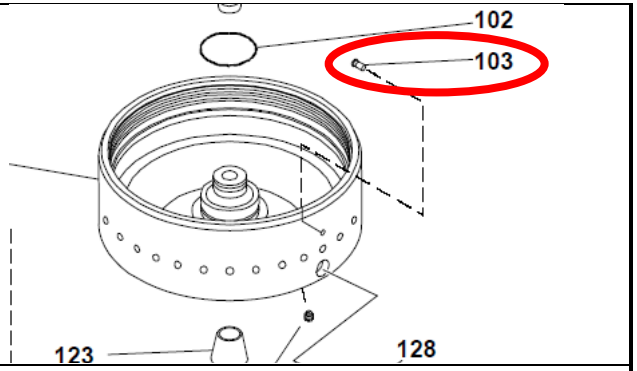
2. Pilot Activity Supplementary Report

INSPECTION ON JICA ENGINE, ELECTRICAL PANEL AND AUXILIARIES.

The table below shows status of Niigata No.1&2 engine components, electrical panel and auxiliaries with their respective challenges

Item No	Name of Component	Component Location	Component Status	Observation	Comment on challenge
DE-1	Fuel pump rack	JICA plant 2nd floor	Working	lack of Lubricant	- lubrication should be done one time each shift - For trouble shooting (high exhaust temperature), rack position has changed to reduce the fuel supply.
DE-2	Fuel injection valve	JICA plant 2nd floor	Working	-	-Injection valve has inspected by LEC in June 2022. And the nozzle are replaced for unit 1.
DE-3	Exhaust gas Thermometer	JICA plant 2nd floor	Working	Normal	- One of A1 Unit 1 was broken and replaced with new one. - During the OH, the others will be checked. 

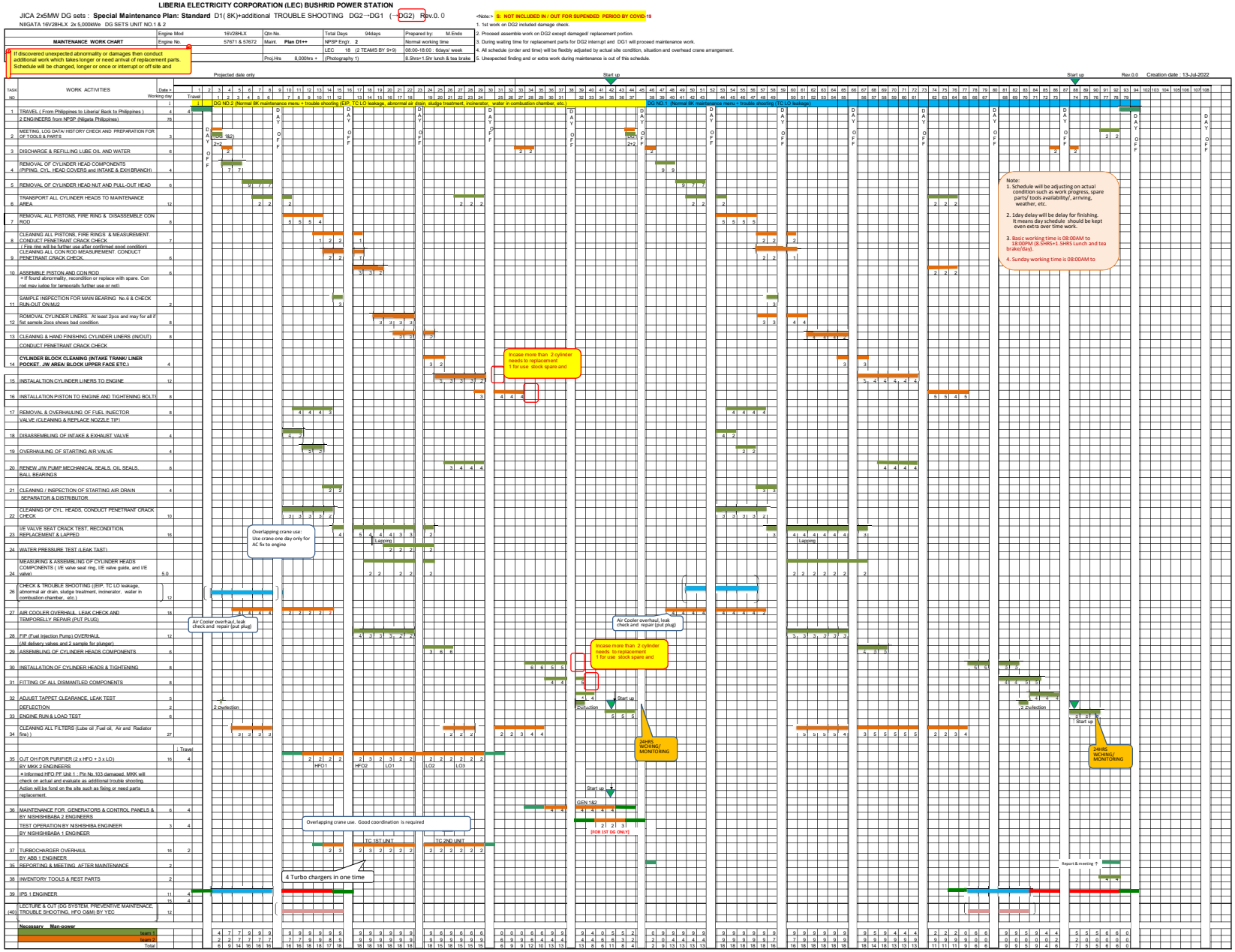
DE-4	Exhaust gas manifold	JICA plant 2nd floor	Working	Lagging has removed (Unit 1 A1)	- Unit 1 A1 experienced high exhaust gas temperature and smoke. And the lagging has removed to check.
DE-5	Intake air manifold	JICA plant 2nd floor	Working	Normal	-Unit 2 B4 had the fire from the gasket and replaced.
DE-6	Turbocharger	JICA plant 2nd floor	Working	Oil leakage	-After the inspection of FV in June 2022, during the engine starting, abnormal sound "Bun" was heard from T/C. External appearance is OK. During the OH, it will be checked.
DE-7	Connecting rod	JICA plant 2nd floor	Not good	Rusted (B5 of unit2) Color check (PT)	-Removing the rust. LEC needs to get quotation for a connecting rod.
FO-1	HFO Storage Tank / Transfer pump	HFO station	Good	Normal	-Condition will be checked at 8000OH
FO-2	HFO Buffer tank	Outside of JICA plant	Good	Normal	- Condition will be checked at 8000OH
FO-3	HFO Purifier Unit	JICA plant grand floor	Unit1: Stopped about 1 year Unit2: Working	Dirty with oil	- For unit 1, the pin for bowl is damaged and should be replaced. LEC needs to get quotation and purchase the item. 

