262 to it.
    - · Hexagon key wrench: 10 mm
    - · Tightening torque : 1.6 ~ 1.8 kgf·m

(11.6~13.0 lbf-ft)

- Pay attention not to fasten the vise excessively to the shape of the spool is deformed.
- ② Insert the spool assemblies of Items ① above into the P2 housing (101) and P1 housing (102).
- Fit spool assemblies into P2 housing (101) and P1 housing (102) carefully and slowly.
- Do not push them forcibly without fail.



21098MC39



21098MC3

#### (13) Assembling of bypass cut spool (310, 313):

- ① Hold the middle of each spool in the mouthpiece-attached vise applying a protection plate (aluminum plate and the like) in between. Attach the spring seats (331), springs (370, 371) and stopper (337) and tighten the spacer bolt (333) with specified torque.
- * Before tightening the spacer bolt (333), apply loctite #262 to it.
  - Hexagon key wrench: 10 mm
  - Tightening torque : 1.6 ~ 1.8 kgf⋅m

 $(11.6 \sim 13.0 \text{ lbf} \cdot \text{ft})$ 

- * Pay attention not to fasten the vise excessively to the shape of the bypass cut spool (310, 313) is deformed.
- ② Insert the spool assemblies of Items ① above into the P1 housing (102).
- Fit spool assemblies into the P1 housing (102) carefully and slowly.
- Do not push them forcibly without fail.



#### (14) Assembling of covers:

- ① Fit the O-rings (264) to the spool covers (204, 205, 206) to sides reverse to the spring sides of spools, and tighten the hexagon socket head bolts (273) with specified torque.
- Confirm that O-rings (264) have been fitted to the spool covers (204, 205, 206).
  - · Hexagon key wrench: 6 mm
  - · Tightening torque : 2.5 ~ 3.5 kgf⋅m

(18.1~25.3 lbf·ft)

- ② Bucket spool cover (206): Assemble piston (355) into bucket spool cover (206). Put O-ring (561) onto plug (258) and tighten it with specified torque.
  - · Box wrench: 32 mm
  - Tightening torque: 15.3 ~ 18.4 kgf⋅m (111~133 lbf·ft)
- ③ Fit the O-rings (261, 262) to spring covers (201, 202, 203) to the spring sides of spools, and tighten the hexagon socket head bolts (273) with specified torque.
- Confirm that O-rings (261,262) have been fitted to spring covers (204, 205, 206).
  - Hexagon key wrench: 6 mm
  - Tightening torque : 2.5 ~ 3.5 kgf⋅m (18.1~25.3 lbf·ft)



21098MC46

### **GROUP 5 SWING DEVICE (TYPE 1, 2)**

#### 1. REMOVAL AND INSTALL OF MOTOR

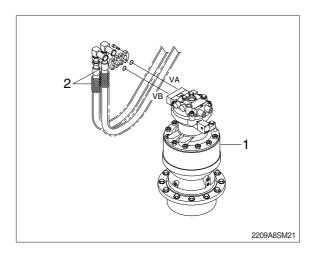
#### 1) REMOVAL

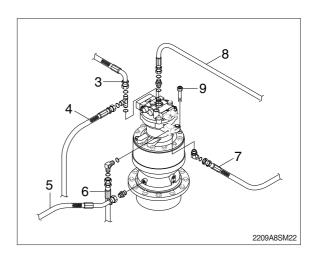
- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
- When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Disconnect hose assembly (2).
- (5) Disconnect pilot line hoses (3, 4, 5, 6, 7, 8).
- (6) Sling the swing motor assembly (1) and remove the swing motor mounting socket bolts (9).
  - Motor device weight: 61 kg (135 lb)
- (7) Remove the swing motor assembly.
- When removing the swing motor assembly, check that all the piping have been disconnected.

#### 2) INSTALL

- Carry out installation in the reverse order to removal.
- (2) Bleed the air from the swing motor.
- ① Remove the air vent plug.
- ② Pour in hydraulic oil until it overflows from the port.
- ③ Tighten plug lightly.
- Start the engine, run at low idling and check oil come out from plug.
- ⑤ Tighten plug fully.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

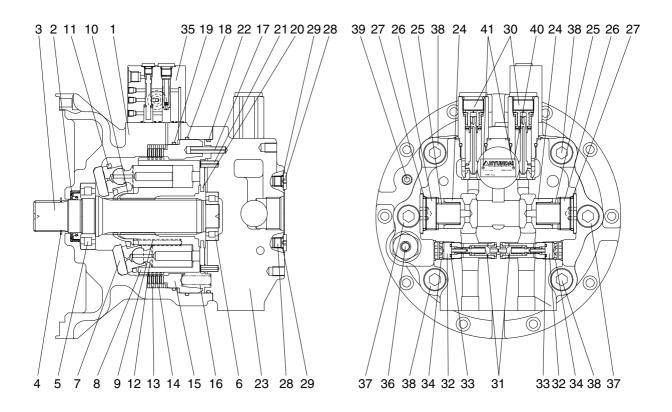






#### 2. DISASSEMBLY AND ASSEMBLY OF SWING MOTOR

## 1) STRUCTURE



220L2SM02

1	Casing	15	Parking piston	29	O-ring
2	Oil seal	16	Spring	30	Relief valve assy
3	Shaft	17	Spring pin	31	Reactionless valve assy
4	Snap ring	18	O-ring	32	Plug
5	Roller bearing	19	O-ring	33	O-ring
6	Needle bearing	20	Valve plate	34	O-ring
7	Swash plate	21	Spring pin	35	Time delay valve assy
8	Cylinder block	22	O-ring	36	Level gauge
9	Spring	23	Valve casing	37	Socket bolt
10	Ball guide	24	Check valve	38	Socket bolt
11	Retainer plate	25	Spring	39	Plug
12	Piston assy	26	Plug	40	Name plate
13	Friction plate	27	O-ring	41	Rivet
14	Separate plate	28	Plug		

### 2) DISASSEMBLY

#### (1) Disassemble drive shaft

① Unloosing socket bolt (time delay valve, 42) and disassemble time delay valve assy (35) from casing (1).



2209A8SM51

② Disassemble level gauge (36) from casing (1).



③ Hang valve casing (23) on hoist, unloose socket bolt (37, 38) and disassemble from casing (1).



④ Disassemble spring (16) and using a jig, disassemble parking piston (15) from casing (1).



⑤ Disassemble respectively cylinder block sub (8), friction plate (13), separate plate (14) from casing (1).



2209A8SM55

⑥ Disassemble swash plate (7) from casing (1).



2209A8SM56

Using a plier jig, disassemble snap ring(4) from casing (1).



2209A8SM57

Disassemble shaft assy (3), oil seal (2) and O-ring (18, 22) from casing (1).



2209A8SM58

### (2) Disassemble cylinder block sub

① Disassemble piston assy (12) from cylinder block (8).



2209A8SM59

- ② Disassemble ball guide (10) and spring (cylinder block, 9) from cylinder block (8).
  - · Ball guide × 1EA
  - Spring  $\times$  9EA



2209A8SM60

### (3) Disassemble valve casing sub

① Disassemble spring pin (17, 21), valve plate (20), O-ring (22) from valve casing (23).



2209A8SM61

② Using a torque wrench, disassemble relief valve (30) from valve casing (23).



2209A8SM62

③ Using a torque wrench, disassemble plug (32) from valve casing (23) and disassemble O-ring (33, 34) and reactionless valve assy (31).



2200A8SM63

④ Using a torque wrench, disassemble check valve (24) from valve casing (23).



2209A8SM64

⑤ Disassemble plug (28), O-ring (29) from valve casing (23).



2209A8SM65

#### 3) ASSEMBLING

#### (1) Assemble shaft sub

① Put roller bearing (3) on preheater and provide heat to inner race.

(Temperature in conveyor: 120°C for 3~5 minutes)



2209A8SM66

② Using a robot machine, assemble and press preheated roller bearing (3) into shaft (5).



2209A8SM67

### (2) Assemble cylinder block sub

- ① Assemble 9 springs (cylinder block, 9) into cylinder block (8).
  - · Spring×9EA



2209A8SM68

- ② Assemble ball guide (10) into cylinder block (8).
  - · Ball guide × 1EA



2209A8SM69

- ③ Assemble 9 piston assy (12) into retainer plate (11).
  - Piston assy  $\times$  9EA
  - Retainer plate  $\times$  1EA



2209A8SM70

④ Assemble parts of procedure ② and ③.



2209A8SM71

#### (3) Assemble valve casing sub

- ① Assemble make up check valve sub Assemble check valve (24), O-ring (27), plug (26) in that order and then screw it torque wrench.
  - · Make up check valve × 2EA
  - · Spring×2EA
  - Plug×2EA
  - · O-ring $\times$ 2EA



2209A8SM72

- ② Assemble reactionless valve assy Assemble reactionless valve assy (31), plug (32), O-ring (33, 34) in that order and then screw it a torque wrench.
  - · Reactionless valve assy (31)×2EA
  - Plug (32) × 2EA
  - · O-ring (33, 34) × 2EA



2209A8SM73

- ③ Using a torque wrench, assemble relief valve (30) 2 sets into valve casing (23).
  - · Relief valve (30) × 2EA



2209A8SM74

- ④ Assemble plug (28) and O-ring (27) into valve casing (23).
  - Plug (28) × 3EA
  - O-ring (27) × 3EA



2209A8SM75

- Assemble needle bearing (6) into valve casing (23) and assemble spring pin (17, 21) into valve casing (23).
  - Needle bearing (6) × 1EA
  - Spring pin (17, 21)×1EA



2209A8SM76

⑥ Apply some grease valve plate (20) and assemble it into valve casing (23).



2209A8SM77

# (4) Assemble drive shaft sub

① Using a jig, assemble oil sealing (2) into casing (1).



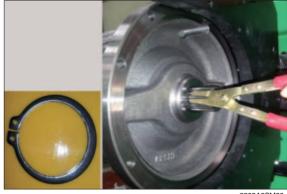
2209A8SM78

② Fit shaft sub (shaft+roller bearing) into casing (1).



2209A8SM79

- ③ Using a plier jig, assemble snap ring (4) to shaft (3).
  - Snap ring  $\times$  1EA



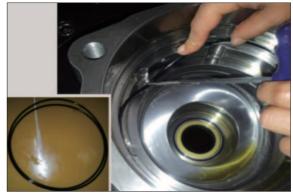
2209A8SM80

- ④ Apply some grease swash plate (7) and assemble it into casing (1).
  - · Swash plate × 1EA



2209A8SM81

- ⑤ Insert O-ring (18, 19) into casing (1).
  - O-ring (18) × 1EA
  - O-ring (19)×1EA



2209A8SM82

Assemble cylinder block (8) into casing (1).



2209A8SM83

- Assemble separate plate (14) and friction plate (13) 4 sets into casing (1) and fit parking piston (15) into casing (1) by a jig or a press.
  - · Separate plate × 4EA
  - Friction plate  $\times$  4EA
  - · Parking piston × 1EA



2209A8SM84

- Assemble spring (parking piston, 16) into parking piston (15).
  - · Spring×26EA



2209A8SM85

 Lift up valve casing (23) on casing (1) by a crane and assemble it with socket bolts (37, 38).



2200 4 2 2 1 4 2 6

① Assemble level gauge (36) and plug (39) into casing (1).



2209A8SM87

- ① Assemble time delay valve assy (35) into valve casing (23) with socket bolt (42).
  - · Time delay valve × 1EA
  - · Socket bolt × 3EA



2209A8SM88

### ② Air pressing test

Be sure of leakage, after press air into assembled motor and put it in water for 1 minute (pressure : 2 kgf/cm²).



2209A8SM89

# (3) Leakage check

Place motor on a bench tester and after cleaning motor by color check No.1, paint No.3 and be sure of leakage.



2209A8SM90

### **Mount test bench**

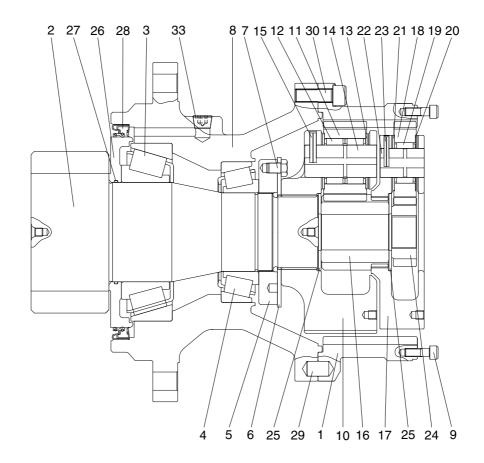
Mounting motor a test bench, test the availability of each part.



2200A8SM01

# 3. DISASSEMBLY AND ASSEMBLY OF REDUCTION GEAR

# 1) STRUCTURE



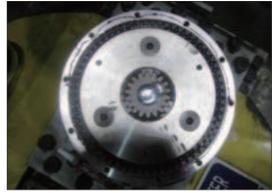
220L2SM03

1	Ring gear	11	Planetary gear 2	21	Thrust washer 1
2	Drive shaft	12	Needle bearing 2	22	Carrier pin 1
3	Taper bearing	13	Thrust washer 2	23	Spring pin 1
4	Taper bearing	14	Carrier pin 2	24	Sun gear 1
5	Ring nut	15	Spring pin 2	25	Thrust plate
6	Lock plate	16	Sun gear 2	26	Sleeve
7	Hexagon bolt	17	Carrier 1	27	O-ring
8	Casing	18	Planetary gear 1	29	Parallel pin
9	Socket bolt	19	Needle bearing 1	30	Socket bolt
10	Carrier 2	20	Thrust washer 1	33	Plug

### 2) DISASSEMBLY

### (1) Preparation

- ① The reduction gear removed from machine is usually covered with mud.
  - Wash out side of reduction gear and dry it.
- ② Setting reduction gear on work stand for disassembling.
- ③ Mark for mating Put marks on each mating parts when disassembling so as to reassemble correctly as before.
- ▲ Take great care not to pinch your hand between parts while disassembling not let fall parts on your foot while lifting them.



2209A8SM01

#### (2) Disassembly

- ① Remove every "Socket bolt (M10)" that secure swing motor and reduction gear.
- ② Removing carrier sub assy & sun gear
  - a. Removing No.1 sun gear from No.1 carrier sub assy.
  - ** Be sure maintaining it vertical with ground when disassembling No.1 sun gear.



2209A8SM02

- b. Removing No.1 carrier sub assy screwing I-bolt to tab hole (M10) in No.1 carrier.
   Lifting it gradually maintaining it vertical with ground.
- ** It's impossible to disassemble No.1 spring pin. If No.1 spring pin has problem, change whole No.1 carrier sub assy.



2209A8SM03

- c. Removing No.2 sun gear from No.2 carrier sub assy.
- * Be sure maintaining it vertical with ground when disassembling No.2 sun gear.



- d. Removing No.2 carrier sub assy screwing I-bolt to tab hole (M10) in No.2 carrier. Lifting it gradually maintaining it vertical with ground.
- * It's impossible to disassemble No.2 spring pin. If No.2 spring pin has problem, change whole No.2 carrier sub assy.



2209A8SM05

### ③ Removing ring gear

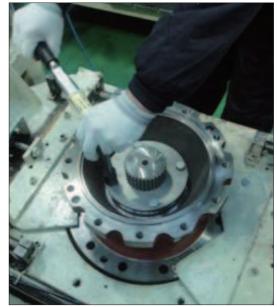
- After unscrewing every socket bolt (M16), remove ring gear from casing.
- * Because of liquid gaskets between ring gear and casing, put sharp punch between ring gear and casing and tapping it to remove them.



2209A8SM06

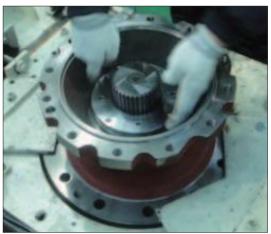
# ④ Removing drive shaft sub assy

a. Unscrew every hex head bolt (M12) to remove lock plate.



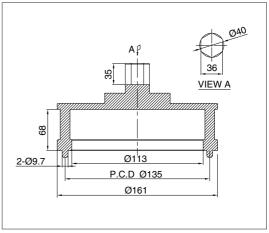
2209A8SM07

b. Rolling ring nut for removing them from drive shaft sub assy.



2209A8SM08

* Use special tool to roll ring nut to counter clockwise.



220L8SM01

- c. Remove drive shaft sub assy from casing.
- * Set a rack for flange of casing, and remove drive shaft sub assy from casing by using press.

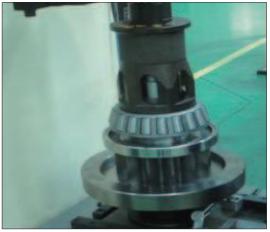


2209A8SM09

- d. Remove oil seal & taper bearing (small) from casing.
- * Do not re-use oil seal. It is impossible to disassemble drive shaft sub assy.



2209A8SM10



2209A8SM11

#### 4. ASSEMBLY REDUCTION UNIT

### 1) GENERAL NOTES

- (1) Clean every part by kerosene and dry them in a cool and dry place.
- (2) Loctite on surface must be removed by solvent.
- (3) Check every part for any abnormal.
- (4) Each hexagon socket head bolt should be used with loctite #242 applied on its threads.
- (5) Apply gear oil slightly on each part before assembling.
- ▲ Take great care not to pinch your hand between parts or tools while assembling nor let fall parts on your foot while lifting them. Inspection before assembling.

#### Thrust washer

- · Check the seizure, abnormal wear or uneven wear.
- Check the unallowable wear.

#### Gear

- · Check the pitting or seizure on tooth surface.
- · Check the cracks on the root of tooth.

#### **Bearing**

· Rotate it by hands to check such noise or uneven rotation.

#### 2) ASSEMBLING NO.1 CARRIER SUB ASSY

- (1) Put thrust plate firmly in No.1 carrier.
- (2) After assembling No.1 needle bearing to No.1 planetary gear, put a pair of No.1 thrust washer on both sides of bearing and install them to No.1 carrier.



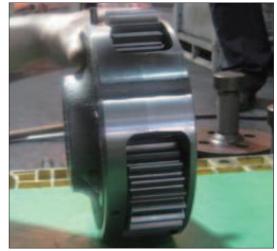
2209A8SM12



2209A8SM13

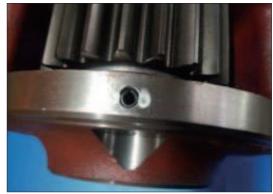
(3) Make of spring pin hole No.1 pin and No.1 carrier of spring pin hole in line, press No.1 spring pin into the holes.

Make No.1 spring pin hole head for No.1 planetary gear.



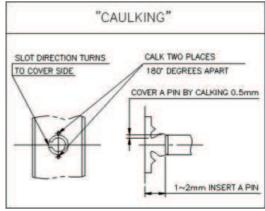
2209A8SM14

(4) Caulk carrier holes to make No.1 spring pin settle down stably.



2209A8SM15

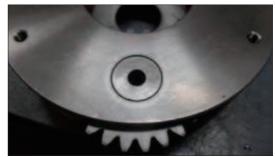
Refer to "Caulking details"Use paint marker for marking after caulking.