					
FO-4	HFO Service tank/ Booster pump	Outside of JICA plant	Good	Normal	- Condition will be checked at 8000OH
FO-5	DO Storage tank/ Transfer pump	Outside of JICA plant	Good	Normal	-
FO-6	DO Service tank/ Booster pump	JICA plant 2nd floor	Good	Normal	-
FO-7	FO change over valve	JICA plant grand floor	Good	Normal	-
FO-8	FO Circulating pump	JICA plant grand floor	Good	Normal	- The battery of the FO flow meter (Unit 1&2) is running out and should be changed. LEC needs to get quotation of four batteries for the HFO/LO purifier and purchase the item..
LO-1	LO purifier unit	JICA plant grand floor	Good	Normal	-
LO-2	LO filter	JICA plant grand floor	Good	Normal	- the third filter to be replaced. The manufacturer strongly recommend to use genuine parts because the third party parts may cause of the crank shaft damage. LEC needs to get quotation for LO third filters and purchase the item..

					
LO-3	LO back wash filter	JICA plant grand floor	Not work Automatically	Air leakage of the solenoid valve	- Cleaning and sealing is needed. During the OH, it will be checked. LEC needs to get quotation for a solenoid valve and purchase the item..
LO-3	LO pump	JICA plant grand floor	Good	Normal	-
LO-4	LO sump tank	JICA plant 2nd floor	Good	Normal	-Sample check will be done in July, and new Lo will be procured for unit 1 and unit 2.
LO-5	Oil mist detector	Engine side	Good	Normal	-
A-1	Air compressor	JICA plant grand floor	Unit1: Not operated Unit2: Good	Unit1: Air leakage	- For unit1, Air leakage is observed from the air relief valve when the air pressure exceeds 2 MPa. During the OH, it will be checked. LEC needs to get quotation for a relief valve and purchase the item.
A-2	Air receiver	JICA plant grand floor	Good	Drain water was accumulated at the bottom of the Air receiver	- Drain should be done one time each shift. During the OH, it will be checked.
W-1	Water treatment unit	JICA plant grand floor	Good	Normal	-
W-2	Treated Water Tank/ Treated Water pump	JICA plant grand floor	Good	Normal	-

W-3	LT/HT water expansion tank	JICA plant 2nd floor	Good	Normal	- Inhibitor has not used and should be add to the cooling water. LEC should procure the inhibitor.
W-4	Water circulating pump	JICA plant grand floor	Good	Normal	-
W-5	LO cooler	JICA plant grand floor	Good	Normal	-
W-6	Air Cooler	JICA plant 2nd floor	Working	Water leakage is suspected	- It will be inspected during the OH.
W-7	Radiator	JICA plant grand floor	Good	Normal	-
SL-1	Sludge Treatment System	Outside of JICA plant	Not working the incinerator	Damaged	- To be confirmed during the OH.
O-1	Blowers	Blower room	Good	Normal	-
E-1	Generator	JICA plant 2nd floor	Good	Normal	-
E-2	Electrical Control panel	JICA plant grand floor / Control room	Good	Normal	- Space heater on MCC is ON (it should be on during the engine stop to avoid insulation deterioration)
E-3	6.6kV Switchgear	Electrical room	Good	Normal	- During the long term stop of the engine, CB for generator should be off and drawn out position.
E-4	22kV Switchgear	Electrical room	Good	Normal	- During the long term stop of the engine, CB for generator should be off and drawn out position. - Burnout had happed at the station feeder. The cause should be checked.
E-5	6.6/22kV Transformer	Electrical room	Good	Normal	-

2. Pilot Activity Supplementary Report



2. Pilot Activity Supplementary Report

LIBERIA ELECTRICITY CORPORATION (LEC) BUSHRID POWER STATION

ACTUAL PROGRESS OF MAINTENANCE WORK

Engine Type : 16V28HLX	Total Days: 94 days	Total Input of LEC staffs 1,464	Total Input of SVs: 334
Installed Capacity: 5MW x 2sets (Unit1 and Unit 2)	Total Working Days:	Max. Number of LEC staffs/day: 25	Total Input of JICA Experts: 124
Maintenance Plan: D1(8KOH items)+Trouble Shooting	Normal working time: 08:30-18:00 : Monday to Friday	Min. Number of LEC staffs/day: 16	
	08:30-16:00 : Saturday	Other Input by LEC: Spare parts, Mask, Safety Jacket and Hat, Lunch, LEC Staff Transportation	

Legend
- : Unit 1
- : Unit 2
- : Common Work

MONTH: AUGUST (DATE 10–31) / SEPTEMBER (DATE 1–30) / OCTOBER (DATE 1–18)

Day Count 1–101; Working Day Count 1–79

DG NO.2 (Normal 8K maintenance menu + trouble shooting) / DG No.1&2 (Normal 8K maintenance menu + trouble shooting)

NO.	WORK ACTIVITIES
	TRAVEL
1	KICKOFF MEETING
2	LOG DATA/ HISTORY CHECK AND PREPARATION OF TOOLS & PARTS
3	DISCHARGE & REFILLING LUBE OIL AND WATER
4	REMOVAL OF CYLINDER HEAD COMPONENTS (PIPING, CYL. HEAD COVERS and INTAKE & EXH BRANCH)
5	REMOVAL OF CYLINDER HEAD NUT AND PULL-OUT HEAD
6	TRANSPORT ALL CYLINDER HEADS TO MAINTENANCE AREA
7	REMOVAL ALL PISTONS, FIRE RING & DISASSEMBLE CON ROD
8	CLEANING ALL PISTONS, FIRE RINGS & MEASUREMENT. CONDUCT PENETRANT CRACK CHECK
	(Fire ring will be further use after confirmed good condition)
9	CLEANING ALL CON ROD MEASUREMENT. CONDUCT PENETRANT CRACK CHECK.
10	ASSEMBLE PISTON AND CON ROD
	＊If found abnormality, recondition or replace with spare. Con rod may judge for temporally further use or not)
11	SAMPLE INSPECTION FOR MAIN BEARING No.6 & CHECK RUN-OUT ON MJ2
12	REMOVAL CYLINDER LINERS. At least 2pcs and may for all if fist sample 2pcs shows bad condition.
13	CLEANING & HAND FINISHING CYLINDER LINERS (IN/OUT)
	CONDUCT PENETRANT CRACK CHECK
14	**CYLINDER BLOCK CLEANING (INTAKE TRANK/ LINER POCKET, JW AREA/ BLOCK UPPER FACE ETC.)**
15	INSTALALTION CYLINDER LINERS TO ENGINE
16	INSTALLATION PISTON TO ENGINE AND TIGHTENING BOLTS
17	REMOVAL & OVERHAULING OF FUEL INJECTOR
	VALVE (CLEANING & REPLACE NOZZLE TIP)
18	DISASSEMBLING OF INTAKE & EXHAUST VALVE
19	OVERHAULING OF STARTING AIR VALVE
20	RENEW J/W PUMP MECHANICAL SEALS, OIL SEALS, BALL BEARINGS
21	CLEANING / INSPECTION OF STARTING AIR DRAIN
	SEPARATOR & DISTRIBUTOR
22	CLEANING OF CYL. HEADS, CONDUCT PENETRANT CRACK CHECK
23	I/E VALVE SEAT CRACK TEST, RECONDITION, REPLACEMENT & LAPPED
24	WATER PRESSURE TEST (LEAK TAST)
25	MEASURING & ASSEMBLING OF CYLINDER HEADS COMPONENTS (I/E valve seat ring, I/E valve guide, and I/E valve)
26	CHECK & TROUBLE SHOOTING ((EIP, TC LO leakage, abnormal air drain, sludge treatment, incinerator, water in combustion chamber, etc.) — See A-1~9
27	AIR COOLER OVERHAUL, LEAK CHECK AND TEMPORELLY REPAIR (PUT PLUG)
28	FIP (Fuel Injection Pump) OVERHAUL
	(All delivery valves and 2 sample for plunger)
29	ASSEMBLING OF CYLINDER HEADS COMPONENTS
30	INSTALLATION OF CYLINDER HEADS & TIGHTENING
31	FITTING OF ALL DISMANTLED COMPONENTS
32	ADJUST TAPPET CLEARANCE, LEAK TEST
	DEFLECTION
33	ENGINE RUN & LOAD TEST
34	CLEANING ALL FILTERS (Lube oil ,Fuel oil, Air and Radiator fins))
35	OJT OH FOR PURIFIER (2 x HFO + 3 x LO)
36	MAINTENANCE FOR GENERATORS & CONTROL PANELS
37	TURBOCHARGER OVERHAUL
38	INVENTORY TOOLS & REST PARTS
A-1	LO PIPE CLEANING FROM ENGINE TO GENERATOR
A-2	CRANK CASE CLEANING, OIL TRANSFER FROM Unit#1 TO Unit #2 FOR FLUSHING
A-3	EXHAUST GAS MANIFOLD CLEANING
A-4	AUTO-SWITCHING TEST OF DO AND HFO
A-5	HFO TANK ARRANGEMENT
A-6	SILENCER DRAIN ARRANGEMENT
A-7	HFO LINE&TANK CHECK&CLEANING
A-8	DO LINE&TANK CHECK&CLEANING
A-9	LO LINE&TANK CHECK&CLEANING
A-10	COOLING WATER SERVICE TANK CLEANING (INSIDE)

Chart annotations: Discharge, LO discharge, Refilling of water and LO, LO Line Flushing, A1, Fire ring, Piston&Conrod, PT, Measurement, Fire Ring Cleaning, No.5, A2, JW pump cleaning, Air Trunk Cleaning, making, Overhaul, Replace, Removing, Installation, Cleaning, Adjustment, Cleaning Grinding, Leak test by water, Leak test by air for each pipe, Assembling, Unit 1 LO Main Filter, Unit 2 Sludge Tank, Alarm Check, FO Primary Filter, Strainer, Sludge Tank, Radiator Fin, Strainer, Intake Air Filter, FO Secondary Filter, FO Third Filter Replacement, LO Indication Filter, FO Secondary Filter, HFO No.2, HFO No.1, LO No.2, LO No.3, LO No.1, Unit1 A&B, Classroom Training, Reporting, Inventory List, Inventory Card, Shelf Fabrication, Buffer Tank & Service Tank, Service Tank

NO.	MEETING	Total
M-1	KICKOFF MEETING	1
M-2	WEEKLY MEETING WITH GENERATION MANAGER	14
M-3	EVERYDAY TOOL BOX MEETING	80
M-4	After OH Meeting	0

Ceremony; LEC HQ

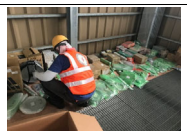
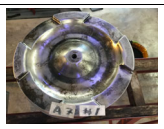
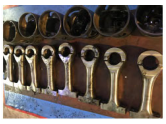
NO.	INPUT	Total
I-1	Total Number of LEC Staffs (Engineer, Technician, Operator)	1464
I-2	Total Number of SVs	334
	- OH Maintenance	186
	- Initial Checking / Test Running	40
	- Turbo Charger (T/C)	22
	- Purifier	50
	- Generator/ Generator Panel	36
I-3	JICA Experts	124

14 (August 3rd to 9th x 2 Experts)

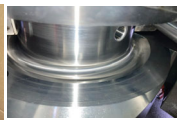
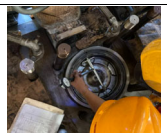
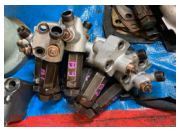
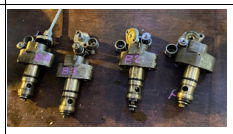
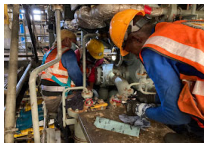
2. Pilot Activity Supplementary Report

Unit 1

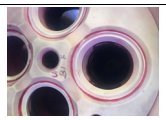
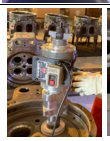
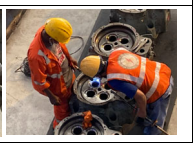
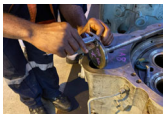
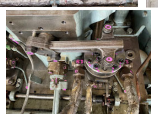
November 2022

Item No.	Work	Status	Progress and Remarks	Photo
1	TRAVEL (From Philippines to Liberia/ Back to Philippines)	Completed	N/A	
2	MEETING, LOG DATA/ HISTORY CHECK AND PREPARATION FOR OF TOOLS & PARTS	Completed	the Rod for the Deflection Gauge has missing. Mr. Endo has brought the other Deflection Gauge.	
3	DISCHARGE & REFILLING LUBE OIL AND WATER	Completed	Lube oil and water is refilled.	
4	REMOVAL OF CYLINDER HEAD COMPONENTS (PIPING, CYL. HEAD COVERS and INTAKE & EXH BRANCH)	Completed	OK	
5	REMOVAL OF CYLINDER HEAD NUT AND PULL-OUT HEAD	Completed	OK	
6	TRANSPORT ALL CYLINDER HEADS TO MAINTENANCE AREA	Completed	OK	
7	REMOVAL ALL PISTONS, FIRE RING & DISASSEMBLE CON ROD	Completed	OK. There is much carbon on the piston, but there is no problem with visual check.	
8	CLEANING ALL PISTONS, FIRE RINGS & MEASUREMENT. CONDUCT PENETRANT CRACK CHECK (Fire ring will be further use after confirmed good condition)	Completed	OK	
9	CLEANING ALL CON ROD MEASUREMENT. CONDUCT PENETRANT CRACK CHECK.	Completed	OK	
10	ASSEMBLE PISTON AND CON ROD * If found abnormality, recondition or replace with spare. Con rod may judge for temporally further use or not)	Completed	OK	