2209A8SM16

### 2) ASSEMBLING NO.2 CARRIER SUB ASSY

(1) Put thrust plate in firmly No.2 carrier.



2209A8SM17

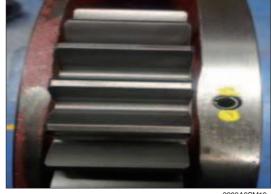
(2) After assembling No.2 needle bearing to No.2 planetary gear, put 2 pieces of No.2 thrust washer on both sides of bearing and install them to No.2 carrier.



2209A8SM18

(3) Align No.2 spring pin hole and No.2 carrier spring pin hole, put No.2 spring pin into the holes.

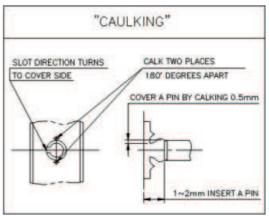
Make No.2 spring pin cutting line face to No.2 planetary gear.



2209A8SM19

- (4) Caulk carrier holes to make No.2 spring pin settle down stably.
- * Refer to "Caulking details"

Use paint marker for marking after caulking.



2209A8SM20

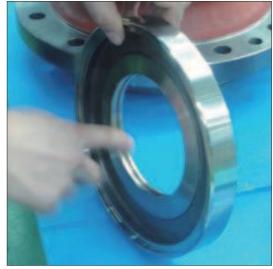
# 3) ASSEMBLING PINION GEAR SUB ASSY

(1) Prepare drive shaft pinion gear vertical with ground.



2209A8SM21

- (2) Fully apply grease (albania EP02) to O-ring groove of sleeve.
- * Be sure to maintain it vertical with ground when assembling it.
- (3) Put O-ring into O-ring groove of sleeve. Fully apply grease on O-ring.



2209A8SM22

(4) Assemble taper bearing and sleeve into drive shaft using press jig. Use special jig for pressing. Leave no space between sleeve and taper bearing.





2209A8SM24

# 4) ASSEMBLING BEARING CUP & OIL SEAL (PRESSING)

- (1) Put top, bottom bearing cup into casing. Use special jig for pressing. Pay attention to foreign materials while assembling bearing cup.
- * Flip over casing to assemble oil seal.



2209A8SM25



2209A8SM26

(2) Assemble oil seal to casing. Use special jig for pressing. Pay attention to direction of dust seal and dent.



### **** WHILE ASSEMBLING OIL SEAL**

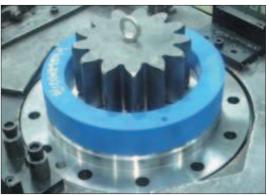
- 1. Be sure to set dust seal to gear oil.
- 2. Before assembling, charge enough grease in oil seal.
- 3. Before assembling, apply enough grease inside and outside of oil seal.



2209A8SM28

# 5) ASSEMBLING SHAFT SUB ASSY & RING NUT

(1) After assembling casing & drive shaft sub assy, flip it over.



2209A8SM29

- (2) Put drive shaft sub assy into casing.
- * Be sure to maintain it vertical with ground when assembling it.



2209A8SM30

(3) Put taper bearing into it. Rotate bearing by hands for checking after assembly.



2209A8SM31

(4) Put ring nut into drive shaft sub assy by using special jig.

The tightening torque (M95) =  $3.5\pm0.4$  kgf·m (25.3 $\pm2.9$  lbf·ft)



2209A8SM32

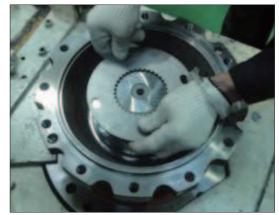
* Apply enough loctite #242 before screwing bolts.



2209A8SM33

(5) Align bolt screw of ring nut with lock plate's hole.

In case of misalign between bolt screw ring nut and lock plate's hole, put lock plate as near as possible to hole of bolt screw of ring nut and make it in line by increasing tightening torque.



2209A8SM34



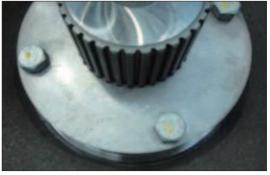
2209A8SM35

- (6) Screw 4 bolts (M12×16) to connect ring nut and lock plate by using torque wrench. Bolt (M12, 4EA) = 10.9T The tightening torque =  $8.8 \pm 0.9 \text{ kgf} \cdot \text{m}$  $(63.7 \pm 6.5 \, lbf \cdot ft)$
- * Apply enough loctite #242 before screwing bolts.



2209A8SM36

(7) Use paint marker for checking surplus parts after assembling.



2209A8SM37

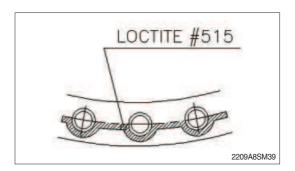
# 6) ASSEMBLING RING GEAR

(1) Apply loctite #515 bottom of casing sub assy contacting with ring gear without disconnection.



2209A8SM38

Refer to loctite detail.

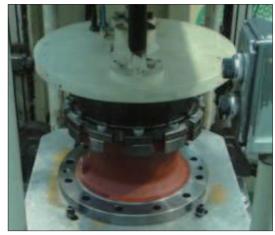


(2) Put parallel pin into hole of casing sub assy. Mark parallel pin position using paint marker.



2209A8SM40

- (3) Align ring gear with parallel pin to put them into casing sub assy.
- * Be sure to maintain them vertical with ground while using press.



2209A8SM41

(4) Screw 12 bolts (M16 $\times$ 45) to connect casing sub assy and ring gear (01) by using torque wrench.

Bolt (M16, 12EA) = 12.9T The tightening torque =  $27 \pm 2.7$  kgf·m (195 $\pm$ 19.5 lbf·ft)

- * Apply enough loctite #242 before screwing bolts.
- (5) Use paint marker for checking surplus parts after assembling.



2209A8SM42



2209A8SM43



2209A8SM44

# 7) ASSEMBLING CARRIER SUB ASSY & SUN GEAR

- (1) Put No.2 carrier sub assy along spline of drive shaft spline.
- Screw M10 I-bolt to No.2 carrier sub assy.
- Lifting up No.2 carrier sub assy and align planetary gear and tooth of ring gear by rotating planetary gear by hands.
- Rotate No.2 carrier sub assy by hands to fit No.2 carrier sub assy into drive shaft spline.



2209A8SM45

(2) Put No.2 sun gear into No.2 carrier sub assy.



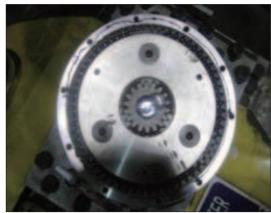
2209A8SM46

- (3) Put No.1 carrier sub assy into No.2 sun gear along spline.
- Screw M10 I-bolt to No.1 carrier sub assy.
- Lifting up No.1 carrier sub assy and align planetary gear and tooth of ring gear by rotating planetary gear by hands.
- Rotate No.1 carrier sub assy by hands to fit No.1 carrier into No.2 sun gear spline.



2209A8SM47

- (4) Put No.1 sun gear into No.1 carrier sub assy. Be sure to maintain it vertical with ground. And align with No.1 planetary gear spline.
- (5) Rotate No.1 carrier sub assy by hands to check noise.



2209A8SM48

### 8) MEASURING CLEARANCE & ASSEMBLING NAME PLATE

(1) Check the clearance between ring gear and No.1 sun gear using a tool with dial gauge.

Check the clearance Dial gauge = -0.3 ~ +2.95



2209A8SM49

# **GROUP 6 TRAVEL DEVICE (TYPE 1, 2)**

#### 1. REMOVAL AND INSTALL

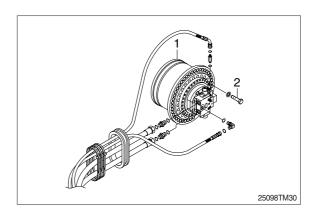
#### 1) REMOVAL

- (1) Swing the work equipment 90° and lower it completely to the ground.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ♠ Escaping fluid under pressure can penetrate the skin causing serious injury.
- When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Remove the track shoe assembly.
  For details, see removal of track shoe assembly.
- (5) Remove the cover.
- (6) Remove the hoses.
- * Fit blind plugs to the disconnected hoses.
- (7) Remove the bolts and the sprocket.
- (8) Sling travel device assembly (1).
- (9) Remove the mounting bolts (2), then remove the travel device assembly.
  - Weight: 305 kg (670 lb)

#### 2) INSTALL

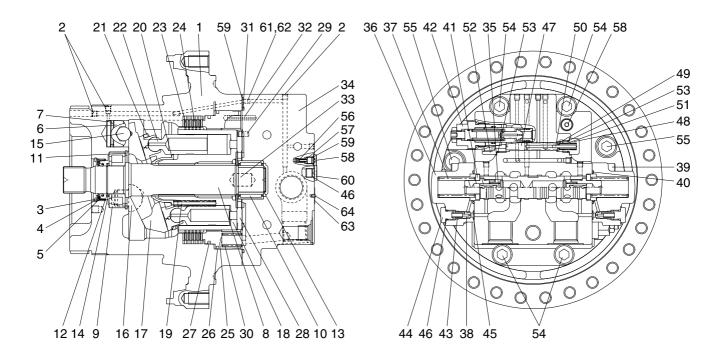
- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from the travel motor.
- ① Remove the air vent plug.
- ② Pour in hydraulic oil until it overflows from the port.
- 3 Tighten plug lightly.
- Start the engine, run at low idling, and check oil come out from plug.
- ⑤ Tighten plug fully.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.





### 2. TRAVEL MOTOR

# 1) STRUCTURE



2209A2TM21

1	Casing	23	Friction plate	44	Plug
2	Plug	24	Separated plate	45	O-ring
3	Oil seal	25	Parking piston	46	O-ring
4	Thrust plate	26	D-ring	47	Spool
5	Snap ring	27	D-ring	48	Plug
6	Piston	28	Valve plate	49	Spring seat
7	Piston seal	29	Parallel pin	50	Parallel pin
8	Shaft	30	Spring	51	Spring
9	Cylinder roller bearing	31	O-ring	52	Connector
10	Needle bearing	32	Spring pin	53	O-ring
11	Snap ring	33	Parallel pin	54	Hexagon socket head bolt
12	Snap ring	34	Rear cover	55	Hexagon socket head bolt
13	Snap ring	35	Main spool assy	56	Check valve
14	Thrust plate	36	Cover	57	Spring
15	Steel ball	37	Spring	58	Plug
16	Pivot	38	Restrictor	59	O-ring
17	Swash plate	39	Hexagon socket head bolt	60	Plug
18	Cylinder block	40	O-ring	61	Restrictor
19	Spring	41	Spring seat	62	Restrictor
20	Ball guide	42	Relief valve assy	63	Name plate
21	Retainer plate	43	Spring	64	Rivet
22	Piston assy				

# 2) TOOLS AND TIGHTENING TORQUE

# (1) Tools

Tool name	Remark				
Hexagon wrench	Width across flat 5, 6, 8, 10, 14 mm				
Snap ring prier	For shaft Ø60~80 mm				
Snap ring prier	For bore Ø32~58 mm				
Plastic hammer	1 piece				
Screw dirver	Minus (-), medium size, 2 pieces				
Torque wrench	10 kgf·m (72.3 lbf·ft), 33 kgf·m (238.6 lbf·ft), 45 kgf·m (325.4 lbf·ft)				
Gig for inserting oil seal	Ø58 25098TM31				
Gig for inserting parking piston (M10×100 bolt 2EA, M12×100 bolt 1EA)	230 187 25098TM32				
Gig for pulling out brake piston	24.5° 24.5° 24.5° 24.5° 24.5° 24.5° 24.5° 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00 25.00				

# (2) Tightening torque

Itom	Name	Size	Torque		
Item		Size	kgf ⋅ m	lbf ⋅ ft	
2	Plug	NPTF 1/16	1.1±0.1	7.9±0.72	
39	Hexagon socket head bolt	M12	1.0±1.0	72.3±7.2	
42	Relief valve	1 5/16	34±3.4	246±24.6	
44	Plug	PF 1/4	2.8±0.3	20.3±2.17	
48	Plug	PF 3/8	5.5±0.5	39.8±3.6	
52	Connector	PF 3/8	5.5±0.5	39.8±3.6	
54	Hexagon socket head bolt	M18	38±3.8	275±27.5	
55	Hexagon socket head bolt	M18	38±3.8	275±27.5	
58	Plug	PF 1/8	1.5±0.1	10.8±0.72	
60	Plug	PF 1/4	3±0.3	21.7±2.17	

#### 3. DISASSEMBLING

#### 1) GENERAL INSTRUCTIONS

▲ Combustibles such as white kerosene are used for washing parts.

These combustibles are easily ignited, and could result in fire or injury.

Be very careful when using.

▲ Internal parts are coated with hydraulic fluid during disassembling and are slippery.
If a part slips out of your hand and fails, it could result in bodily injury or could damage the park.

Be very careful when handling.

- (1) Generally, hydraulic equipment is precisely manufactured and clearances between each parts are very narrow. Therefore, disassembling and assembling works should be performed on the clean place where dusts hardly gather. Tools and kerosene to wash parts should also be clean and handled with great care.
- (2) When motor is removed from the host machine, wash around the ports sufficiently and put the plugs so that no dust and/or water may invade. Take off these plugs just before the piping works when re-attach it to the host machine.
- (3) Bofore disassembling, review the sectional drawing and prepare the required parts, depending on the purpose and the range of disassembling.

Seals, O-rings, etc., if once disassembled, are not reusable.

There are some parts that should be replaced as a subassembly.

Consult with the parts manual in advance.

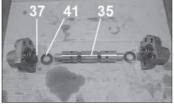
- (4) The piston can be inserted to whichever cylinder block for the initial assembling.

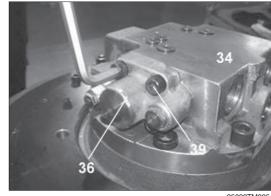
  However, their combination should not be changed if they are once used. To reuse them, put the matching mark on both pistons and cylinder block before disassembling.
- ▲ Take great care not to pinch your hand between parts while disassembling nor let fall parts on your foot while lifting them.

### 2) DISASSEMBLING TRAVEL MOTOR

(1) Disassemble the wrench bolt (39) to tighten the spool cover (36) and rear cover (34) by using the L-wrench or impact wrench and then disassemble the spring (37), spring seat

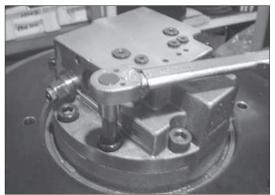
(41) and main spool assy (35) in order.





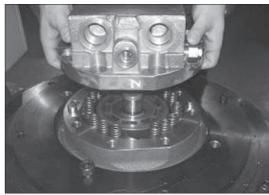
25098TM035

(2) Disassemble the wrench bolt (54, 55) to tighten the casing (1) and rear cover (34) by using the L-wrench or impact wrench.



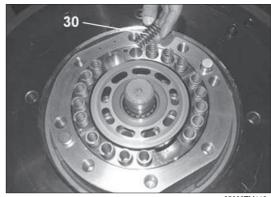
25098TM036

(3) Separate the casing (1) and rear cover (34).



25098TM037

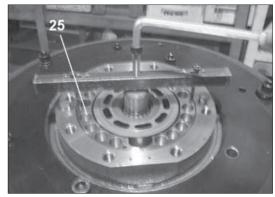
(4) Disassemble the brake spring (30, 18EA) from the piston.



(5) Disassemble the parking piston (25) by using the jig for disassembling parking piston.



25098TM039



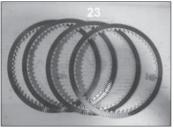
25098TM040

(6) Disassemble the separated plate (24, 5EA) and friction plate (23, 4EA) from the casing.





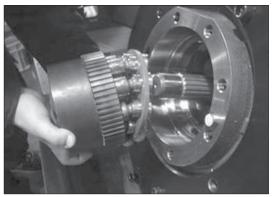
25098TM042





25098TM044

(7) Turn the casing (1) horizontal by using the assemble truck and disassemble the cylinder block kit form the casing (1).

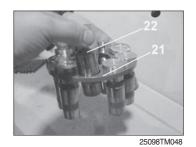


25098TM045

(8) Disassemble the cylinder block (18), retainer plate (21), piston assy (22), ball guide (20) and spring (19) from the cylinder block kit.







20



(9) Disassemble the swash plate (17) from the casing.

25098TM049





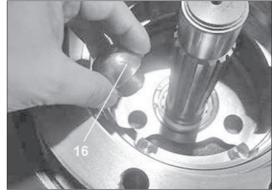
(10) Disassemble the steel ball (15) and swash piston (6) from the casing.





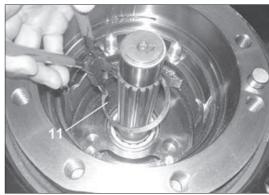


(11) Disassemble the pivot (16, 2EA) from the casing.



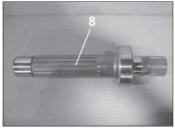
25098TM056

(12) Disassemble the snap ring (11) from the shaft (8) with the pryer for retaining ring.



25098TM057

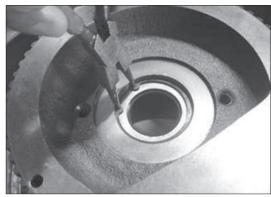
(13) Disassemble the shaft (8) from the casing (1).



25098TM058

25098TM059

(14) Disassemble the snap ring (5) from the casing (1) with the pryer for retaining ring.



25098TM060

(15) Disassemble the thrust plate (4) from the casing (1).



25098TM061

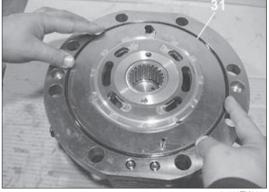
(16) Disassemble the oil seal (3) from the casing (1) with suitable tool.



25098TM062

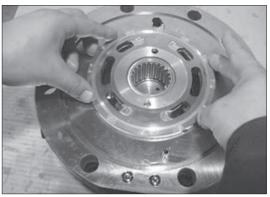
25098TM063

(17) Disassemble the O-ring (31) from the casing (1).



25098TM064

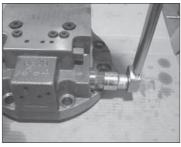
(18) Disassemble the valve plate (28) from the casing (1).

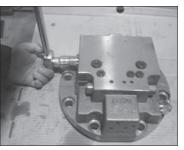


25098TM065

(19) Disassemble the relief valve (42, 2EA) from the rear cover (34) by using the torque wrench.

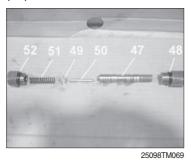






25098TM067

(20) Disassemble both side of the plug (48) and connector (52) from the rear cover (34) by using the torque wrench and then disassemble the spring (51), spring seat (49), parallel pin (50) and spool (47) in order.





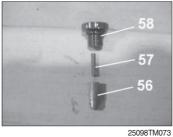


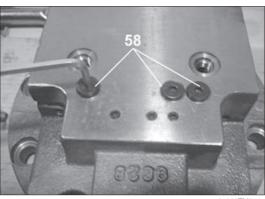
(21) Disassemble the plug (60) from the rear cover.



25098TM072

(22) Disassemble the plug (58) and then disassemble the spring (57) and check valve (56) from the rear cover in order.