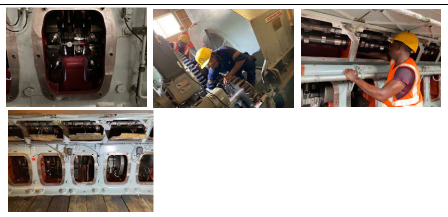
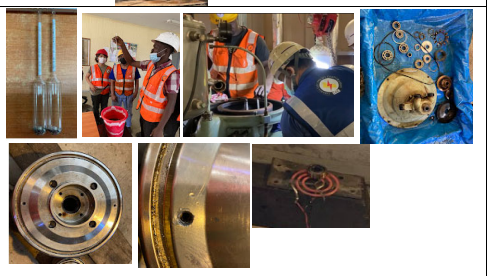
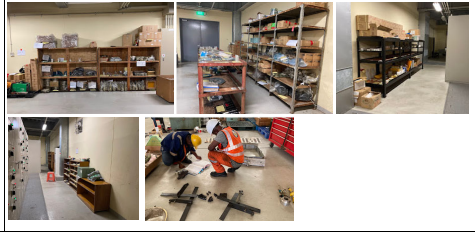
2. Pilot Activity Supplementary Report

11	SAMPLE INSPECTION FOR MAIN BEARING No.6 & CHECK RUN-OUT ON MJ2	Completed	OK Main bearing No.5 has checked. There is no major damage on the main bearing and MJ.	  
12	ROMOVAL CYLINDER LINERS. At least 2pcs and may for all if fist sample 2pcs shows bad condition.	Completed	OK	
13	CLEANING & HAND FINISHING CYLINDER LINERS (IN/OUT) CONDUCT PENETRANT CRACK CHECK	Completed	OK	
14	**CYLINDER BLOCK CLEANING (INTAKE TRANK/ LINER POCKET, JW AREA/ BLOCK UPPER FACE ETC.)**	Completed	Cylinder Block cleaning is completed. JW pump cleaning is completed. Air Trunk cleaning is completed. Indicator cock cleaning is completed. Block Upper face cleaning is not completed.	   
15	INSTALALTION CYLINDER LINERS TO ENGINE	Completed	OK	
16	INSTALLATION PISTON TO ENGINE AND TIGHTENING BOLTS	Completed	OK	
17	REMOVAL & OVERHAULING OF FUEL INJECTOR VALVE (CLEANING & REPLACE NOZZLE TIP)	Completed	All FIV cleaning and replacing nozzle tip work has completed.	 
18	DISASSEMBLING OF INTAKE & EXHAUST VALVE	Completed	EV of A1,2,5,6,8,B1,2,5,6,7 has severe damage. Already replaced to new valve	
19	OVERHAULING OF STARTING AIR VALVE	Completed	OK Inserted to Cylinder	
20	RENEW J/W PUMP MECHANICAL SEALS, OIL SEALS, BALL BEARINGS	Completed	OK	

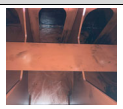
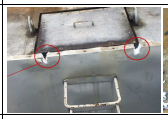
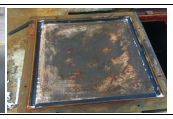
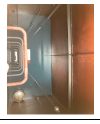
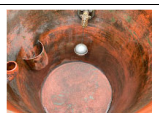
2. Pilot Activity Supplementary Report

21	CLEANING / INSPECTION OF STARTING AIR DRAIN SEPARATOR & DISTRIBUTOR	Completed	OK	
22	CLEANING OF CYL. HEADS, CONDUCT PENETRANT CRACK CHECK	Completed	As a result of the penetrant check, there was a crack on the EV seat of A2, A5, A6, A8, B1, B2, B6 Already replaced to new EV seat	 
23	I/E VALVE SEAT CRACK TEST, RECONDITION, REPLACEMENT & LAPPED	Completed	OK	  
24	WATER PRESSURE TEST (LEAK TAST)	Completed	A1 has crack on the EV seat, no crack on the cylinder head. There is no water leakage for the others. After changing the FV sleeve Oring of A1, the water leakage test was conducted again and confirmed no leakage.	 
25	MEASURING & ASSEMBLING OF CYLINDER HEADS COMPONENTS (I/E valve seat ring, I/E valve guide, and I/E valve)	Completed	OK	  
26	CHECK & TROUBLE SHOOTING ((EIP, TC LO leakage, abnormal air drain, sludge treatment, incinerator, water in combustion chamber, etc.)	See A-1~6		
27	AIR COOLER OVERHAUL, LEAK CHECK AND TEMPORELLY REPAIR (PUT PLUG)	Completed	OK Cleaning and pressure test has been completed. The installation to the Unit #1 was completed.	
28	FIP (Fuel Injection Pump) OVERHAUL (All delivery valves and 2 sample for plunger)	Completed	Cleaning is completed.	
29	ASSEMBLING OF CYLINDER HEADS COMPONENTS	Completed	The O rings for the FIV sleeve have damaged and should be replaced for all of unit 2 and A1 for unit1. Inside Intake Manifold was checked. Starting Air Valve, Indicator cock and FIP are inserted to Cylinder Heads Components.	    
30	INSTALLATION OF CYLINDER HEADS & TIGHTENING	Completed	All cylinders was installed and tightened.	 

2. Pilot Activity Supplementary Report

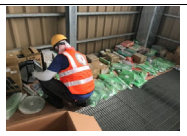
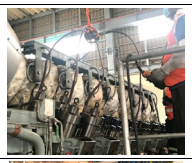
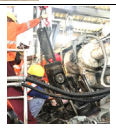
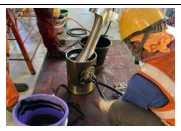
31	FITTING OF ALL DISMANTLED COMPONENTS	Completed	Measurement of the items attached to the crankshaft was completed. Gear was cleaned and Governor was adjusted. The camshaft contact check was completed.	
32	ADJUST TAPPET CLEARANCE, LEAK TEST	Completed	Tappet Clearance Adjustment is completed. Leak test of FIP is completed. The LO lubrication check is completed.	
	DEFLECTION	Completed	OK.	
33	ENGINE RUN & LOAD TEST	Completed	Load Test is completed successfully.	
34	CLEANING ALL FILTERS (Lube oil ,Fuel oil, Air and Radiator fins))	Completed	Lube oil filters (strainer, sludge tank, indication filer), Fuel oil filters (Primary filter, Secondary filter) and Radiator are completed. Intake Air Filter is completed. FO Third filter replacement is completed. FO Primary filter should be replaced to new one (under procurement).	
35	OJT OH FOR PURIFIER (2 x HFO + 3 x LO) BY MKK 2 ENGINEERS * Informed HFO PF Unit 1 : Pin No.103 damaged. MKK will check on actual and evaluate as additional trouble shooting. Action will be fond on the site such as fixing or need parts replacement.	ongoing	The gravity test of HFO and LO is completed. HFO PF No.1 and No.2 test run is completed. LO PF No.1 and No.2 test run is completed. LO PF No.3 maintenance will not complete due to the lack of the spare parts.	
36	MAINTENANCE FOR GENERATORS & CONTROL PANELS & BY NISHISHIBABA 2 ENGINEERS	Completed	OK	
	TEST OPERATION BY NISHISHIBA ENGINEER BY NISHISHIBABA 1 ENGINEER	Completed	OK	
37	TURBOCHARGER OVERHAUL BY ABB 1 ENGINEER	Completed	It was dirty with carbon, but there is no damages to all components. The lecture of T/C was conducted by SV.	
38	INVENTORY TOOLS & REST PARTS	Completed	Spare Parts and Tools inventory work was completed.	