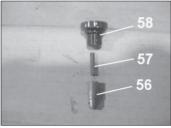
25098TM074

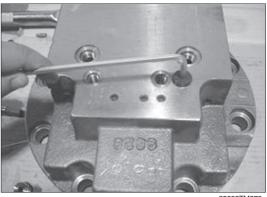
### 4. REASSEMBLING

### 1) ASSEMBLING MOTOR

### - REAR COVER ASSY

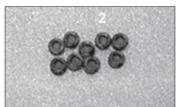
(1) Assemble the check valve (56) and the spring (57) to the rear cover and then tighten the plug (60) by using the L-wrench.



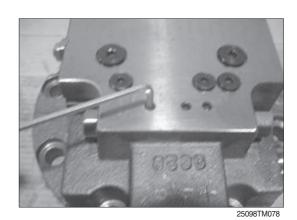


25098TM076

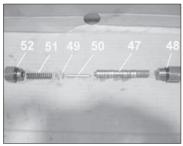
(2) Apply the loctite #242 on the NPTF 1/16 plug (2, 12EA) and tighten it.



25098TM077



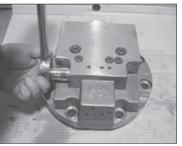
(3) Assemble the spool (47), parallel pin (50), spring seat (49) and spring (51) into the rear cover (34) and tighten both side of the plug (48) and connector (52) into the rear cover (34).



25098TM079



25098TM080



25098TM081

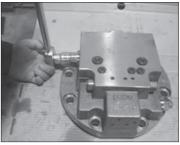
(4) Assemble the relief valve (42, 2EA) into rear cover (34).



25098TM082



25098TM083



25098TM084

(5) Tight fit the needle bearing (10) into rear cover (34) by using pressing jig.



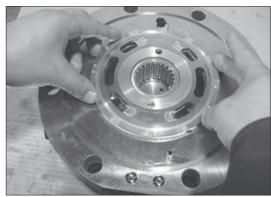
25098TM085

(6) Assemble the spring pin (32) and parallel pin (29) into rear cover (34) by using round bar or small hammer.



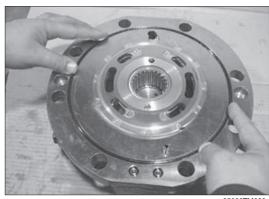
25098TM086

(7) Assemble the valve plate (28) into rear cover (34).Before assembling, apply some grease on contact surface of the valve plate.



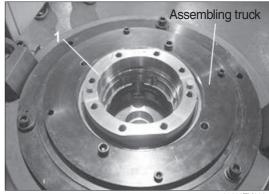
25098TM087

(8) Apply some grease on the O-ring and fit it into groove.



25098TM088

(9) Assemble the casing (1) on the assembling truck.



25098TM089

- (10) Tight fit the oil seal (3) into the casing (1) by using jig.

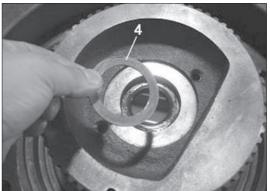


25098TM090



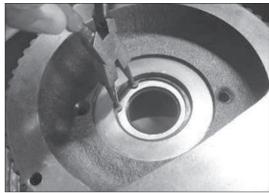
25098TM091

(11) Assemble the thrust plate (4) into the casing (1).



25098TM092

(12) Assemble the snap ring (5) into the casing (1) with the plier for retaining ring.



25098TM093

- (13) Heat the roller bearing (9) and fit it into the shaft with shrink fitting.
  - a. Shrink fitting can be used induction heating system and set the temperature at 100°C.
  - b. Be careful not to damage the sliding surface of the oil seal of the shaft.







(14) Assemble the heat-fitted shaft (8) into casing (1).



25098TM097

(15) Assemble the snap ring (11) into the casing (1) with the plier for retaining ring.



25098TM098

(16) Apply a little grease on the pivot (16, 2EA) and assemble it into the casing (1).

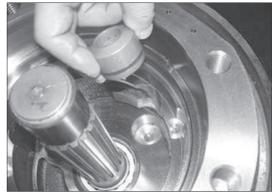


25098TM099

(17) Heat the piston seal (7) and fit it into the swash piston (6) and then tighten it a few minutes by band or tie. Loosen the band or tie and assemble it to the casing (1).

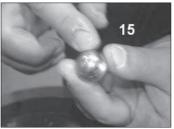


25098TM100

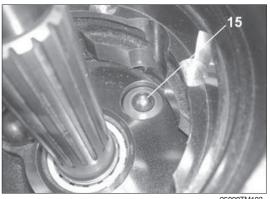


25098TM101

(18) Apply a little grease on the steel ball (15) and assemble it into the swash plate (17).



25098TM102



25098TM103

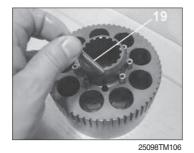
(19) Apply some grease on the steel ball hole of the swash plate (17) and assemble it casing (1).

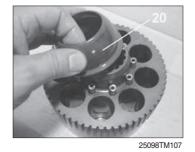


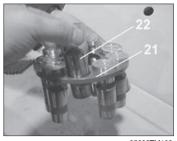


25098TM105

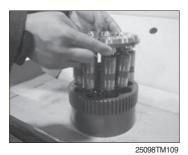
(20) Assemble the spring (19), ball guide (20), retainer plate (21) and piston assy (22) into cylinder block (18) in order.







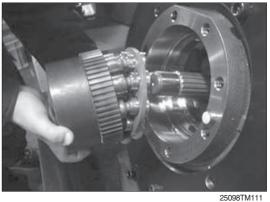
25098TM108





25098TM110

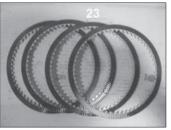
(21) Tilt the casing (1) sideways and assemble the cylinder block kit into the casing (1).



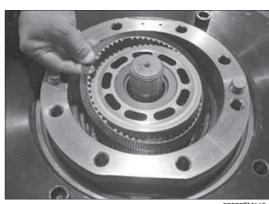
(22) Assemble the separated plate (24) and friction plate (23) into the cylinder block alternately.

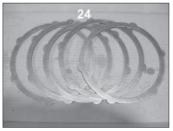
Friction plate: 4EA

Separated plate: 5EA



25098TM112

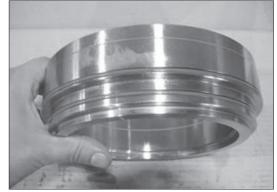




25098TM114

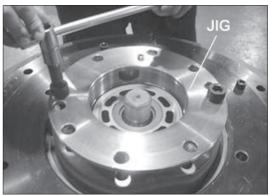


(23) Apply some grease on the D-ring and assemble it parking piston.



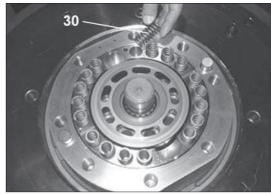
25098TM116

(24) Insert the parking piston into the casing and assemble it by using jig.



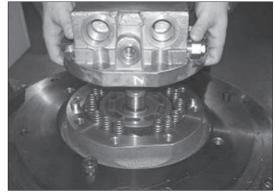
25098TM117

(25) Assemble the brake spring (30, 18EA) into the piston.

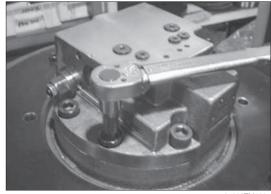


25098TM118

(26) Place the rear cover (34) on the casing (1).



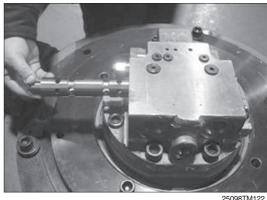
(27) Tighten the casing (1) and rear cover (34) specified torque with wrench bolt (54, 55) by using the impact wrench and torque wrench.



25098TM120

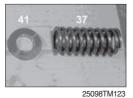
- (28) Confirm the insert direction of the main spool assy (35) exactly and assemble it into the rear cover (34).
- Assure that four balance hole is directed VA port.



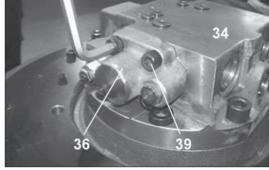


25098TM122

(29) Assemble the spring seat (41), spring (37) and main spool cover (36) into valve plate and tighten the wrench bolt (39, M12x35) by using L-wrench or impact wrench.

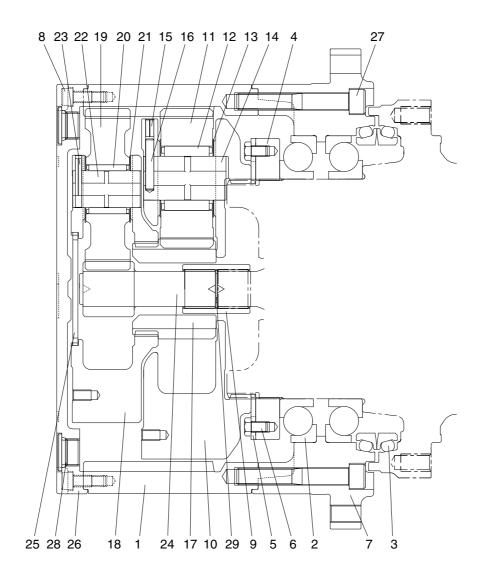






25098TM125

# 2) TRAVEL REDUCTION GEAR



2209A2TM22

1	Ring gear	12	Needle bearing 2	22	Carrier pin 1
2	Ball bearing	13	Thrust washer 2	23	Spring pin 1
3	Floating seal assy	14	Carrier pin 2	24	Sun gear 1
4	Ring nut	15	Spring pin 2	25	Thrust plate
5	Lock plate	16	Solid pin 2	26	Cover
6	Hexagon bolt	17	Sun gear 2	27	Hexagon socket head bolt
7	Housing	18	Carrier 1	28	Plug
8	Hexagon socket head bolt	19	Planetary gear 1	29	Snap ring
9	Coupling	20	Needle bearing 1	30	Name plate
10	Carrier 2	21	Thrust washer 1	31	Rivet
11	Planetary gear 2				

#### 6. DISASSEMBLING

#### 1) GENERAL INSTRUCTIONS

▲ Combustibles such as white kerosene are used for washing parts.

These combustibles are easily ignited, and could result in fire or injury.

Be very careful when using.

▲ Internal parts are coated with gear oil during disassembling and are slippery.
If a part slips off from your hand and fails, it could result in bodily injury or could damage the park.

Be very careful when handling.

(1) Therefore, disassembling and assembling works should be performed on the clean place where dusts hardly gather.

Tools and kerosene to wash parts should also be clean and handled with great care.

(2) Bofore disassembling, review the sectional drawing and prepare the required parts, depending on the purpose and the range of disassembling.

Seals, O-rings, etc., if once disassembled, are not reusable.

There are some parts that should be replaced as a subassembly.

Consult with the parts manual in advance.

▲ Take great care not to pinch your hand between parts while disassembling nor let fall parts on your foot while lifting them.

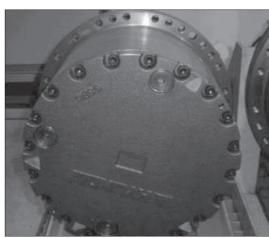
#### 2) DISASSEMBLING TRAVEL REDUCTION GEAR

#### (1) Preparation for disassembling

- ① The reduction units removed from excavator are usually covered with mud. Wash outside of propelling unit and dry it.
- 2 Locate reducer in order for drain port to be at the lowest level, loosen taper screw plug of drain port, and drain oil from reduction gear.
- While oil is still hot, inside of the unit may be pressurized.
- ▲ Take care of the hot oil gushing out of the unit when loosening the plug.

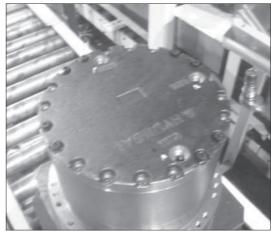


Put marks on each mating parts when disassembling so as to reassemble correctly as before.



#### (2) Setting reduction unit (or whole propelling unit) on work stand for disassembling

- ① Remove 7/16-14UNC hexagon socket head bolts at 3 places from cover almost equally apart each other, and then install 7/16-14UNC eye bolts.
- ▲ Take great care not to pinch your hand between parts while disassembling nor let fall parts on your foot while lifting them.



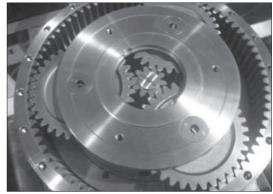
#### (3) Removing cover

- ① Remove the rest of 7/16-14UNC hexagon socket head bolts that secure cover and ring gear. Loosen all the socket bolts and then, disassemble cover.
- ② As the cover is adhered to ring gear, disassemble ring gear and cover by lightly hammering slantwise upward using sharpen punch inserted between the cover and ring gear.



#### (4) Removing No.1 carrier sub assembly

① Screw three M10 eye-bolt in No.1 carrier and lift up and remove No.1 carrier assy.



25098TM129

- ② Remove No.1 sun gear.
- Be sure to maintain it vertical with the ground when disassembling No.1 sun gear.



25098TM130

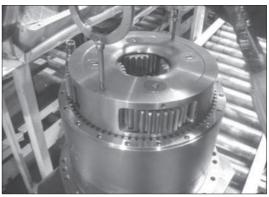
# (5) Removing No.2 carrier sub assembly

① Screw three M10 eye-bolt in No.2 carrier and lift up and remove No.2 carrier assy.



25098TM131

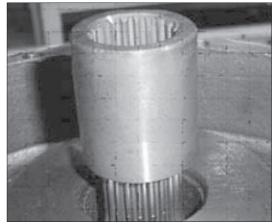
- ② Remove No.2 sun gear.
- Be sure to maintain it vertical with the ground when disassembling No.1 sun gear.



25098TM132

## (6) Removing coupling

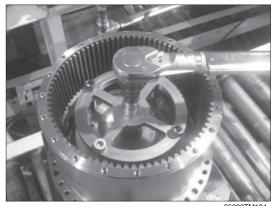
① Remove coupling.



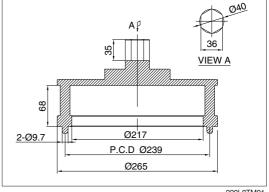
25098TM133

#### (7) Removing ring nut & lock plate

- ① Remove M12 hexagon head bolts that secure ring nut and lock plate.
- ② Remove lock plate.



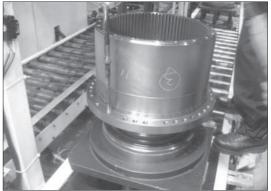
- ③ Remove ring nut from motor casing.
- * Remove the ring nut by using the special tool for removing the ring nut.



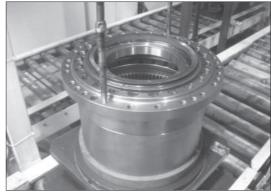
220L8TM01

## (8) Removing housing sub assembly & ring gear

① Screw 7/16-14UNC eye bolt in housing and lift up ring gear and housing assembly including anguler bearing and floating seal.



② Setting reduction unit on work stand for disassembling. Remove M16 hexagon socket head bolts that secure ring gear and housing assembly.



25098TM136

③ As the ring gear is adhered to housing assy, disassemble housing assy and ring gear by lightly hammering slantwise upward using sharpen punch inserted between the housing assy and ring gear.



25098TM137

### (9) Removing floating seal

① Lift up a piece of floating seal of motor side.



25098TM138

#### (10) Removing housing sub assembly

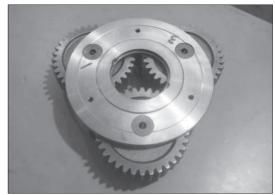
- ① Setting housing assembly on work stand for disassembling.
- ② After setting housing, lift up a piece of floating seal from housing and then remove it.
- Don't disassemble angular bearing.



25098TM139

# (11) Disassembling No.1 carrier

① Remove thrust plate.



25098TM140

② Knock spring pin fully into No.1 pin.



25098TM141

③ Remove planetary, thrust washer, No.1 pin, bearing from carrier.



25098TM142

# (12) Disassembling No.2 carrier

- ① Knock spring pin fully into No.2 pin.
- ② Remove No.2 solid pin.
- ③ Remove planetary, thrust washer, No.2 pin, bearing from carrier.



25098TM143

#### 7. ASSEMBLY REDUTION UNIT

#### 1) GENERAL NOTES

- (1) Clean every part by kerosene and dry them by air blow.
- (2) Surfaces to be applied by loctite must be decreased by solvent.
- (3) Check every part for any abnormal.
- (4) Each hexagon socket head bolt should be used with loctite No.242 applied on its threads.
- (5) Apply gear oil slightly on each part before assembling.
- ▲ Take great care not to pinch your hand between parts or tools while assembling nor let fall parts on your foot while lifting them. Inspection before reassembling.

#### Thrust washer

- · Check if there are seizure, abnormal wear or uneven wear.
- · Check if wear is over the allowable limit.

#### Gear

- · Check if there are pitting or seizure on the tooth surface.
- · Check if there are cracks on the root of tooth by die check.

#### Bearing

· Rotate by hand to see if there are something unusual such as noise or uneven rotation.

#### Floating seal

· Check flaw or score on sliding surfaces or O-ring.

#### 2) ASSEMBLING CARRIER 1 ASSY

- (1) Put No.1 carrier on a flat place.
- (2) Install No.1 needle bearing into No.1 planetary gear, put 2EA of No.1 thrust washer on both sides of planetary gear, and then, install it into carrier.



25098TM144

(3) Install No.1 pin into No.1 carrier where the holes for No.1 pin are to be in line with those of No.1 carrier, and then, install spring pins into the holes.



25098TM145

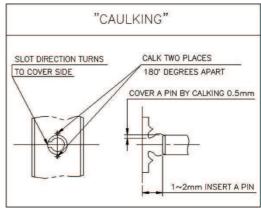
(4) Caulk carrier holes as shown on the picture.



25098TM146

#### 3) ASSEMBLING CARRIER 2 ASSY

- (1) Put No.2 carrier on a flat place.
- (2) Install No.2 needle bearing into No.2 planetary gear, put 2EA of No.2 thrust washer on both sides of planetary gear, and then, install it into carrier.



25098TM147

- (3) After install solid pin into the holes, install No.2 pin into No.1 carrier where the holes for No.1 pin are to be in line with those of No.1 carrier, and then, install spring pins into the holes.
- (4) Caulk carrier holes as shown on the picture.



25098TM148

#### 4) ASSEMBLING FLOATING SEAL

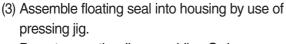
- (1) Assemble floating seal into motor by use of pressing jig.
  - Grease the contact parts for floating seal which is assembled into motor.
- * Be sure to maintain it vertical with the ground when assembling bearing and floating seal.



25098TM149

#### 5) ASSEMBLING HOUSING

- (1) Heat housing at 60~70°C while clearing it out and then, assemble floating seal into housing by use of pressing jig.
- (2) Setting housing assembly on work stand for assembling.
  - Assemble angular bearing into housing by use of pressing jig.



Do not reuse the disassembling O-ring. Grease the contact parts for floating seal which is assembled into housing.

Be sure to maintain it vertical with the ground when assembling bearing and floating seal.



25098TM150

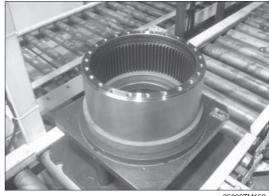


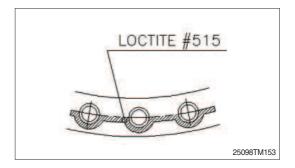
25098TM151

#### 6) ASSEMBLING HOUSING ASSY AND RING **GEAR**

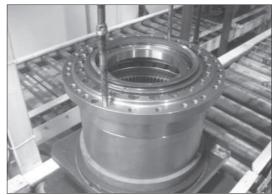
(1) Setting ring gear on work stand for assembling.

Apply loctite #515 on ring gear for housing without gap.





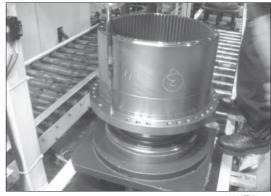
- (2) Install M16 eye-bolt on the tap of housing.
- (3) Lift housing and then, assemble into housing in order for bolt hole of ring gear and bolt hole of housing to be in line.
- (4) Apply loctite #242 on M16 hexagon socket head bolt, and then, bolt.



25008TM15/

# 7) ASSEMBLING HOUSING ASSY AND MOTOR

- (1) Install 7/16-14UNC eye-bolt on the tap of ring gear.
- (2) Assemble housing assembly into motor by use of hoist and eye-bolt.
- Be sure to tighten eye-bolt deep enough.



25098TM155

#### 8) ASSEMBLING MAIN BEARING

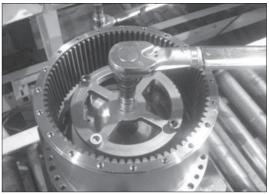
- (1) Assemble angular bearing into housing by use of pressing jig.
- Be sure to maintain it vertical with the ground when assembling bearing.



25098TM156

# 9) ASSEMBLING NUT RING AND LOCK PLATE

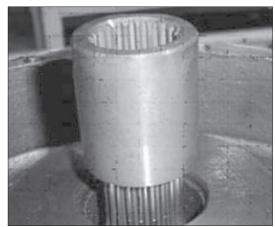
- (1) Tighten nut ring to specified torque, utilizing special tool.
  - Tightening torque: 60.3 kgf·m (436 lbf·ft)
- (2) After install lock plate, apply loctite #242 on M12 hexagon head bolt, and then, bolt. Tighten M12 hexagon head bolt to specified torque, with torque wrench.



25098TM157

#### 10) ASSEMBLING COUPLING

(1) Install coupling on spline of the motor.



25098TM158

#### 11) ASSEMBLING NO.2 CARRIER SUB **ASSEMBLY**

- (1) Install M10 eye-bolt on No.2 carrier assembly.
- (2) Lift No.2 carrier assembly and then, slowly put it down on ring gear.
- (3) Rotate planetary gear by hands and install on ring gear.
- (4) Rotate No.2 carrier assembly by hands and install on motor.
- * Match pin hole of No.2 carrier with main (A, B) port of motor.



#### 12) ASSEMBLING NO.2 SUN GEAR

(1) Install No.2 sun gear on the No.2 planetary gear, matching teeth of them.



#### 13) ASSEMBLING NO.1 CARRIER SUB **ASSEMBLY**

- (1) Install M10 eye-bolt on No.1 carrier assembly.
- (2) Lift No.1 carrier assembly and then, slowly put it down on ring gear.
- (3) Rotate planetary gear by hands and install on ring gear.
- (4) Rotate No.1 carrier assembly by hands and install on No.2 sun gear.



#### 14) ASSEMBLING NO.1 SUN GEAR

- (1) Put down No.1 sun gear on No.1 carrier, maintaining it vertical with spline of coupling.
- (2) Install No.1 sun gear on No.1 planetary gear, matching their teeth.



25098TM162

#### 15) ASSEMBLING THRUST PLATE

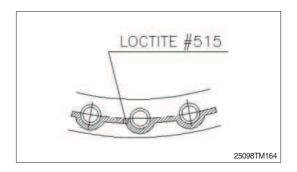
- (1) Assembly thrust plate into No.1 carrier.
- Edge of thrust plate direction turns to cover side.



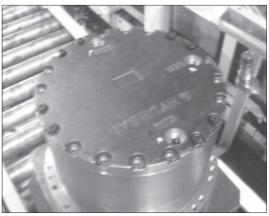
25098TM163

#### 16) ASSEMBLING COVER

(1) Apply loctite #515 on the ring gear for cover without gap.



- (2) Put cover on ring gear, apply loctite #242 on 7/16-14UNC hexagon socket head bolt, and then, bolt.
  - Tighten 7/16-14UNC hexagon socket head bolt to specified torque, with torque wrench.
- (3) Fill gear oil (6 liter) into drain port.
- (4) Apply gear oil on PF3/4 hydraulic plug and then, bolt.



25098TM165

#### **GROUP 7 RCV LEVER**

#### 1. REMOVAL AND INSTALL

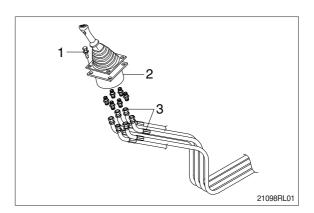
#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
- (4) Loosen the socket bolt (1).
- (5) Remove the cover of the console box.
- (6) Disconnect pilot line hoses (3).
- (7) Remove the pilot valve assembly (2).
- When removing the pilot valve assembly, check that all the hoses have been disconnected.

#### 2) INSTALL

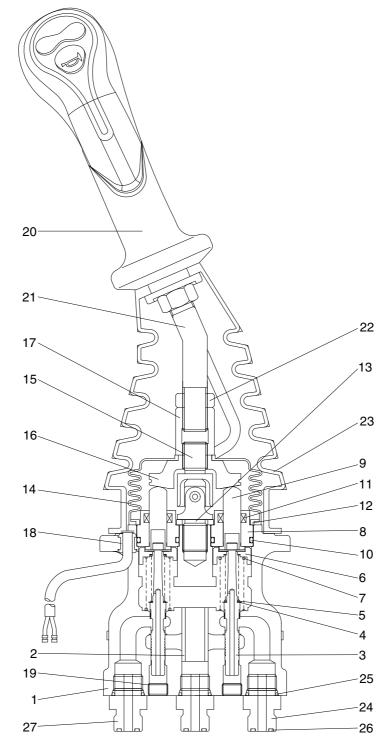
- Carry out installation in the reverse order to removal.
- (2) Confirm the hydraulic oil level and check the hydraulic oil leak or not.





#### 2. DISASSEMBLY AND ASSEMBLY

# 1) STRUCTURE



Plug Case Joint assembly 22 Nut 1 8 15 Swash plate 2 Bushing 9 Push rod 16 23 Boot Adjusting nut Last guard filter 3 Spool 10 O-ring 17 24 Bushing 4 Shim 11 Rod seal 18 25 O-ring Plate 5 Spring 12 19 Plug 26 O-ring 6 Spring seat Spacer Handle assembly 27 Connector 13 20 7 Boot 21 Handle bar Spring 14

300L2RL06

# 2) TOOLS AND TIGHTENING TORQUE

# (1) Tools

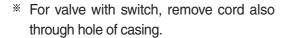
Tool name	Remark		
Allen wrench	6 B		
Channe	22		
Spanne	27		
(+) Driver	Length 150		
(-) Driver	Width 4~5		
Torque wrench	Capable of tightening with the specified torques		

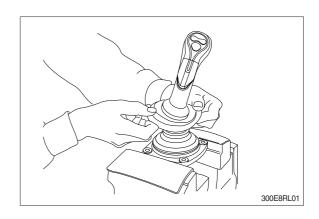
# (2) Tightening torque

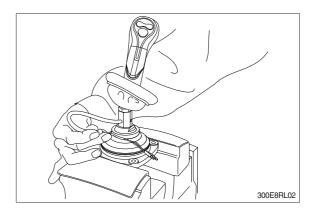
Part name	Item	Size	Torque		
Fait name			kgf ⋅ m	lbf ⋅ ft	
Joint	15	M14	3.5	25.3	
Swash plate	16	M14	5.0±0.35	36.2±2.5	
Adjusting nut	17	M14	$5.0 \pm 0.35$	36.2±2.5	
Lock nut	22	M14	5.0±0.35	36.2±2.5	

#### 3) DISASSEMBLY

- * Procedures are based on the type M1.
- (1) Clean pilot valve with kerosene.
- * Put blind plugs into all ports
- (2) Fix pilot valve in a vise with copper (or lead) sheets.
- (3) Remove end of boot (23) from case (1) and take it out upwards.



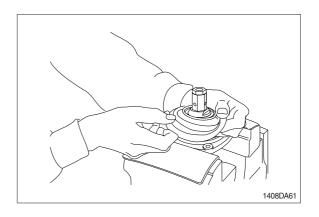




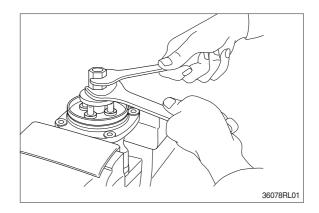
(4) Loosen lock nut (22) and adjusting nut (17) with spanners on them respectively, and take out handle section as one body.

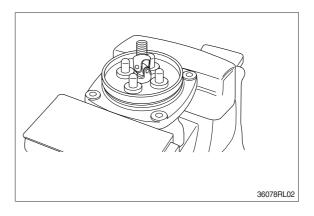


(5) Remove the boot (14).

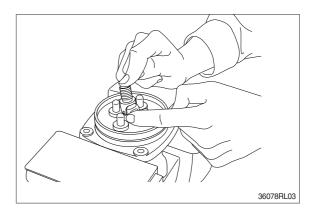


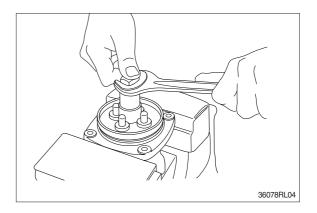
(6) Loosen adjusting nut (17) and swash plate (16) with spanners on them respectively, and remove them.



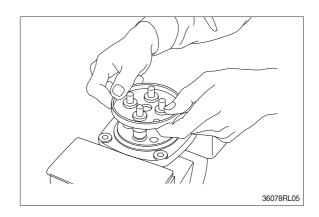


- (7) Turn joint anticlockwise to loosen it, utilizing jig (Special tool).
- When return spring (7) is strong in force, plate (12), plug (8) and push rod (9) will come up on loosening joint. Pay attention to this.

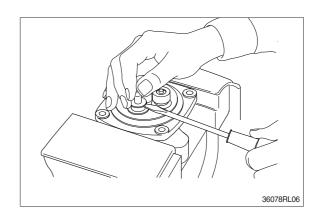


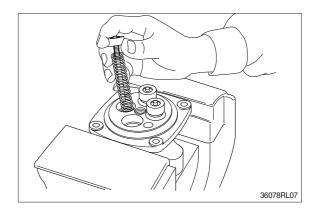


#### (8) Remove plate (12).

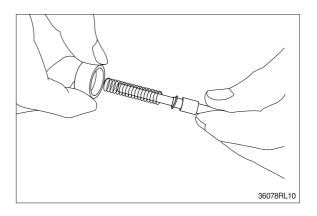


- (9) When return spring (7) is weak in force, plug (8) stays in casing because of sliding resistance of O-ring.
- * Take it out with minus screwdriver. Take it out, utilizing external periphery groove of plug and paying attention not to damage it by partial loading.
- During taking out, plug may jump up due to return spring (7) force.
   Pay attention to this.
- (10) Remove reducing valve subassembly and return spring (7) out of casing.
- ** Record relative position of reducing valve subassembly and return springs.

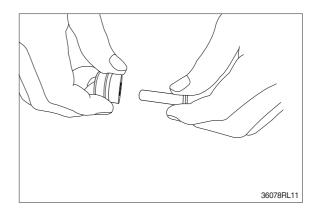




- (11) Separate spool (3), spring seat (6), spring (5) and shim (4) individually.
- * Pay attention not to damage spool surface.
- * Record original position of spring seat (6).
- We Until being assembled, they should be handled as one subassembly group.

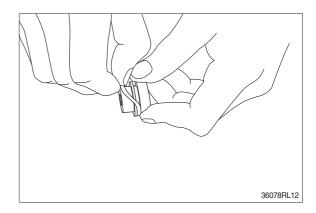


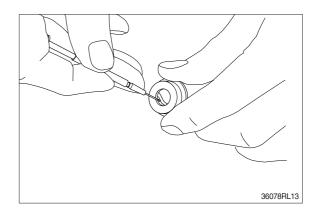
(12) Take push rod (9) out of plug (8).



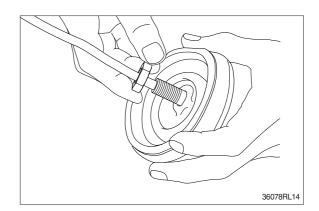
(13) Remove O-ring (10) and seal (11) from plug (8).

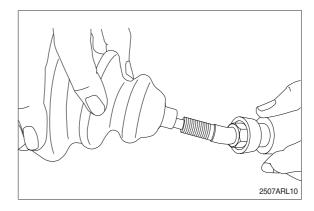
Use small minus screwdriver or so on to remove this seal.





(14) Remove lock nut (22) and then boot (23).





#### (15) Cleaning of parts

- ① Put all parts in rough cleaning vessel filled with kerosene and clean them (rough cleaning).
- If dirty part is cleaned with kerosene just after putting it in vessel, it may be damaged. Leave it in kerosene for a while to loosen dust and dirty oil.
- ** If this kerosene is polluted, parts will be damaged and functions of reassembled valve will be degraded.
  - Therefore, control cleanliness of kerosene fully.
- ② Put parts in final cleaning vessel filled with kerosene, turning it slowly to clean them even to their insides (finish cleaning).
- * Do not dry parts with compressed air, since they will be damaged and/or rusted by dust and moisture in air.

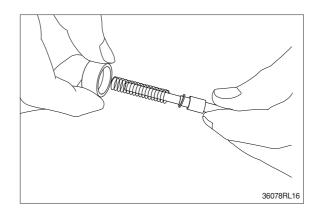
#### (16) Rust prevention of parts

Apply rust-preventives to all parts.

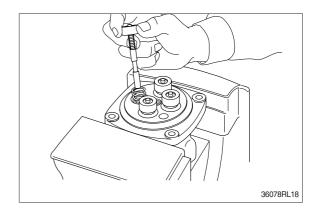
If left as they after being cleaned, they will be rusted and will not display their functions fully after being reassembled.

# 4) ASSEMBLY

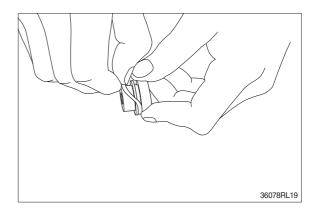
(1) Put shim (4), springs (5) and spring seat (6) onto spool (3) in this order.



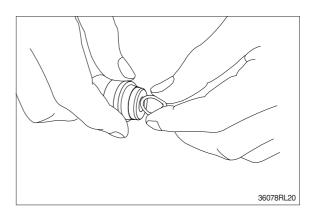
- (2) Assemble spring (7) into casing (1). Assemble reducing valve subassembly into casing.
- * Assemble them to their original positions.



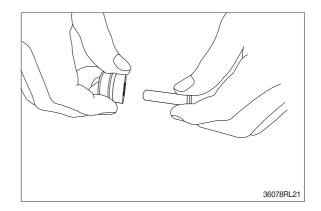
(3) Assemble O-ring (10) onto plug (8).



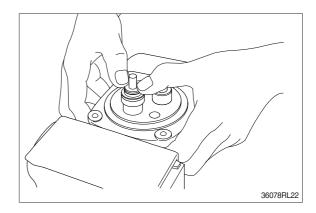
- (4) Assemble seal (11) to plug (8).
- * Assemble seal in such lip direction as shown below.



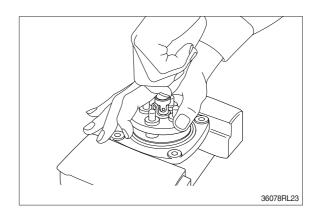
- (5) Assemble push rod (9) to plug (8).
- * Apply working oil on push-rod surface.



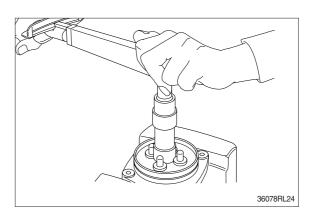
- (6) Assemble plug subassembly to casing.
- When return spring is weak in force, subassembly stops due to resistance of O-ring.



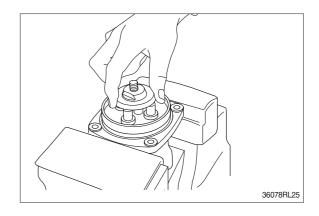
(7) When return spring is strong in force, assemble 4 sets at the same time, utilizing plate (12), and tighten joint (15) temporarily.



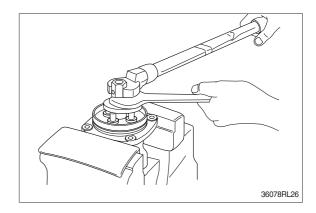
- (8) Fit plate (12).
- (9) Tighten joint (15) with the specified torque to casing, utilizing jig.



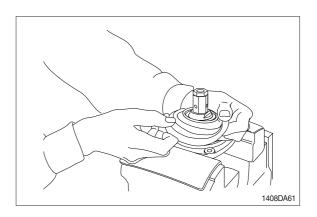
- (10) Assemble swash plate (16) to joint (15).
- Screw it to position that it contacts with 4 push rods evenly.
- * Do not screw it over.



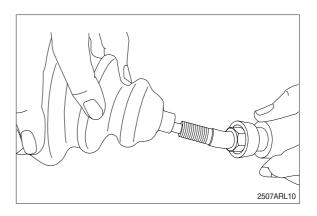
- (11) Assemble adjusting nut (17), apply spanner to width across flat of plate (16) to fix it, and tighten adjusting nut to the specified torque.
- * During tightening, do not change position of disk.

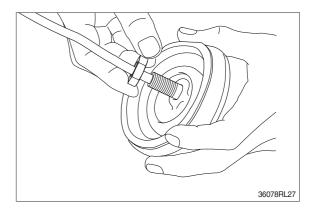


(12) Fit boot (14) to plate.

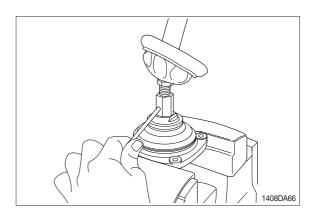


(13) Fit boot (23) and lock nut (22), and handle subassembly is assembled completely.

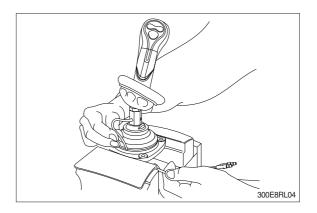




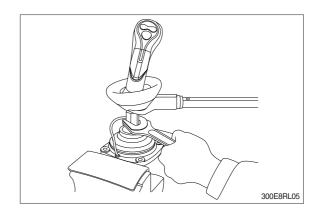
(14) Pull out cord and tube through adjusting nut hole provided in direction 60° to 120° from casing hole.