2. Pilot Activity Supplementary Report

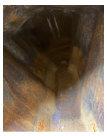
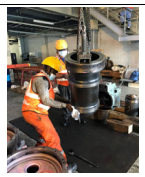
A-1	LO PIPE CLEANING FROM ENGINE TO GEENRATO	N/A	Unit 2 ONLY	
A-2	CRANK CASE CLEANING, OIL TRANSFER FROM Unit#1 TO Unit #2 FOR FLUSHING	Completed	OK	
A-3	EXHAUST GAS MANIFOLD CLEANING	N/A	Unit 2 ONLY	
A-4	AUTO-SWITCHING TEST OF DO AND HFO	Completed	OK	
A-5	HFO TANK ARRANGEMENT	Completed	OK	 
A-6	SILENCER DRAIN ARRANGEMENT	Completed	OK There is dust (like sand) inside and stuck and clogged.	  
A-7	HFO LINE&TANK CHECK&CLEANING	Completed	①~⑤ are common w/ Unit 2 but separated from DO line. ①HFO big tank >> No drain pipe there. Need to be considered the way to check. ②HFO buffer tank >> Water inside due to the clearance between tank itself and cover. No space for the gasket so need to be considered another way. ③HFO PF >> OH Done ④HFO service tank >> Water inside due to the clearance between tank itself and cover. No space for the gasket so need to be considered another way. ⑤HFO overflow >> OK (O)~(U) are common facilities with DO line but separated from Unit 2. (O) FO Primary Filter >> Already Cleaned. The filter should be replaced for Unit 1. (P) FO Mixing Tube >> Small water but normal amount. (Q) FO Line Heater >> No water and air. (R) FO Secondary Filter >> Already Cleaned. OK. (S) FO Third Filter >> Cleaned and the filter was replaced to new one. (T) FO Accumulator >> Already cleaned, OK. Gasket for Accumulator was made. (U) FO Drain Tank >> Water drained.	        
A-8	DO LINE&TANK CHECK&CLEANING	Completed	①DO storage tank >> No water ②DO service tank >> Inside was very clean. The drainage was clogged and cleaned already. (O)~(U) is same as HFO comment above.	 
A-9	LO LINE&TANK CHECK&CLEANING	Completed	①LO oil cooler >> OK ②LO main filter (Strainer) >> Already cleaned. OK. ③LO indication filter >> Already cleaned. OK. ④LO sludge checker >> Already cleaned. OK.	
A-10	COOLING WATER SERVICE TANK CLEANING (INSIDE)	Completed	OK	 
M-1	KICKOFF MEETING	Completed		
M-2	WEEKLY MEETING WITH GENERATION MANAGER	Completed		
M-3	EVERYDAY TOOL BOX MEETING	Completed		
M-4	After OH Meeting	Completed	The ceremony was conducted on Nov. 9th. Reporting to LEC HQ was conducted on Nov. 16th.	

2. Pilot Activity Supplementary Report

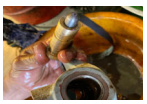
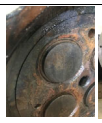
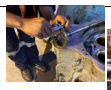
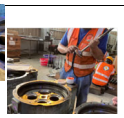
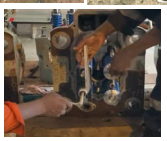
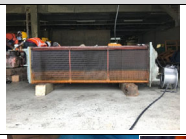
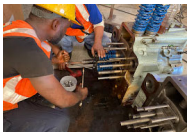
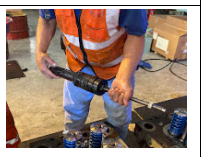
Unit 2

Item No.	Work	Status	Progress and Remarks	Photo
1	TRAVEL (From Philippines to Liberia/ Back to Philippines)	Completed	N/A	
2	MEETING, LOG DATA/ HISTORY CHECK AND PREPARATION FOR OF TOOLS & PARTS	Completed	the Rod for the Deflection Gauge has missing. Mr. Endo has brought the other Deflection Gauge.	
3	DISCHARGE & REFILLING LUBE OIL AND WATER	Completed	OK	
4	REMOVAL OF CYLINDER HEAD COMPONENTS (PIPING, CYL. HEAD COVERS and INTAKE & EXH BRANCH)	Completed	OK	
5	REMOVAL OF CYLINDER HEAD NUT AND PULL-OUT HEAD	Completed	OK.	
6	TRANSPORT ALL CYLINDER HEADS TO MAINTENANCE AREA	Completed	B4 Cyl. Head was stuck on the cylinder block.	
7	REMOVAL ALL PISTONS, FIRE RING & DISASSEMBLE CON ROD	Completed	Removal of Fire ring is finished (B2, B6, B7 has broken). All Piston and Con Rod was disassembled.	 
8	CLEANING ALL PISTONS, FIRE RINGS & MEASUREMENT. CONDUCT PENETRANT CRACK CHECK (Fire ring will be further use after confirmed good condition)	Completed	Piston Pins of A6,7,B3,4,5,6,7 have is not good condition due to the rust. These piston pins will be reused after cleaning, but replacement is recommended. There is no crack on the pistons with penetrant check. Fire ring cleaning is completed.	   
9	CLEANING ALL CON ROD MEASUREMENT. CONDUCT PENETRANT CRACK CHECK.	Completed	Some of the con rods have black color stain (corrosion), but it can reuse. Replacement of B3,5,6,7,A6,7 con rods are recommended. B6,7 & A6,7 is not so bad condition.	 
10	ASSEMBLE PISTON AND CON ROD * If found abnormality, recondition or replace with spare. Con rod may judge for temporally further use or not)	Completed	OK *some conrod should be replaced at 12,000 OH	 

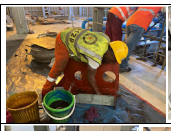
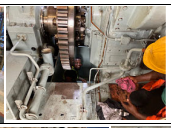
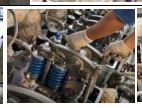
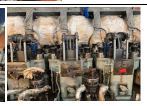
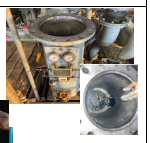
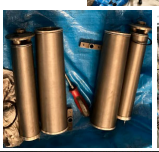
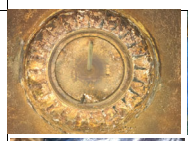
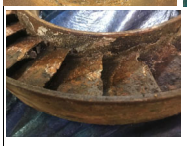
2. Pilot Activity Supplementary Report