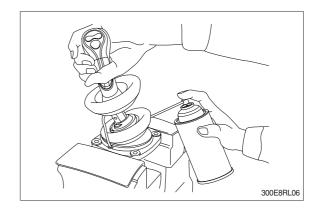
- (15) Assemble bushing (18) to plate and pass cord and tube through it.
- * Provide margin necessary to operation.



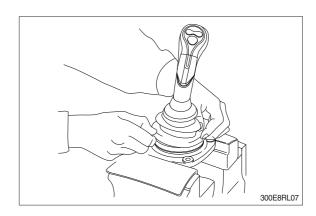
(16) Determine handle direction, tighten lock nut (22) to specified torque to fix handle.



(17) Apply grease to rotating section of joint and contacting faces of disk and push rod.



- (18) Assemble lower end of bellows to casing.
- (19) Inject volatile rust-preventives through all ports and then put blind plugs in ports.



#### **GROUP 8 TURNING JOINT**

#### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- A Escaping fluid under pressure can penetrate the skin causing serious injury.
- When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Disconnect all hoses.
- (5) Sling the turning joint assembly (1) and remove the mounting bolt (2).

· Weight: 55 kg (120 lb)

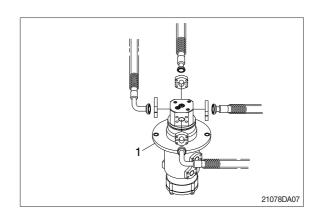
 $\cdot$  Tightening torque : 12.3  $\pm$  1.3 kgf  $\cdot$  m (88.9  $\pm$  9.4 lbf  $\cdot$  ft)

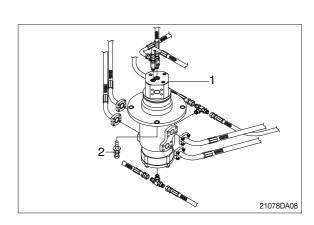
- (6) Remove the turning joint assembly.
- When removing the turning joint, check that all the hoses have been disconnected.

#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- * Take care of turning joint direction.
- * Assemble hoses to their original positions.
- * Confirm the hydraulic oil level and check the hydraulic oil leak or not.

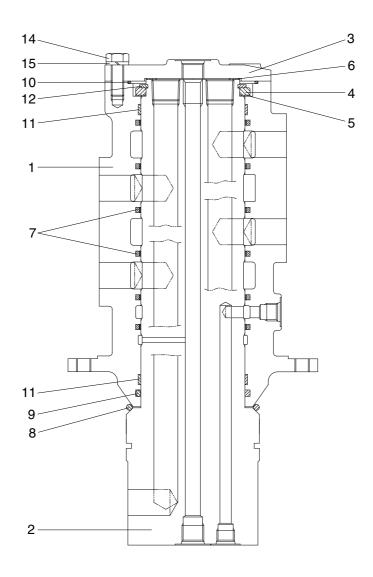






# 2. DISASSEMBLY AND ASSEMBLY

# 1) STRUCTURE

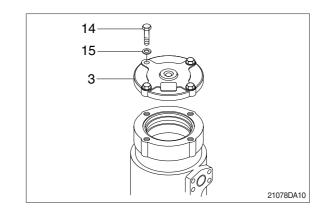


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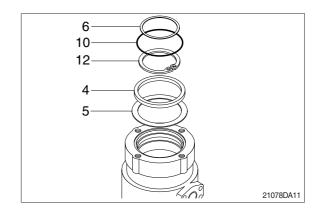
1	Hub	6	Shim	11	Wear ring
2	Shaft	7	Slipper seal	12	Retainer ring
3	Cover	8	O-ring	13	Plug
4	Spacer	9	O-ring	14	Hexagon bolt
5	Shim	10	O-ring	15	Spring washer

#### 2) DISASSEMBLY

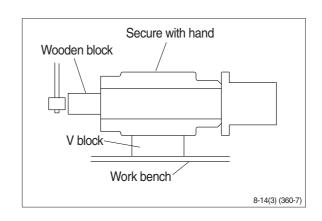
- * Before the disassembly, clean the turning joint.
- (1) Remove bolts (14), washer (15) and cover (3).



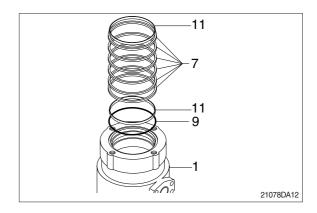
- (2) Remove shim (6) and O-ring (10).
- (3) Remove retainer ring (12), spacer (4) and shim (5).



- (4) Place hub (1) on a V-block and by using a wood buffer at the shaft end, hit out shaft(2) to about 1/2 from the body with a hammer.
- * Take care not to damage the shaft (2) when remove hub (1) or rest it sideway.
- * Put a fitting mark on hub (1) and shaft (2).

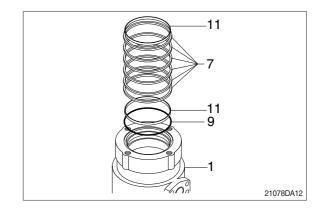


(5) Remove six slipper seals (7) and O-ring (9), two wear ring (11) from hub (1).

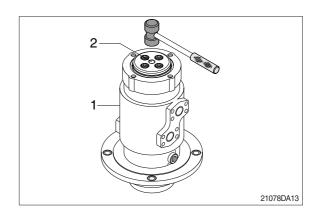


## 3) ASSEMBLY

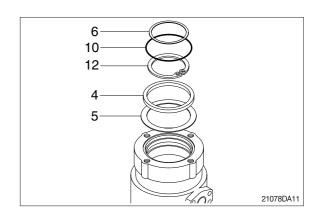
- * Clean all parts.
- * As a general rule, replace oil seals and O-ring.
- * Coat the sliding surfaces of all parts with engine oil or grease before installing.
- (1) Fix seven slipper seal (7) and O-ring (9), two wear ring (11) to hub (1).
- (2) Fit O-ring (8) to shaft (2).



(3) Set shaft (2) on block, tap hub (1) with a plastic hammer to install.

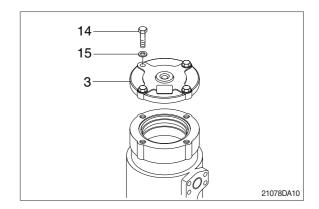


- (4) Fit shim (5), spacer (4) and retainer ring (12) to shaft (2).
- (5) Fit O-ring (10) to hub (1).
- (6) Fit shim (6) to shaft (2).



(7) Install cover (3) to body (1) and tighten bolts (14).

 $\cdot$  Torque : 10~12.5 kgf  $\cdot$  m  $(72.3{\sim}90.4 \text{ lbf} \cdot \text{ft})$ 



# GROUP 9 BOOM, ARM AND BUCKET CYLINDER

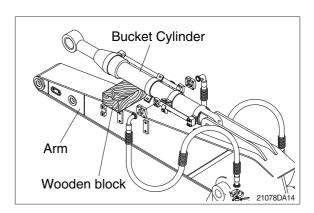
#### 1. REMOVAL AND INSTALL

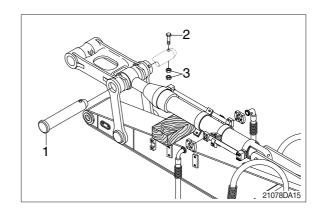
#### 1) BUCKET CYLINDER

#### (1) Removal

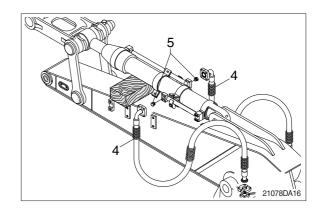
- Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- ** Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- * Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
- Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.
- ① Set block between bucket cylinder and arm.
- ② Remove bolt (2), nut (3) and pull out pin (1).
- * Tie the rod with wire to prevent it from coming out.



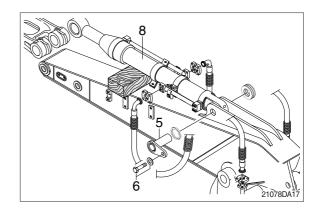




③ Disconnect bucket cylinder hoses (4) and put plugs (5) on cylinder pipe.



- ④ Sling bucket cylinder assembly (8) and remove bolt (6) then pull out pin (5).
- ⑤ Remove bucket cylinder assembly (8).
  - · Weight: 175 kg (390 lb)



- ① Carry out installation in the reverse order to removal.
- ♠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.
- * Bleed the air from the bucket cylinder.
- * Confirm the hydraulic oil level and check the hydraulic oil leak or not.

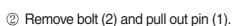
#### 2) ARM CYLINDER

#### (1) Removal

- Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- * Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- * Loosen the breather slowly to release the pressure inside the hydraulic tank.

### ♠ Escaping fluid under pressure can penetrate the skin causing serious injury.

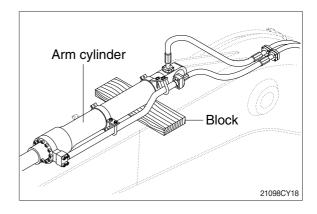
- Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.
- ① Set block between arm cylinder and boom.

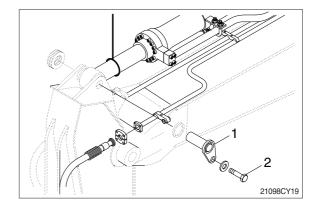


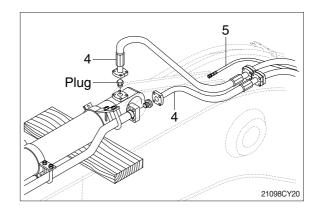
* Tie the rod with wire to prevent it from coming out.

- ③ Disconnect arm cylinder hoses (4) and put plugs on cylinder pipe.
- ④ Disconnect greasing pipings (5).

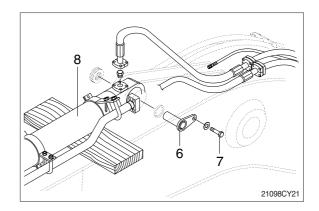








- ⑤ Sling arm cylinder assembly(8) and remove bolt (7) then pull out pin (6).
- 6 Remove arm cylinder assembly (8).
  - · Weight: 290 kg (640 lb)



- ① Carry out installation in the reverse order to removal.
- ♠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.
- * Bleed the air from the arm cylinder.
- ** Confirm the hydraulic oil level and check the hydraulic oil leak or not.

#### 3) BOOM CYLINDER

#### (1) Removal

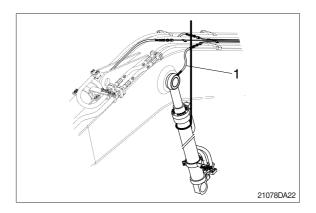
- Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- * Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- * Loosen the breather slowly to release the pressure inside the hydraulic tank.

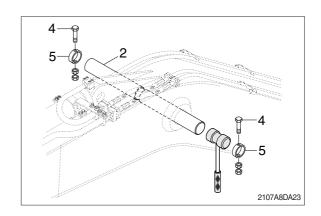
# A Escaping fluid under pressure can penetrate the skin causing serious injury.

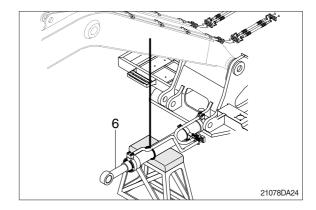
- Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.
- ① Disconnect greasing hoses (1).
- ② Sling boom cylinder assembly.
- ③ Remove bolt (4), stopper (5) and pull out pin (2).
- * Tie the rod with wire to prevent it from coming out.

④ Lower the boom cylinder assembly (6) on a stand.

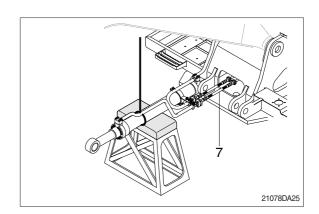




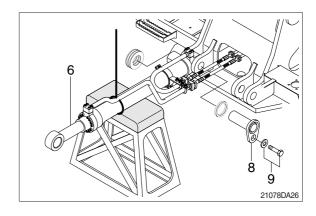




⑤ Disconnect boom cylinder hoses (7) and put plugs on cylinder pipe.



- ⑥ Remove bolt (9) and pull out pin (8).
- ? Remove boom cylinder assembly (6).
  - · Weight: 180 kg (400 lb)

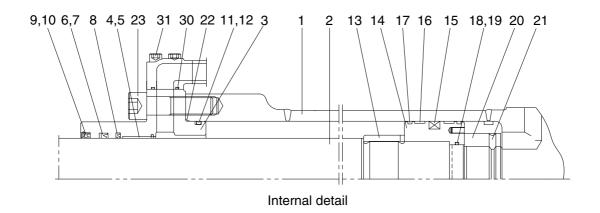


- ① Carry out installation in the reverse order to removal.
- ♠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.
- * Bleed the air from the boom cylinder.
- * Conformed the hydraulic oil level and check the hydraulic oil leak or not.

# 2. DISASSEMBLY AND ASSEMBLY

# 1) STRUCTURE

# (1) Bucket cylinder

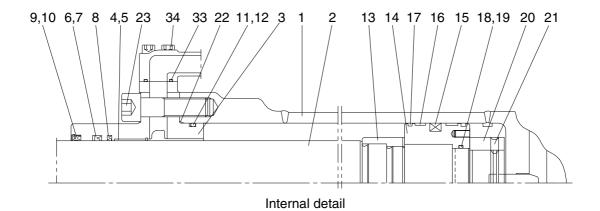


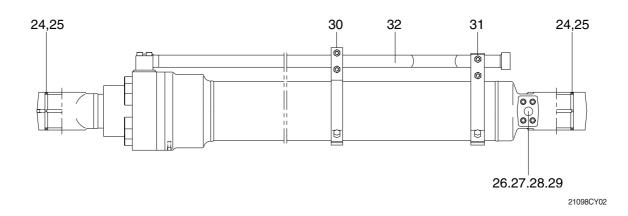
24,26 28 27 29 25,26

21098CY01

1	Tube assembly	12	Back up ring	23	Hexagon socket head bolt
2	Rod assembly	13	Cushion ring	24	Pin bushing
3	Gland	14	Piston	25	Pin bushing
4	DD2 bushing	15	Piston seal	26	Dust seal
5	Snap ring	16	Wear ring	27	Band assembly
6	Rod seal	17	Dust ring	28	Pipe assembly-R
7	Back up ring	18	O-ring	29	Pipe assembly-B
8	Buffer ring	19	Back up ring	30	O-ring
9	Dust wiper	20	Lock nut	31	Hexagon socket head bolt
10	Snap ring	21	Hexagon socket set screw		
11	O-ring	22	O-ring		

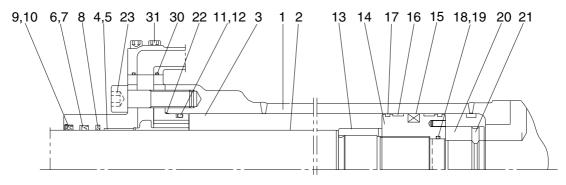
# (2) Arm cylinder



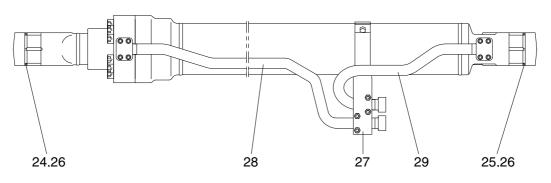


1	Tube assembly	13	Cushion ring	25	Dust seal
2	Rod assembly	14	Piston	26	Check valve
3	Gland	15	Piston seal	27	Coil spring
4	DD2 bushing	16	Wear ring	28	O-ring
5	Snap ring	17	Dust ring	29	Plug
6	Rod seal	18	O-ring	30	Band assembly-R
7	Back up ring	19	Back up ring	31	Band assembly-B
8	Buffer ring	20	Lock nut	32	Pipe assembly-R
9	Dust wiper	21	Hexagon socket set screw	33	O-ring
10	Snap ring	22	O-ring	34	Hexagon socket head bolt
11	O-ring	23	Hexagon socket head bolt		
12	Back up ring	24	Pin bushing		

# (3) Boom cylinder



Internal detail



1	Tube assembly	12	Back up ring	23	Hexagon socket head bolt
2	Rod assembly	13	Cushion ring	24	Pin bushing
3	Gland	14	Piston	25	Pin bushing
4	DD2 bushing	15	Piston seal	26	Dust seal
5	Snap ring	16	Wear ring	27	Band assembly
6	Rod seal	17	Dust ring	28	Pipe assembly-R
7	Back up ring	18	O-ring	29	Pipe assembly-B
8	Buffer ring	19	Back up ring	30	O-ring
9	Dust wiper	20	Lock nut	31	Hexagon socket head bolt
10	Snap ring	21	Hexagon socket set screw		
11	O-ring	22	O-ring		

# 2) TOOLS AND TIGHTENING TORQUE

# (1) Tools

Tools	Remark		
	6		
Allen uweneb	8 B		
Allen wrench	14		
	17		
Channer	7		
Spanner	8		
(-) Driver	Small and large sizes		
Torque wrench	Capable of tightening with the specified torques		

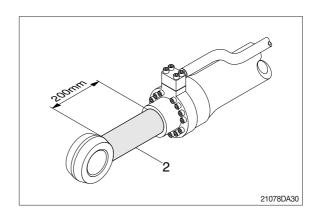
# (2) Tightening torque

Part name		Item	Size	Torque	
		Item	Size	kgf ⋅ m	lbf ⋅ ft
	Bucket cylinder	23	M16	23±2.0	166±14.5
	Ducket cyllinder	31	M10	5.4±0.5	39.1±3.6
Socket head bolt	Boom cylinder	23	M16	23±2.0	166±14.5
Socket flead boil	boom cylinder	31	M10	5.4±0.5	39.1±3.6
	Arm outlindor	23	M18	32±3.0	232±21.7
	Arm cylinder	34	M12	9.4±1.0	68±7.2
	Bucket cylinder	20	-	100±10	723±72.3
Lock nut	Boom cylinder	20	-	200±20.0	1447±145
	Arm cylinder	20	-	150±15	1085±108
	Bucket cylinder	14	-	150±15	1085±108
Piston	Boom cylinder	14	-	100±10.0	723±72.3
	Arm cylinder	14	-	200±20	1447±145

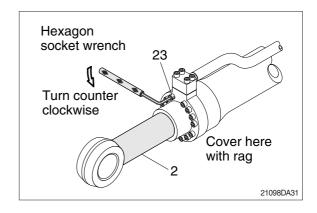
#### 3) DISASSEMBLY

#### (1) Remove cylinder head and piston rod

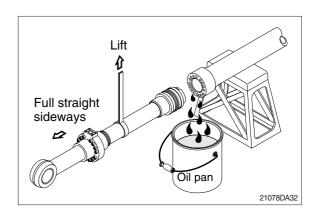
- * Procedures are based on the bucket cylinder.
- ① Hold the clevis section of the tube in a vise.
- ** Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.
- ② Pull out rod assembly (2) about 200 mm (7.1 in). Because the rod assembly is rather heavy, finish extending it with air pressure after the oil draining operation.



- 3 Loosen and remove socket bolts (23) of the gland in sequence.
- ** Cover the extracted rod assembly (2) with rag to prevent it from being accidentally damaged during operation.

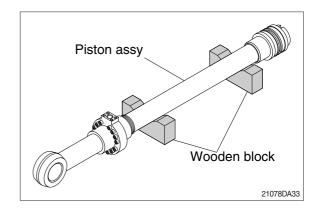


- ① Draw out cylinder head and rod assembly together from tube assembly (1).
- Since the rod assembly is heavy in this case, lift the tip of the rod assembly (2) with a crane or some means and draw it out. However, when rod assembly (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



Note that the plated surface of rod assembly (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

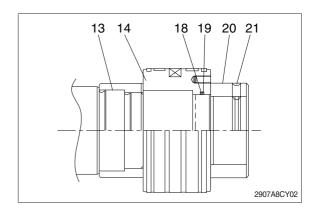
- ⑤ Place the removed rod assembly on a wooden V-block that is set level.
- * Cover a V-block with soft rag.

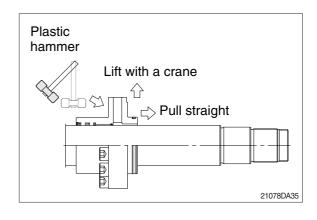


#### (2) Remove piston and cylinder head

- ① Remove set screw (21).
- Since set screw (21) and lock nut (20) is tightened to a high torque, use a hydraulic and power wrench that utilizers a hydraulic cylinder, to remove the lock set screw (21) and lock nut (20).
- ② Remove piston assembly (14), back up ring (19), and O-ring (18).
- ③ Remove the cylinder head assembly from rod assembly (2).
- If it is too heavy to move, move it by striking the flanged part of cylinder head with a plastic hammer.
- ** Pull it straight with cylinder head assembly lifted with a crane.
  Exercise care so as not to damage the lip of rod bushing (4) and packing (5,6,7,8,9,10) by the threads of rod

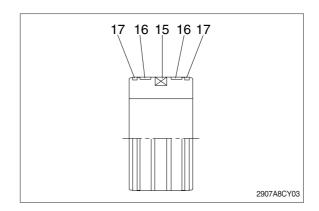
assembly (2).





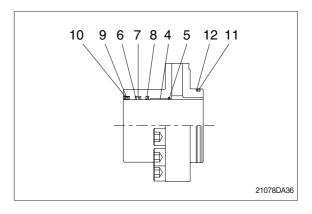
#### (3) Disassemble the piston assembly

- ① Remove wear ring (16).
- ② Remove dust ring (17) and piston seal (15).
- Exercise care in this operation not to damage the grooves.



#### (4) Disassemble cylinder head assembly

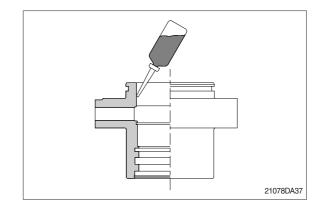
- ① Remove back up ring (12) and O-ring (11).
- ② Remove snap ring (10), dust wiper (9).
- ③ Remove back up ring (7), rod seal (6) and buffer ring (8).
- Exercise care in this operation not to damage the grooves.
- * Do not remove seal and ring, if does not damaged.
- * Do not remove bushing (4).



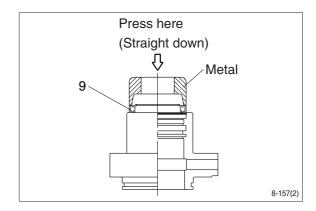
#### 3) ASSEMBLY

#### (1) Assemble cylinder head assembly

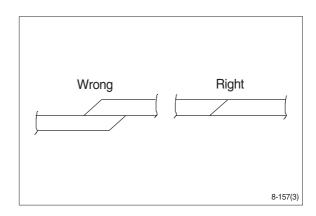
- * Check for scratches or rough surfaces if found smooth with an oil stone.
- ① Coat the inner face of gland (3) with hydraulic oil.



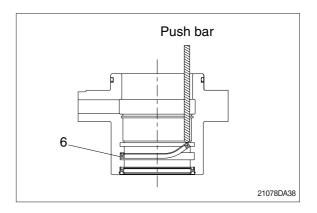
- ② Coat dust wiper (9) with grease and fit dust wiper (9) to the bottom of the hole of dust seal.
  - At this time, press a pad metal to the metal ring of dust seal.
- ③ Fit snap ring (10) to the stop face.



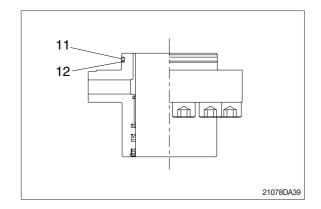
- ④ Fit back up ring (7), rod seal (6) and buffer ring (8) to corresponding grooves, in that order.
- * Coat each packing with hydraulic oil before fitting it.
- ** Insert the backup ring until one side of it is inserted into groove.



- ** Rod seal (6) has its own fitting direction. Therefore, confirm it before fitting them.
- * Fitting rod seal (6) upside down may damage its lip. Therefore check the correct direction that is shown in fig.

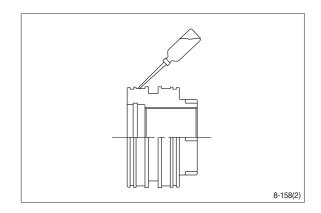


- ⑤ Fit back up ring (12) to gland (3).
- Put the backup ring in the warm water of 30~50°C.
- ⑥ Fit O-ring (11) to gland (3).

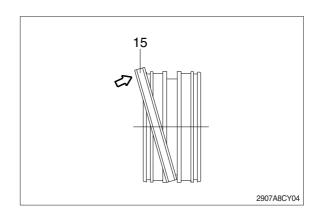


#### (2) Assemble piston assembly

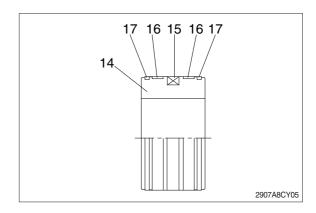
- * Check for scratches or rough surfaces. If found smooth with an oil stone.
- ① Coat the outer face of piston (14) with hydraulic oil.



- ② Fit piston seal (15) to piston.
- Put the piston seal in the warm water of 60~100°C for more than 5 minutes.
- * After assembling the piston seal, press its outer diameter to fit in.

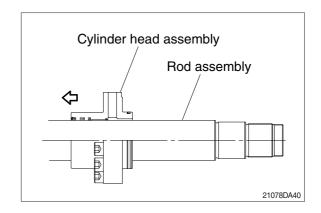


③ Fit wear ring (16) and dust ring (17) to piston (14).

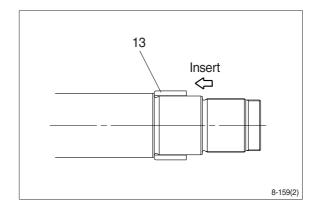


#### (3) Install piston and cylinder head

- ① Fix the rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of rod assembly (2), the inner surface of piston and cylinder head.
- ③ Insert cylinder head assembly to rod assembly.

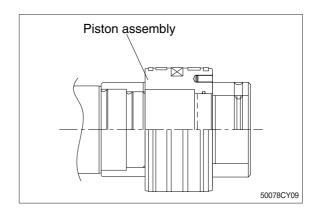


- ④ Insert cushion ring (13) to rod assembly.
- * Note that cushion ring (13) has a direction in which it should be fitted.



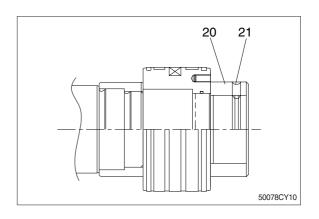
- ⑤ Fit piston assembly to rod assembly.
  - · Tightening torque : 150±15 kgf · m

 $(1085 \pm 108 \text{ lbf} \cdot \text{ft})$ 



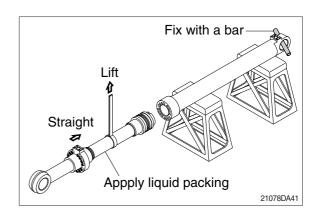
- ⑥ Fit lock nut (20) and tighten the screw (21).
  - · Tightening torque :

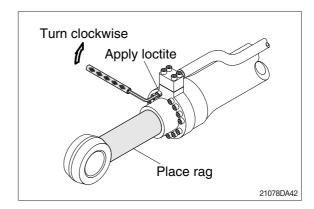
Item		kgf ⋅ m	lbf ⋅ ft	
	Bucket	100±10	723±72.3	
20	Boom	200±20	1447±145	
	Arm	150±15	1085±108	
21		2.7±0.3	19.6±2.2	



#### (3) Overall assemble

- ① Place a V-block on a rigid work bench. Mount the tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
- ② Insert the rod assembly in to the tube assembly, while lifting and moving the rod assembly with a crane.
- ** Be careful not to damage piston seal by thread of tube assembly.
- ③ Match the bolt holes in the cylinder head flange to the tapped holes in the tube assembly and tighten socket bolts to a specified torque.
- * Refer to the table of tightening torque.





#### **GROUP 10 UNDERCARRIAGE**

#### 1. TRACK LINK

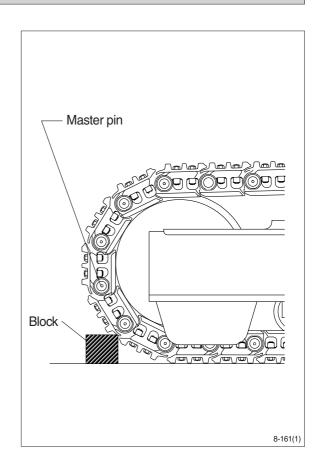
#### 1) REMOVAL

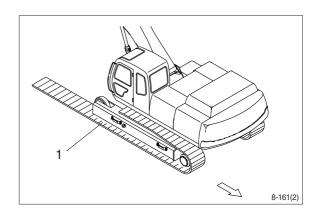
- (1) Move track link until master pin is over front idler in the position put wooden block as shown.
- (2) Loosen tension of the track link.
- ** If track tension is not relieved when the grease valve is loosened, move the machine backwards and forwards.
- ** Unscrew the grease nipple after release the tension by pushing the poppet only when necessarily required. Grease leaking hole is not existing. So, while unscrew the grease nipple, grease is not leaking until the grease nipple is completely coming out. If the tension is not released in advance, the grease
- (3) Push out master pin by using a suitable tool.

pressurized grease.

nipple can be suddenly popped out by

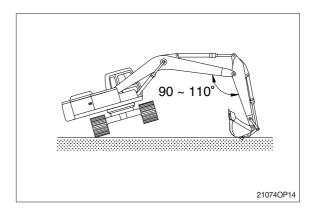
- (4) Move the machine slowly in reverse, and lay out track link assembly (1).
- * Jack up the machine and put wooden block under the machine.
- ** Don't get close to the sprocket side as the track shoe plate may fall down on your feet.





#### 2) INSTALL

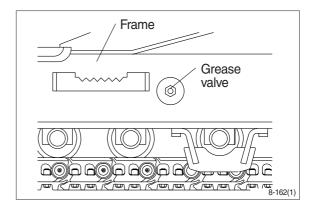
- (1) Carry out installation in the reverse order to removal.
- * Adjust the tension of the track link.



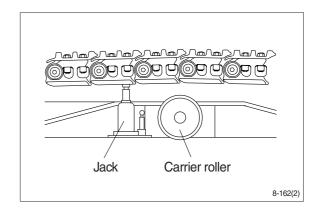
#### 2. CARRIER ROLLER

#### 1) REMOVAL

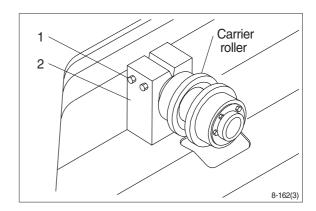
(1) Loosen tension of the track link.



(2) Jack up the track link height enough to permit carrier roller removal.



- (3) Loosen the lock nut (1).
- (4) Open bracket(2) with a screwdriver, push out from inside, and remove carrier roller assembly.
  - · Weight: 20 kg (45 lb)



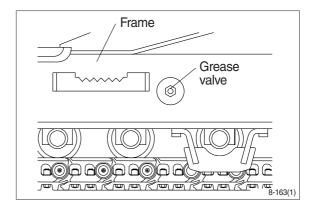
# 2) INSTALL

(1) Carry out installation in the reverse order to removal.

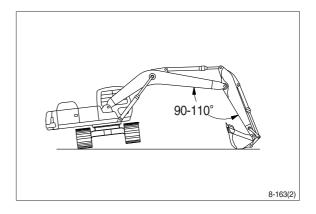
#### 3. TRACK ROLLER

# 1) REMOVAL

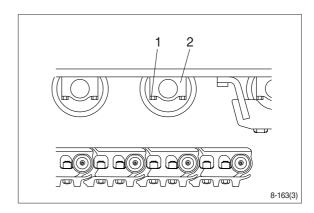
(1) Loosen tension of the track link.



- (2) Using the work equipment, push up track frame on side which is to be removed.
- * After jack up the machine, set a block under the unit.



- (3) Remove the mounting bolt (1) and draw out the track roller (2).
  - · Weight: 40 kg (90 lb)



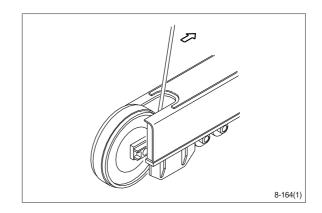
# 2) INSTALL

(1) Carry out installation in the reverse order to removal.

#### 4. IDLER AND RECOIL SPRING

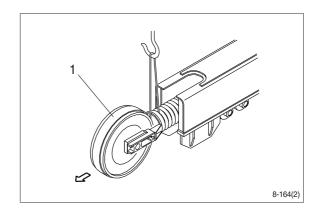
#### 1) REMOVAL

(1) Remove the track link.
For detail, see removal of track link.

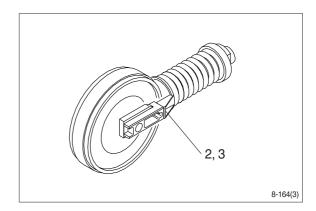


(2) Sling the recoil spring (1) and pull out idler and recoil spring assembly from track frame, using a pry.

· Weight: 310 kg (680 lb)

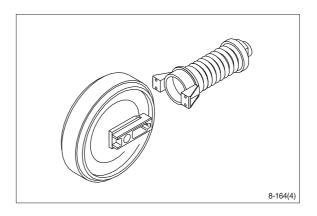


(3) Remove the bolts (2), washers (3) and separate ilder from recoil spring.



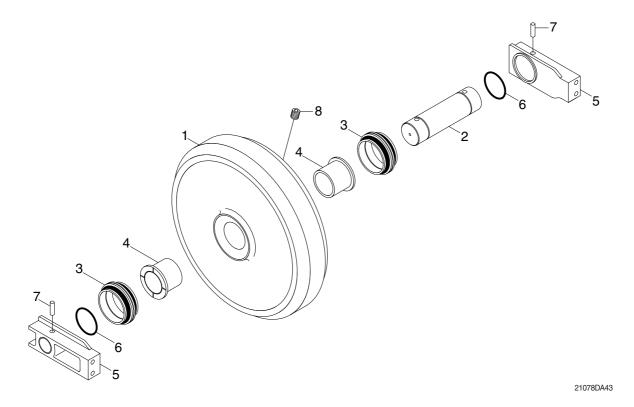
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- * Make sure that the boss on the end face of the recoil cylinder rod is in the hole of the track frame.



# 3) DISASSEMBLY AND ASSEMBLY OF IDLER

# (1) Structure

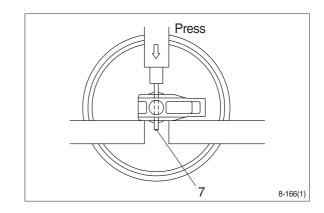


- 1 Shell
- 2 Shaft
- 3 Seal assembly
- 4 Bushing
- 5 Bracket
- 6 O-ring

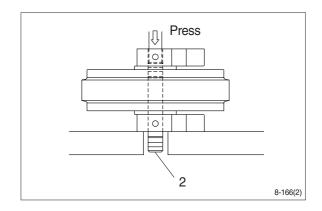
- 7 Spring pin
- 8 Plug

# (2) Disassembly

- ① Remove plug and drain oil.
- ② Draw out the spring pin (7), using a press.

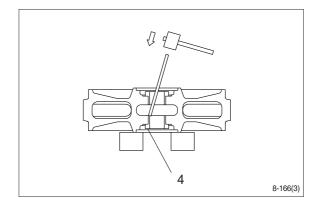


- ③ Pull out the shaft (2) with a press.
- ④ Remove seal (3) from idler (1) and bracket (5).
- ⑤ Remove O-ring (6) from shaft.



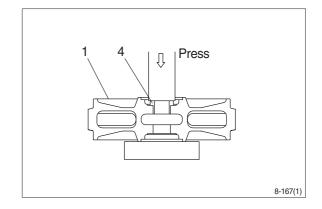
⑥ Remove the bushing (4) from idler, using a special tool.

Only remove bushing if replacement is necessity.

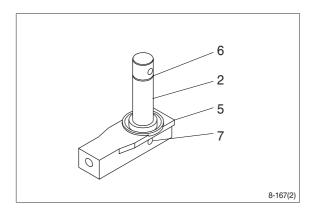


#### (3) Assembly

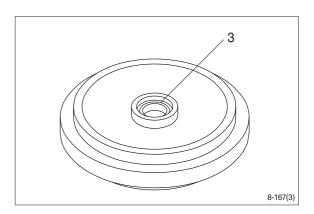
- * Before assembly, clean the parts.
- * Coat the sliding surfaces of all parts with oil.
- Cool up bushing (4) fully by some dry ice and press it into shell (1).
   Do not press it at the normal temperature, or not knock in with a hammer even after the cooling.



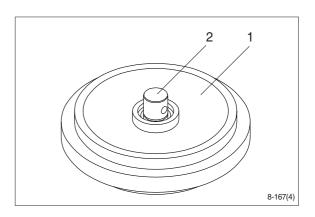
- ② Coat O-ring (6) with grease thinly, and install it to shaft (2).
- ③ Insert shaft (2) into bracket (5) and drive in the spring pin (7).



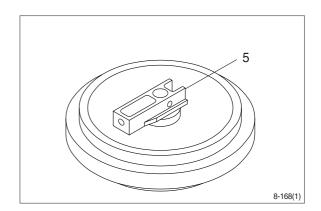
④ Install seal (3) to shell (1) and bracket (5).



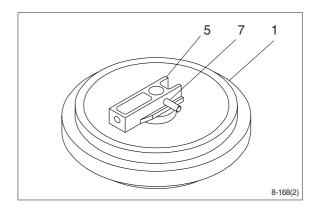
⑤ Install shaft (2) to shell (1).

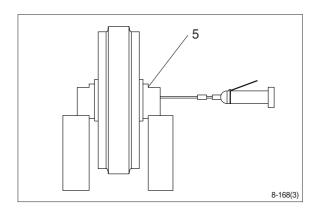


⑥ Install bracket (5) attached with seal (3).