11	SAMPLE INSPECTION FOR MAIN BEARING No.6 & CHECK RUN-OUT ON MJ2	Completed	Main bearing No.5 has checked. There is no major damage on the main bearing and MJ.	  
12	ROMOVAL CYLINDER LINERS. At least 2pcs and may for all if fist sample 2pcs shows bad condition.	Completed	B2 and B4 was removed as samples.	 
13	CLEANING & HAND FINISHING CYLINDER LINERS (IN/OUT) CONDUCT PENETRANT CRACK CHECK	Completed	OK. There is no crack or major damage on B2 and B4 cylinder liners. Before inseting the fire ring, the inside of cylinder liner was hand finished again.	
14	**CYLINDER BLOCK CLEANING (INTAKE TRANK/ LINER POCKET, JW AREA/ BLOCK UPPER FACE ETC.)**	Completed	Cylinder Block cleaning is completed. JW pump cleaning is completed. Air Trunk cleaning is completed. Indicator cock cleaning is completed. Block Upper Face Cleaning is completed.	    
15	INSTALALTION CYLINDER LINERS TO ENGINE	Completed	OK	
16	INSTALLATION PISTON TO ENGINE AND TIGHTENING BOLTS	Completed	OK	
17	REMOVAL & OVERHAULING OF FUEL INJECTOR VALVE (CLEANING & REPLACE NOZZLE TIP)	Completed	Before the overhauling, the pressure was not going up to the nominal pressure 35 MPa, but around 20 Mpa. Overhauling of the Fuel valve is finished.	
18	DISASSEMBLING OF INTAKE & EXHAUST VALVE	Completed	EV(A1,A3,A5,A8, B1, B2) & IV(B4) has damaged. Some valve stem were not took out easily from the Cly head due to rusting. Replacement of some valve guides is needed.	
19	OVERHAULING OF STARTING AIR VALVE	Completed	OK	
20	RENEW J/W PUMP MECHANICAL SEALS, OIL SEALS, BALL BEARINGS	Completed	OK	

2. Pilot Activity Supplementary Report

21	CLEANING / INSPECTION OF STARTING AIR DRAIN SEPARATOR & DISTRIBUTOR	Completed	Inside of the part which send the air to the air valves was rusted. By compounding the inside, the rust was removed.	 
22	CLEANING OF CYL. HEADS, CONDUCT PENETRANT CRACK CHECK	Completed	Cleaning is finished with sandpaper and scraper.B4 has a crack (checked by penetrant check). Penetrant check has done. There is no crack.	  
23	I/E VALVE SEAT CRACK TEST, RECONDITION, REPLACEMENT & LAPPED	Completed	OK All EV valve seats and FIV O ring are replaced to new one since the EV valve seats are shrink and deformed into an oval shape.	  
24	WATER PRESSURE TEST (LEAK TAST)	Completed	Water leakage between the EV seat and Cyl head has confirmed for B1~4. A1 has a crack on the cylinder head of exhaust side. B4 has a crack on the intake side. After disassembling the EV seat, It is confirmed that there is no crack B1~3,5~8,A2~8. After exchanging the FV sleeve Oring, the water leak test was conducted again to confirm no water leak from valve sheet etc. and no leakage was there.	  
25	MEASURING & ASSEMBLING OF CYLINDER HEADS COMPONENTS (I/E valve seat ring, I/E valve guide, and I/E valve)	Completed	OK	    
26	CHECK & TROUBLE SHOOTING ((EIP, TC LO leakage, abnormal air drain, sludge treatment, incinerator, water in combustion chamber, etc.)	See A-1~9		
27	AIR COOLER OVERHAUL, LEAK CHECK AND TEMPORELLY REPAIR (PUT PLUG)	Completed	OK	 
28	FIP (Fuel Injection Pump) OVERHAUL (All delivery valves and 2 sample for plunger)	Completed	OK Three sealing rings were arrived and replaced propery.	 
29	ASSEMBLING OF CYLINDER HEADS COMPONENTS	Completed	The O rings for the FIV sleeve have damaged and already replaced.	  
30	INSTALLATION OF CYLINDER HEADS & TIGHTENING	Completed	OK	

2. Pilot Activity Supplementary Report

31	FITTING OF ALL DISMANTLED COMPONENTS	Completed	OK	 
32	ADJUST TAPPET CLEARANCE, LEAK TEST	Completed	OK	  
	DEFLECTION	Completed	Measurement before the OH has done	
33	ENGINE RUN & LOAD TEST	Completed	OK	
34	CLEANING ALL FILTERS (Lube oil ,Fuel oil, Air and Radiator fins))	Completed	Lube oil filters (strainer, sludge tank, indication filer), Fuel oil filters (Primary filter, Secondary filter and Third filter) and Radiator are completed. Intake Air Filter is completed. FO Third filter cleaning (replacement of element) was completed.	      
35	OJT OH FOR PURIFIER (2 x HFO + 3 x LO) BY MKK 2 ENGINEERS * Informed HFO PF Unit 1 : Pin No.103 damaged. MKK will check on actual and evaluate as additional trouble shooting. Action will be fond on the site such as fixing or need parts		Same as Unit 1 remarks	
36	MAINTENANCE FOR GENERATORS & CONTROL PANELS & BY NISHISHIBABA 2 ENGINEERS	Completed	OK	
	TEST OPERATION BY NISHISHIBA ENGINEER BY NISHISHIBABA 1 ENGINEER	Completed	OK	
37	TURBOCHARGER OVERHAUL BY ABB 1 ENGINEER	Completed	Disassembling work and cleaning is ongoing. Nozzle ring and sealing cover has damaged and need to procure and replace. This OH #2 is scheduled from 30th Oct.	   
35	REPORTING & MEETING AFTER MAINTENANCE		Same as Unit 1 remarks	
38	INVENTORY TOOLS & REST PARTS		Same as Unit 1 remarks	