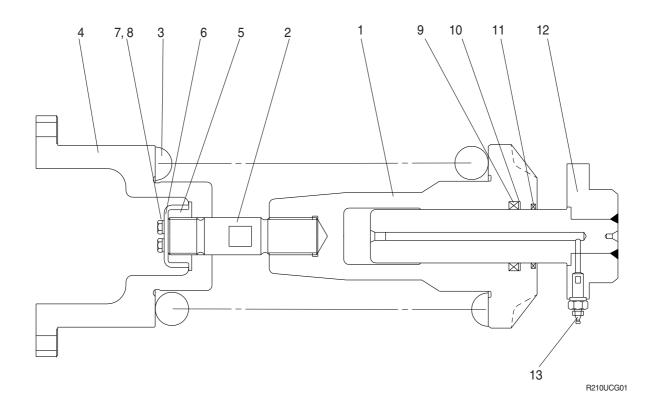
⑦ Knock in the spring pin (7) with a hammer.





# 4) DISASSEMBLY AND ASSEMBLY OF RECOIL SPRING

# (1) Structure



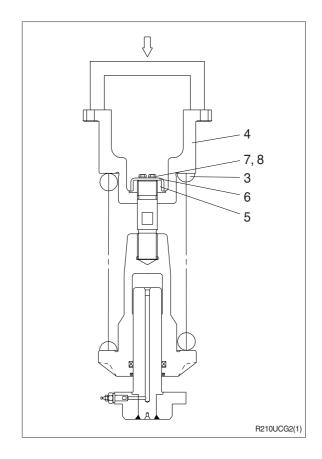
- 1 Body
- 2 Tie bar
- 3 Spring
- 4 Bracket
- 5 Lock nut

- 6 Lock plate
- 7 Bolt
- 8 Spring washer
- 9 Rod seal
- 10 Back up ring

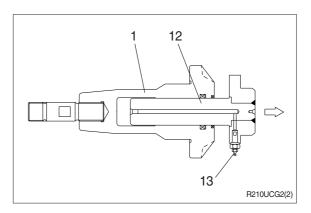
- 11 Dust seal
- 12 Rod assembly
- 13 Grease valve

#### (2) Disassembly

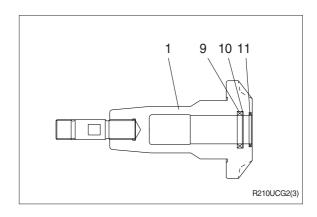
- ① Apply pressure on spring (3) with a press.
- * The spring is under a large installed load. This is dangerous, so be sure to set properly.
  - · Spring set load : 13716 kg (30238 lb)
- ② Remove bolt (7), spring washer (8) and lock plate (6).
- ③ Remove lock nut (5). Take enough notice so that the press which pushes down the spring, should not be slipped out in its operation.
- ④ Lighten the press load slowly and remove bracket (4) and spring (3).



- ⑤ Remove rod (12) from body (1).
- ⑥ Remove grease valve (13) from rod (12).

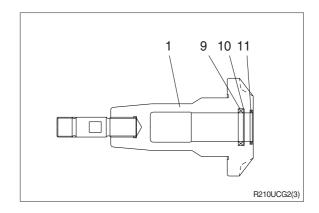


Remove rod seal (9), back up ring (10) and dust seal (11).

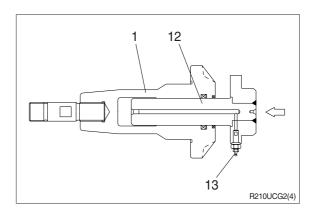


#### (3) Assembly

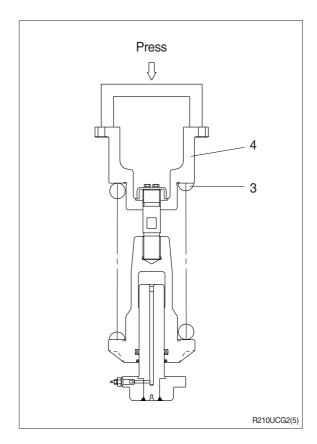
- Install dust seal (11), back up ring (10) and rod seal (9) to body (1).
- When installing dust seal (11) and rod seal (9), take full care so as not to damage the lip.



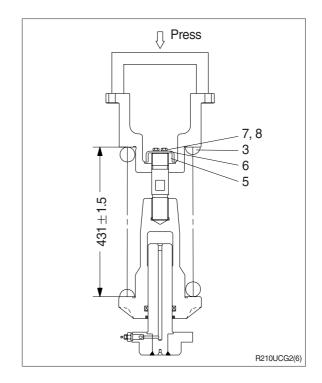
- ② Pour grease into body (1), then push in rod (12) by hand.
  After take grease out of grease valve mounting hole, let air out.
- * If air letting is not sufficient, it may be difficult to adjust the tension of crawler.
- $\ensuremath{\Im}$  Fit grease valve (13) to rod (12).
  - $\cdot$  Tightening torque : 13  $\pm$  1.0 kgf  $\cdot$  m (94  $\pm$  7.2 lbf  $\cdot$  ft)



- (4) Install spring (3) and bracket (4) to body (1).
- ⑤ Apply pressure to spring (3) with a press and tighten lock nut (5).
- * Apply sealant before assembling.
- ** During the operation, pay attention specially to prevent the press from slipping out.

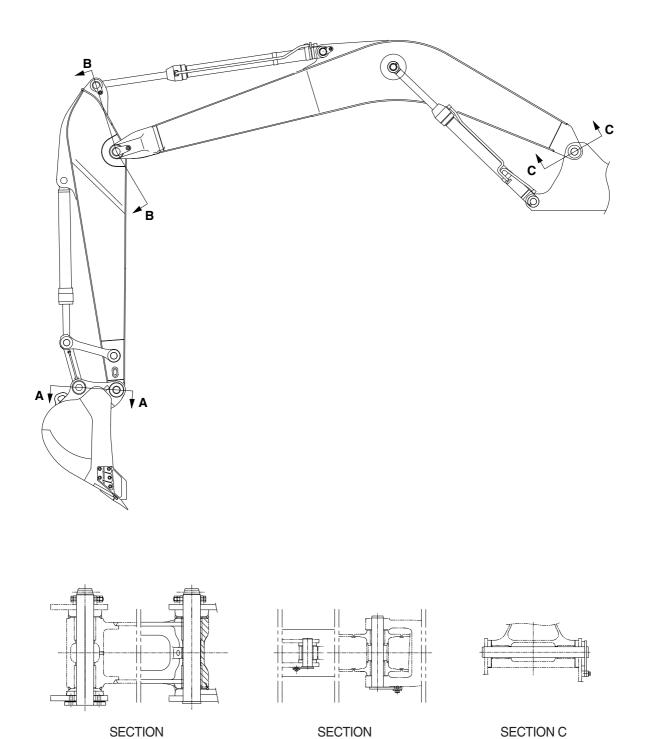


- ⑥ Lighten the press load and confirm the set length of spring (3).
- ② After the setting of spring (3), install lock plate (6), spring washer (8) and bolt (7).



# **GROUP 11 WORK EQUIPMENT**

# 1. STRUCTURE



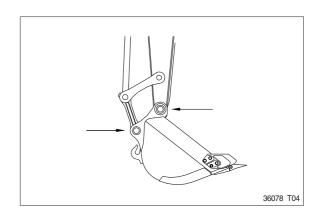
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#### 2. REMOVAL AND INSTALL

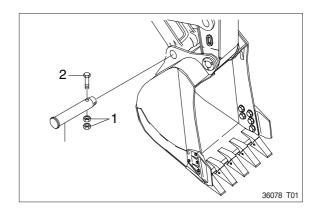
# 1) BUCKET ASSEMBLY

#### (1) Removal

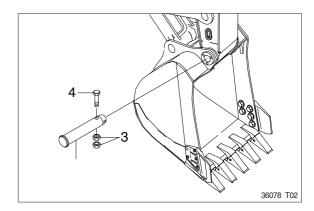
① Lower the work equipment completely to ground with back of bucket facing down.



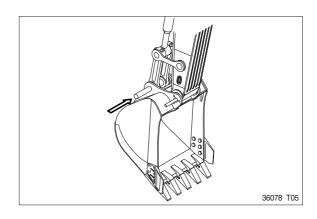
② Remove nut (1), bolt (2) and draw out the pin ( ).



③ Remove nut (3), bolt (4) and draw out the pin ( ).



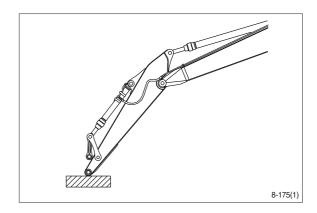
- ① Carry out installation in the reverse order to removal.
- ♠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.
- * djust the bucket clearance.
  For detail, see operation manual.

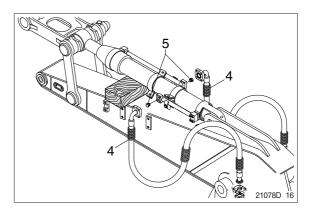


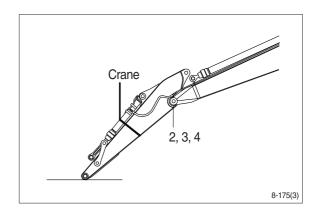
#### 2) ARM ASSEMBLY

#### (1) Removal

- * Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ♠ Escaping fluid under pressure can penetrated the skin causing serious injury.
- Remove bucket assembly.
   For details, see removal of bucket assembly.
- ② Disconnect bucket cylinder hose (1).
- ▲ Fit blind plugs (5) in the piping at the chassis end securely to prevent oil from spurting out when the engine is started.
- ③ Sling arm cylinder assembly, remove spring, pin stopper and pull out pin.
- * Tie the rod with wire to prevent it from coming out.
- ④ For details, see removal of arm cylinder assembly.
  - Place a wooden block under the cylinder and bring the cylinder down to it.
- ⑤ Remove bolt (2), plate (3) and pull out the pin (4) then remove the arm assembly.
- * Weight: 1050 kg (2310 lb)
  When lifting the arm assembly, always lift the center of gravity.







- ① Carry out installation in the reverse order to removal.
- A When lifting the arm assembly, always lift the center of gravity.
- * leed the air from the cylinder.

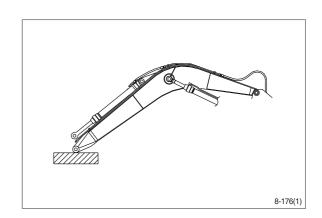
#### 3) BOOM CYLINDER

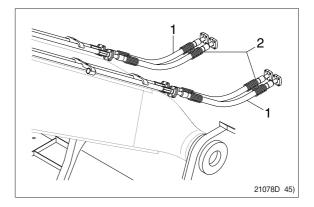
#### (1) Removal

- Remove arm and bucket assembly.
   For details, see removal of arm and bucket assembly.
- ② Remove boom cylinder assembly from boom.
  - For details, see removal of arm cylinder assembly.

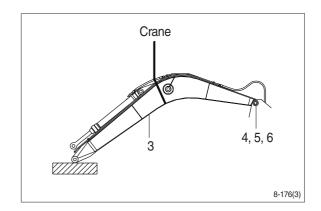


- ④ Disconnect bucket cylinder hose (2) and arm cylinder hose (1).
- When the hose are disconnected, oil may spurt out.
- ⑤ Sling boom assembly (3).

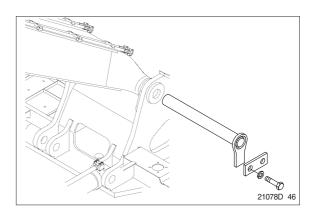




- 6 Remove bolt (4), plate (5) and pull out the pin (6) then remove boom assembly.Weight: 1950 kg (4300 lb)
- When lifting the boom assembly always lift the center of gravity.



- ① Carry out installation in the reverse order to removal.
- ♠ When lifting the arm assembly, always lift the center of gravity.
- * leed the air from the cylinder.



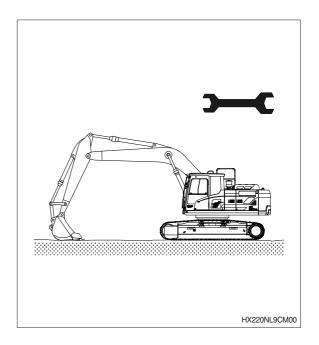
# SECTION 9 COMPONENT MOUNTING TORQUE

Group	1	Introduction guide ·····	9-1
Group	2	Engine system	9-2
Group	3	Electric system	9-4
Group	4	Hydraulic system ·····	9-6
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# SECTION 9 COMPONENT MOUNTING TORQUE

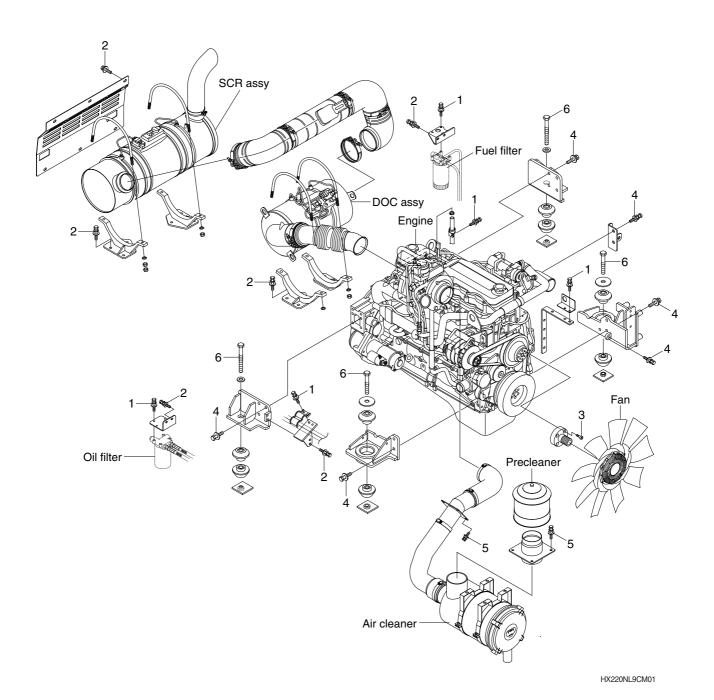
# **GROUP 1 INTRODUCTION GUIDE**

- 1. This section shows bolt specifications and standard torque values needed when mounting components to the machine.
- Use genuine Hyundai spare parts.
   We expressly point out that Hyundai will not accept any responsibility for defects resulted from non-genuine parts.
   In such cases Hyundai cannot assume liability for any damage.
- * Only metric fasteners can be used and incorrect fasteners may result in machine damage or malfunction.
- ** Before installation, clean all the components with a non-corrosive cleaner. Bolts and threads must not be worn or damaged.



# **GROUP 2 ENGINE SYSTEM**

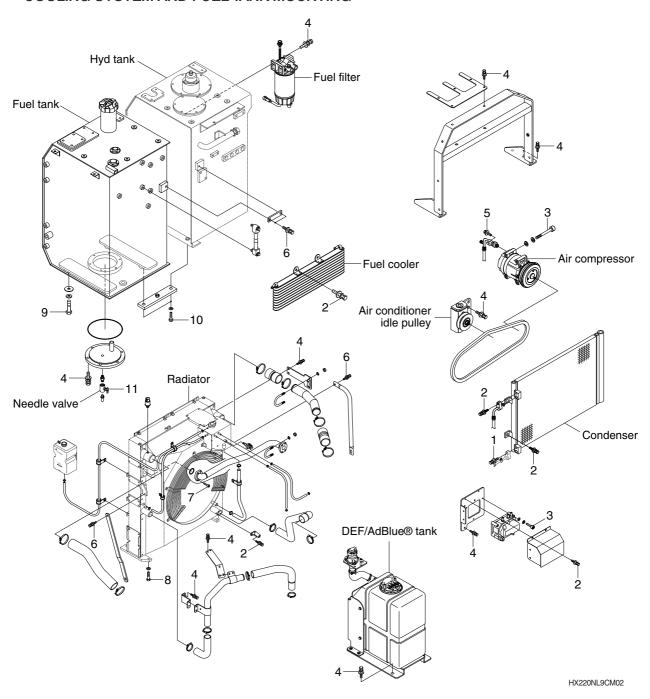
## **ENGINE AND ACCESSORIES MOUNTING**



Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 8×1.25	2.5±0.5	18.1±3.6
2	M10×1.5	6.9±1.4	49.9±10.1
3	M10×1.5	8.27±1.7	59.8±12.3

Item	Size	kgf ⋅ m	lbf ⋅ ft
4	M12×1.75	11.5±1.0	82.8±7.2
5	M12×1.75	12.8±3.0	92.6±21.7
6	M20×2.5	52.1±5.0	377±36.2

## COOLING SYSTEM AND FUEL TANK MOUNTING

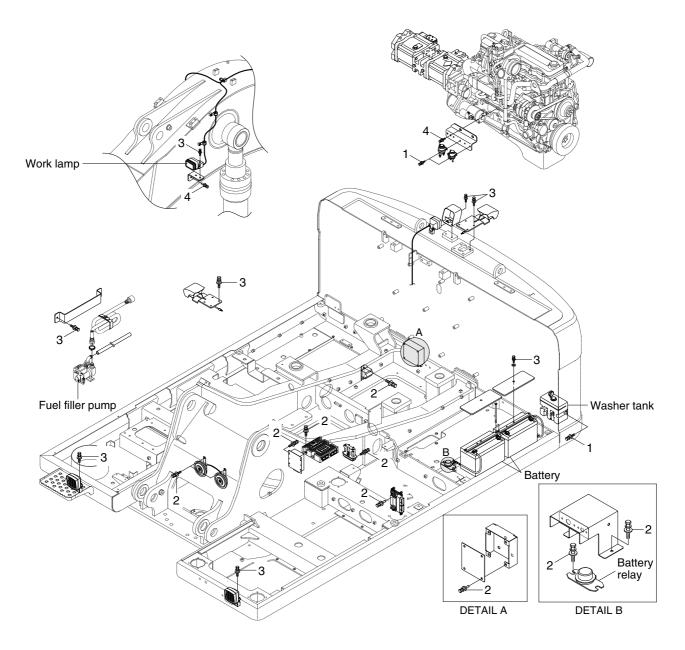


Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M 8×1.25	4.05±0.8	29.3±5.8
4	M10×1.5	6.9±1.4	49.9±10.1
5	M10×1.25	7.4±1.5	53.5±10.8
6	M12×1.75	12.8±3.0	92.6±21.7

Item	Size	kgf ⋅ m	lbf ⋅ ft
7	M12×1.75	14.7±2.2	106±15.9
8	M16×2.0	29.7±4.5	215±32.5
9	M20×2.5	46±5.1	333±36.9
10	M20×2.5	57.9±8.7	419±62.9
11	-	2.3±0.6	16.6±4.3