2. Pilot Activity Supplementary Report

A-1	LO PIPE CLEANING FROM ENGINE TO GEENR/	Completed	Water contamination was confirmed.	 
A-2	CRANK CASE CLEANING, OIL TRANSFER FROM Unit#1 TO Unit #2 FOR FLUSHING	Completed	OK	
A-3	EXHAUST GAS MANIFOLD CLEANING	Completed	OK The rust was removed by hand and grinder.	   
A-4	AUTO-SWITCHING TEST OF DO AND HFO		See Unit 1 remarks (Common Facility with Unit 1)	
A-5	HFO TANK ARRANGEMENT		See Unit 1 remarks (Common Facility with Unit 1)	
A-6	SILENCER DRAIN ARRANGEMENT	Completed	OK There is dust (like sand) inside and stuck and clogged.	
A-7	HFO LINE&TANK CHECK&CLEANING	Completed	① ~ ⑤ are common facilities with Unit 1 but separated from DO line. See the comment of Unit 1. (O)~(U) are common facilities with DO line but separated from Unit 1. (O) FO Primary Filter >> Already Cleaned. OK. (P) FO Mixing Tube >>OK. (Q) FO Line Heater >> OK. (R) FO Secondary Filter >> Already Cleaned. OK. (S) FO Third Filter >> The filter was replaced to new one. (T) FO Accumulator >> Already cleaned, OK. Gasket for Accumulator was made. (U) FO Drain Tank >> OK	 
A-8	DO LINE&TANK CHECK&CLEANING	Completed	①② is same as Unit 1 comment. (O)~(U) is same as HFO comment above.	
A-9	LO LINE&TANK CHECK&CLEANING	Completed	①LO oil cooler >> OK. ②LO main filter (Strainer) >> Already cleaned. OK. ③LO indication filter >> Already cleaned. OK. ④LO sludge checker >> Already cleaned. OK. Flushing of the LO line was conducted.	Same as No.34
A-10	COOLING WATER LINE&TANK CHECK&CLEANING	Completed	OK	

3. LEC Manual

3. LEC Manual

As shown in the chapter 2, it was confirmed that LEC does not have manuals related to maintenance such as work standards manual. In the classroom training of this project, we explained the necessity of preparing manuals and checklists such as work standards. In addition, we have provided the following materials to the LEC as a draft of the work standard, and we plan to update the draft of the work standard and start operation in the next implementation phase.

The Project of Capacity Development for Diesel Generator

Maintenance in the republic of Liberia

Class room training (1st)

Instruction for periodic maintenance works

June 2022

Prepared by West JEC

No.	(1-1)		Kick-off meeting (1) (client and contractor)	
1. Purpose	Periodic inspections are carried out in accordance with the manual for periodic maintenance work to maintain the functionality of the diesel engine in question. Implement smooth and safety maintenance work without accident with confirming the maintenance schedule and content, by held confirmation meetings to check any pending or requested issues.			
2. Agenda	(1) Work Contents (2) Confirmation of additional and deleted construction items (3) Work schedule (4) Safety measures during the construction period (5) Mutual confirmation of pending and requested items. (6) Environmental protection and disaster prevention measures (7) Safety patrols			(Remarks) ① Operating hours and faults since the last maintenance. ② Fuel and lubricant consumption rate fluctuations and trends. ③ Trends of Nox values and exceedances ④ Safety Operation ・Permits to work ・Use of safety tags ・Use of work compartments and nets ・Wearing armbands ・Safety training (induction training) ・Safety check sheets
3.Confirmation Items in advance	(1)Confirmation of pending and requested matters (2) Confirmation of Parallel works, timing and structure of implementation			
4.Check Records	(1)Confirm details of pending and requested items to be dealt with. (2) Confirm minutes of meetings after previous inspection (3) Performance tests (for latest)			
5. Reeference Documents	(1) Periodic inspection manuals (2) Handling manuals (3) Terms of Reference			(1) Safety manual. (2) Safety during periodic inspections of power stations (3) Other safety measures
6. Safety and trouble notification				

No.	(1-1)	Kick-off Meeting ② (between primary and secondary Contractors)		
Item	Procedures	Procedures and safety	Witness	Name
1. Preparation	・Meting between primary and secondary Contractors) (1) Description of work (2) Additional or deleted inspection items (3) Schedule of work (4) Safety measures (5) Confirmation of pending issues and requests. (6) Environmental protection and disaster prevention (7) Safety awareness, safety patrols	① Kick-off Meeting based on meetings among contractors ②Notification of Today's work schedule ③Identification of hazards and danger points and confirmation of countermeasures		
2. results of implementation	(1) Work Contents (2) Confirmation of additional and deleted construction items (3) Work Schedule (4) Safety measures during the construction period (5) Mutual confirmation of pending and requested items. (6) Environmental protection and disaster prevention measures (7) Safety patrols	Meeting points. ① Confirmation of construction work and pending requests. ② Requests for improvements to areas of insecurity. ③ Sharing and informing of dangerous areas ④ Prohibition of unsafe behaviour. Photo		
3. Pre-work checks and follow-up	◎Curing the engine room work area	◎Curing the floor of the engine and the work area with veneer and sheets		

No.	(2-1)		Performance test (1) before disassembly (performance check, vibration check)	
1. Purpose	Before the periodic inspection work, performance and vibration measurements of the diesel power generation equipment should be carried out. Calculate the fuel consumption rate at rated load and check for efficiency loss and abnormal values. Abnormal engine vibrations, abnormal noise and oil leaks are also checked. Engine performance tests should collect accurate data in order to compare before and after maintenance.			
2. Work Item				(Precautions during testing and inspection)
	(1)Performance Test (75% and 100% load)			①Check for abnormalities in each temperature and fuel consumption rate trends at rated output.
	(2)Vibration Check: No abnormal vibration			② Check for abnormal vibrations in the engine body, engine surroundings, piping and major auxiliaries of the generator.
	(3)Check for abnormal noises during operation			③ Check for abnormal noise (surging noise) of the turbocharger and abnormal noise of the engine body during rated load operation.
	(4)Check for oil and water leaks at engines, pipelines and auxiliaries			④ Check for oil leakage, air leakage, etc. from the engine auxiliaries.
	(5)Check rotation of intake and exhaust valve throat caps			⑤ Measure the rotation time of the rotor cap.
	(6)Check equipment operation (after engine shutdown)			⑥ Operate the equipment by mutual confirmation between the client and the contractor based on the equipment operation chart.
	(7)Safety tags fitted, safety sections installed			⑦ Confirmation of safety-related operations Safety tag Safety section
3. Inspection	(1)Confirmation of operating data and fuel consumption rates through performance tests. (2)Confirmation of abnormal vibrations in vibration measurements			
4. Record	(1) Performance test records since last repair (2) Engine performance tests (latest) (3) Vibration measurement records (since last repair)			
5. Reference Documents	(1) Periodic inspection manuals (2) Institutional manuals (3) Previous maintenance inspection list (4) Maintenance records of pending issues from the last maintenance to the current maintenance			(1) Safety manual. (2) Safety during power plant maintenance (3) Other safety measures
6. Safety and trouble notification	・Leakage at WARTSILA Unit 7 due to corrosion of cooling water pipes.			