# **GROUP 3 ELECTRIC SYSTEM**

## **ELECTRIC COMPONENTS MOUNTING 1**

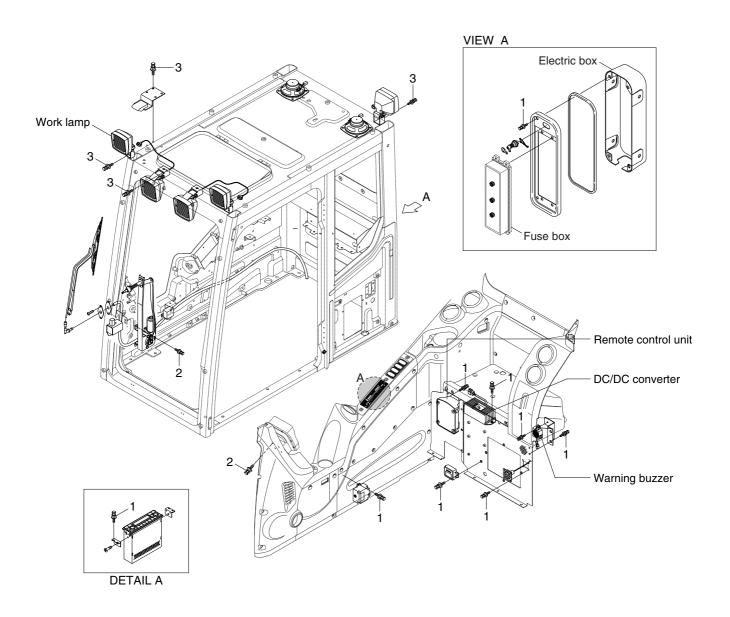


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Item	Size	kgf · m	lbf ⋅ ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6

Item	Size	kgf ⋅ m	lbf ⋅ ft
3	M10×1.5	6.9±1.4	49.9±10.1
4	M12×1.75	12.8±3.0	92.6±21.7

## **ELECTRIC COMPONENTS MOUNTING 2**



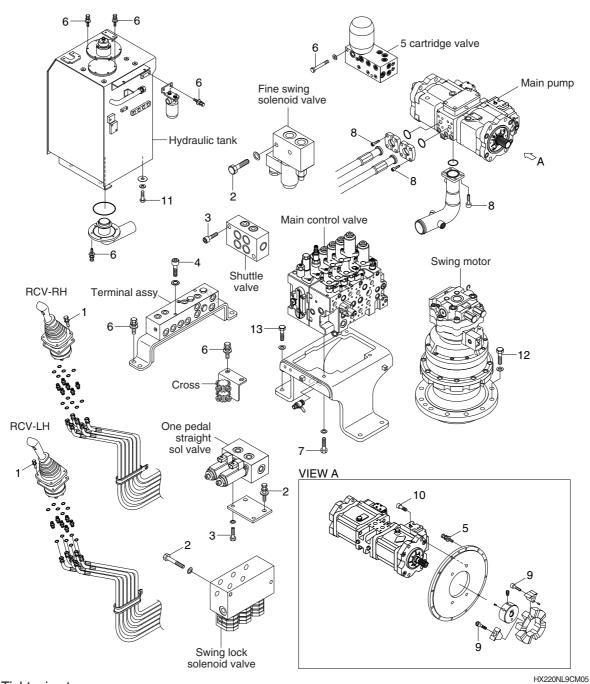
HX220NL9CM04

Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6

Item	Size	kgf ⋅ m	lbf ⋅ ft
3	M10×1.5	6.9±1.4	49.9±10.1

# **GROUP 4 HYDRAULIC SYSTEM**

## **HYDRAULIC COMPONENTS MOUNTING 1**

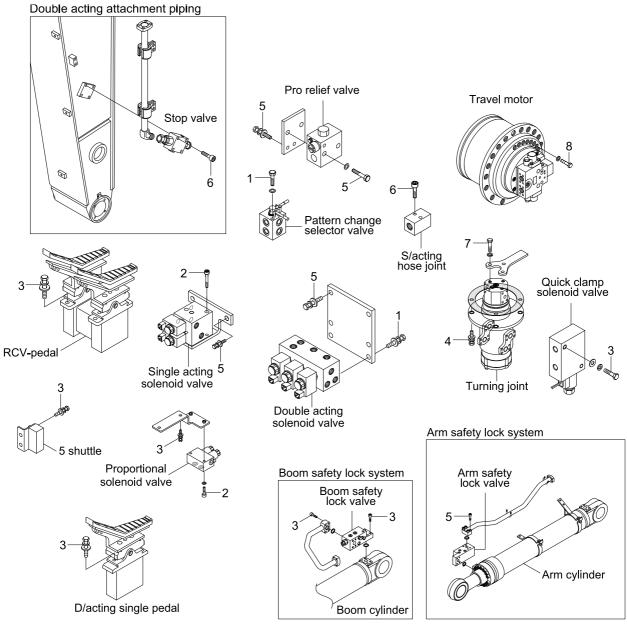


#### · Tightening torque

Item Size lbf ⋅ ft  $kgf \cdot m$ 1 M  $6 \times 1.0$  $1.05 \pm 0.2$  $7.6 \pm 1.45$ 2 M  $8 \times 1.25$  $18.1 \pm 3.6$  $2.5\pm0.5$ 3 M  $8 \times 1.25$  $3.43 \pm 0.7$  $24.8 \pm 5.1$ 4 M  $8 \times 1.25$  $4.05 \pm 0.8$  $29.3 \pm 5.8$ 5  $M10 \times 1.5$  $6.9\pm0.5$  $49.9 \pm 3.6$ 6  $M10 \times 1.5$  $6.9\pm1.4$  $49.9 \pm 10.1$ 7  $M12 \times 1.75$  $12.3 \pm 1.3$  $89\!\pm\!9.4$ 

Item	Size	kgf ⋅ m	lbf ⋅ ft
8	M12×1.75	14.7±2.2	106±15.9
9	M18×2.5	32±1.0	231±7.2
10	$M20 \times 2.5$	52.1±5	377±36.2
11	M20×2.5	46±5.1	333±36.9
12	M20×2.5	57.9±5.8	419±42
13	M20×2.5	57.9±8.7	419±62.9

#### **HYDRAULIC COMPONENTS MOUNTING 2**

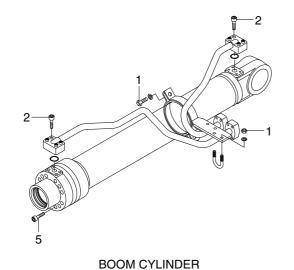


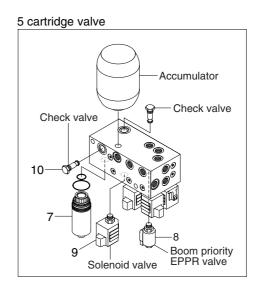
HX220NL9CM06

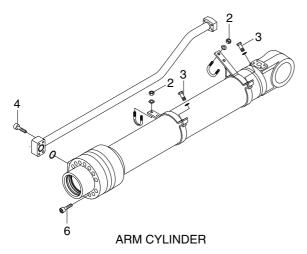
Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 8×1.25	2.5±0.5	18.1±3.6
2	M 8×1.25	$4.05 \pm 0.8$	29.3±5.8
3	M10×1.5	6.9±1.4	49.9±10.1
4	M12×1.75	12.3±1.3	89.0±9.4

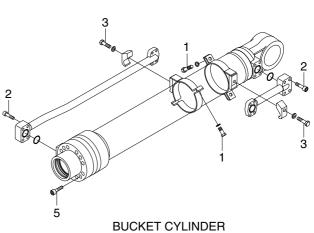
Item	Size	kgf ⋅ m	lbf ⋅ ft
5	M12×1.75	12.8±3.0	92.6±21.7
6	M12×1.75	14.7±2.2	106±15.9
7	M14×2.0	19.6±2.9	142±21.0
8	M16×2.0	29.7±4.5	215±32.5

#### **HYDRAULIC COMPONENTS MOUNTING 3**









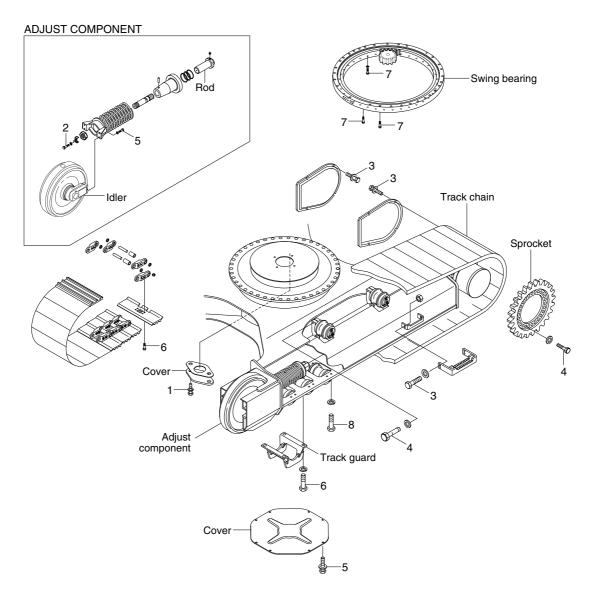
HX220NL9CM07

Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M10×1.5	3.2±0.3	23.1±2.2
2	M10×1.5	5.4±0.5	39.1±3.6
3	M12×1.75	5.5±0.6	39.8±4.3
4	M12×1.75	$9.4 \pm 1.0$	68.0±7.2
5	M16×2.0	23±2.0	166±14.5

Item	Size	kgf ⋅ m	lbf ⋅ ft
6	M18×2.5	32±3.0	232±21.7
7	Line filter	2.5	18.1
8	EPPR valve	2.5	18.1
9	Solenoid valve	3.5	25.3
10	Check valve	4	28.9

# **GROUP 5 UNDERCARRIAGE**

## **UNDERCARRIAGE MOUNTING**



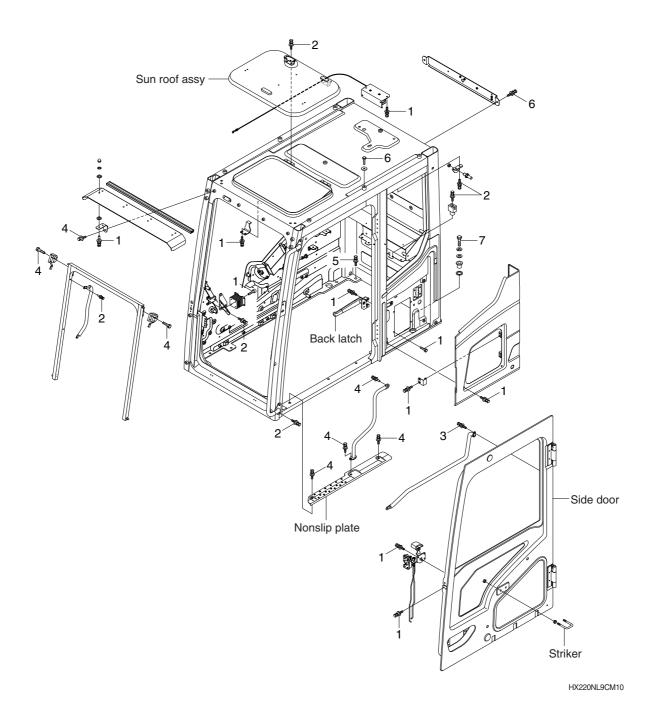
HX220NL9CM08

Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M10×1.5	6.9±1.4	49.9±10.1
2	M12×1.25	13.3±2.7	96.2±19.5
3	M12×1.75	12.8±3.0	92.6±21.7
4	M16×2.0	29.7±3.0	215±21.7

Item	Size	kgf ⋅ m	lbf ⋅ ft
5	M16×2.0	29.7±4.5	215±32.5
6	M20×2.5	57.9±5.8	419±41.9
7	M20×2.5	57.9±6.0	419±43.3
8	M20×2.5	57.9±6.0	419±43.4

# GROUP 6 STRUCTURE

## **CAB AND ACCESSORIES MOUNTING**

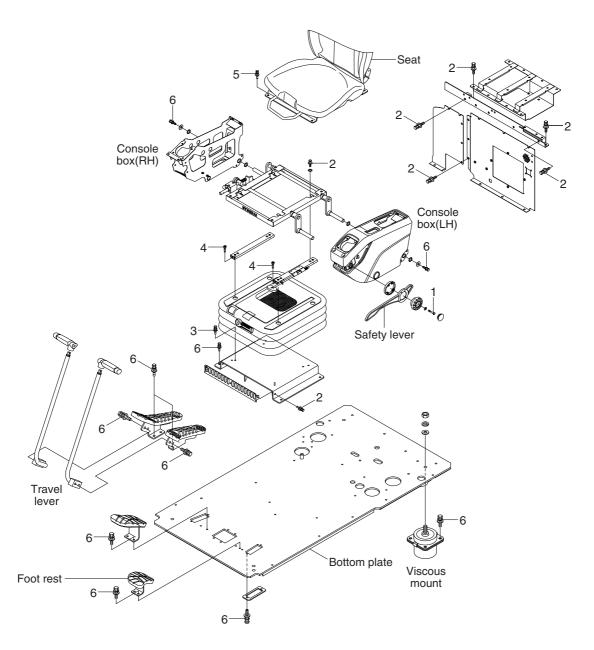


· Tightening torque

Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M8×1.25	3.43±0.7	24.8±5.1
4	M10×1.5	6.9±1.4	49.9±10.1

Item	Size	kgf ⋅ m	lbf ⋅ ft
5	M12×1.75	12.3±1.3	88.9±9.4
6	M12×1.75	$12.8 \pm 3.0$	92.6±21.7
7	M24×3.0	$100\pm15$	723±109

## **CAB INTERIOR MOUNTING**

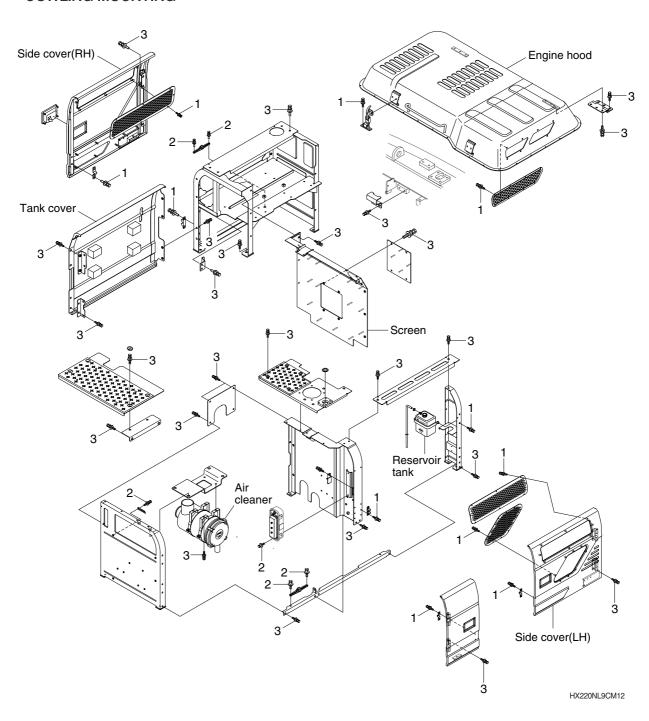


HX220NL9CM11

Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M 8×1.25	3.43±0.7	24.8±5.1

Item	Size	kgf ⋅ m	lbf ⋅ ft
4	M 8×1.25	4.05±0.8	29.3±5.8
5	M10×1.5	6.9±0.5	49.9±3.6
6	M10×1.5	$6.9 \pm 1.4$	49.9±10.1

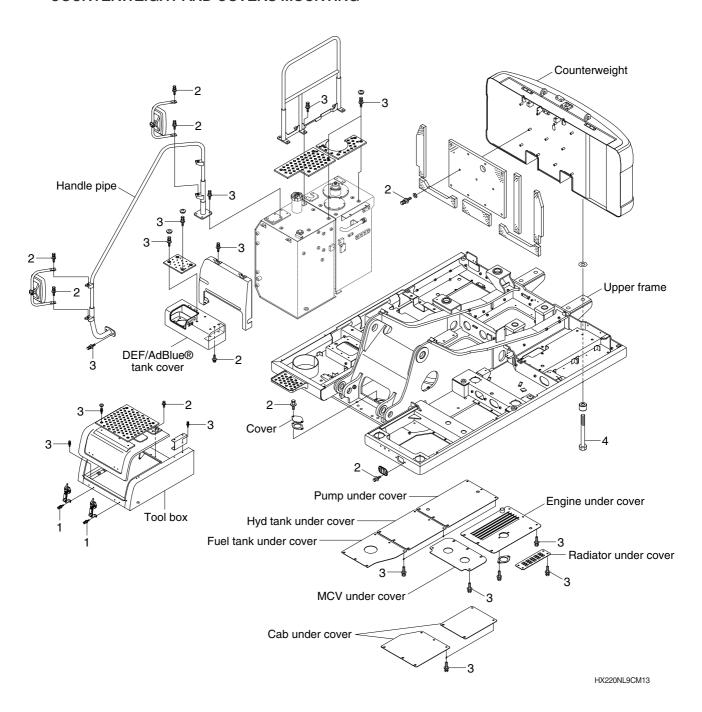
## **COWLING MOUNTING**



Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 8×1.25	2.5±0.5	18.1±3.6
2	M10×1.5	6.9±1.4	49.9±10.1

Item	Size	kgf ⋅ m	lbf ⋅ ft
3	M12×1.75	12.8±3.0	92.6±21.7

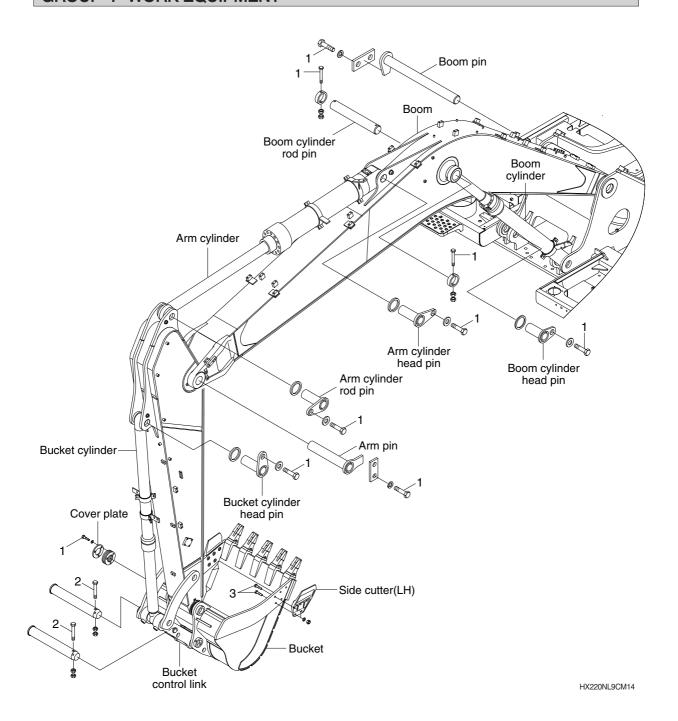
#### **COUNTERWEIGHT AND COVERS MOUNTING**



Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M 8×1.25	2.5±0.5	18.1±3.6
2	M10×1.5	6.9±1.4	49.9±10.1

Item	Size	kgf ⋅ m	lbf ⋅ ft
3	M12×1.75	12.8±3.0	92.6±21.7
4	M36×3.0	337±33	2438±239

# **GROUP 7 WORK EQUIPMENT**



Item	Size	kgf ⋅ m	lbf ⋅ ft
1	M16×2.0	29.7±4.5	215±32.5
2	M20×2.5	57.9±8.7	419±62.9
3	M22×2.5	81.9±16.1	592±116