No.	(2-1)		Performance test (2) before disassembly (performance check, vibration check)		
Item	Procedures		Procedures and safety	Witness	Name
1. Preparation	・Assign a record measurer before commissioning. Measurements are taken simultaneously at the measurement signal. (1) Preparation of each measuring i Pressure indicator, thermometer, stopwatch (2) Preparation of recording forms (3) Assignment of recording and measurement (5) Confirmation of measurement signals (6) Check engine load adjustment (7) Safety-related awareness		① Checking the validity of calibration records for measuring equipment. ② Notification of start signal and measuremet time ③ Identification of hazardous areas and danger points at the time of measurement and confirmation of countermeasures.		
2. Inspection Item	(1) Performance test (75% and 100% load). (2) Check for vibration and abnormal noise. (3) Check for oil, water and air leaks. (4) Intake and exhaust valve rotor cap rotation, time measurement (5) Failure under operation. (6) Operate equipment and attach safety tags after engine shutdown (7) Safety sections and safety markings.		[Check Point] (1) Measured values are within design values. (2) Abnormal vibration of engine, abnormal noise of turbocharger (3) Check for oil and water leakage from main piping, branches and pump gland. (4) Revolutions of 2 to 3 times in 60 sec. (5) Cracks in exhaust expansion pipe, thermocouple failure, etc. (6) Operation based on equipment operation chart (operation of engine, generator, etc.) (7) Safety compartment setting in the work area and installation of safety signage.		
3. Check Test Result and Fllowup	(1)Data check of Engine performan (2) Check Inspection data (3) Check vibration measurement data		①Inspection data are within design values. Comparison with previous data. ② Countermeasures/study of causes in case the inspection data/result are deviated from design values. ③Study of trend of vibration values		

No.	(3-1)	Inspection before Disassembly	Deflection measurement (the measured value in the cold state when the engine is stopped is used as the reference value)①
1. Purpose	Before dismantling the diesel engine, inspect the crankshaft deflection. Compare with recent measurements and check that it is within the design allowance. (When the crankshaft is opened and closed, the shaft moves up and down, opening and closing the space between the shafts. Metal fatigue due to this repeated stress can cause major accidents such as localised damage).		
2. Inspection Method	(1) Open the engine crankcase door (2) Crank pin of cylinder to be measured is moved to bottom dead centre (3) Install gauge for deflection measurement (4) Deflection measurement (5) Deflection recording (6) Judgment of deflection (7) Remove deflection gauge		Remarks (1) To use the value measured in the cold state as the standard value, palpate the crankcase door before releasing it to confirm normal temperature. (2) The crank pin is moved by manual turning. Give a signal at the measurement position (bottom dead centre). (3) For gauge installation, remove oil film from the mounting surface to prevent slipping due to oil film. (4) Since measurement is carried out at the upper dead point and the lower dead point, be careful not to make a reading error. (5) Do not mistake the cylinder numbers on the generator side and the turbocharger side (do not record them in reverse). (6) Compare with recent data and check for any significant differences. (7) Carefully remove the gauge to prevent it from falling into the crank chamber.
3. Check Item	(1) Check past measurement data to get an idea of deflection trends. (2) Check whether the measured deflection values are within the permissible crankshaft opening and closing values.		・If the crankshaft is left in a state of poor deflection, the main bearings will wear out and become damaged. ・Compare the data at the time of operation with the most recently measured data to check that there has been no change.
4. Record	(1) Past deflection data (2) Check latest deflection data (3) Check deflection transition records (4) Check the allowance for deflection		
5. Reference Document	(1) Periodic inspection and maintenance manuals (2) Engine operation manuals (3) Previous maintenance checklist (4) Pending issues and actions taken since the last maintenance.		(1) Safety manual. (2) Safety during power plant inspection
6. Notification of Safety and Trouble	Exceeded deflection allowance in War Unit 6.		

No	(3－1)	Inspection before Disassembly	Deflection inspection (checking crankshaft open/close status) ②		
Item	Procedures		Procedures and safety	Witness	Name
1. Preparation	・計測前に測定器の準備と測定者 (1) Preparation of each measuring instrument Deflection gauges, mirrors, etc. (2) Preparation of recording forms (3) Assignment of recording and measurement work (5) Confirmation of measurement signals (6) Safety-related awareness		① Check the expiry date (year and month) of the calibration records of measuring equipment. ② Pilot mirror inspection ③ Identification of hazardous areas and points at the time of measurement and confirmation of countermeasures. ④ Confirmati		
2. Work Procedure	(1) Turn and move the crank pin to the bottom dead centre. (2) Deflection gauge mounted between crankshafts (3) Measure and record data at bottom dead centre (4) Turn and place crankpin at upper dead centre (5) Deflection gauge mounted between crankshafts (6) Data recording at top dead centre (7) Deflection gauge removal		(1) Deflection measurement points ・Deflection measurement points: - Dial gauges shall be measured using a pilot mirror. (2) The suitability of the measured values shall be judged by the fact that there is no error in the measured values at two locations. (3) Large changes in measured values may indicate abnormalities such as cracks in the base plate or crankshaft, etc. Compare with the previous data to make a judgment.		
	(Reference value for deflection) Engine type16PC2-5V unit: mm				
	Standard: ST	0.046	≤ 1/10000 x stroke		
	Allowable value: LA	0.092	2/10000 x stroke		
	Limit: LR	0.0129	2.8/10000 x stroke		
3. Checking and follow-up after the Inspection	(1) Check deflection measurement data. (2) Determination within measurement data control values		(1) Check whether the measured values are within the design values and compare them with the previous data. (2) If the measured value deviates from the permissible value, investigate the cause and consider the measures to be taken.		

No.	(4-1)	Disasemble of Pipings around Engine ①	
1. Purpose	Before dismantling the top of the diesel engine, remove the fuel, lubricating oil cooling water piping, etc. attached to each cylinder. Before removing the pipework, oil and water draining must be completed before dismantling the top section.		
2. Inspection Item			Remarks
	(1) Drainage of fuel oil inlet/outlet and main pipe (2) Drain the cooling oil main at the fuel valve. (3) Check the engine cooling water, fuel and lubricating oil pipes for drainage. (4) Remove the small pipework around the engine (oil, water, air). (5) After removing the pipes, protect the openings (to prevent foreign objects from entering).		(1) Items to be checked before removing the pipework. Fuel oil and lubricating oil piping valve operations Cooling water and seawater drainage operation Air system valve operation. (2) Check the connection status of small-diameter piping. Check connections with main equipment. (3) Check the status of connections with main equipment. Check after dismantling. Curing of openings as a measure to prevent foreign material from entering.
3. Check Item	(1) Pipe should be removed and cured after the following inspections. Oil and water leakage due to cracks in pipes. Pipeline internal contamination.		Photo
4. Check Reports	・N.A.		
5. Reference Document	(1) Operating instructions		
6. Notification Safety and Trouble	Water leakage due to cracks in pipes at WAR unit.		

No.	(4-1)	Removal of Piping around Engine ②		
Item	Procedure	Manuals and safety measures	Witness	Name
1. Preparation	(1) Preparation of working tools and equipment Spanners, hammers Spanners, screwdrivers, etc. Wrenches, screwdrivers, etc. (2) Others (safety-related) Stepladders Safety ropes Safety belts	(1) Piping removal method ・Prepare an oil bucket to prevent splashing of residual oil. ・Remove the drain plug and drain the remaining oil into the bucket. ・Check that there is no oil or water in the pipework and scaffolding.		
2. Inspection Item	(1) Drainage of fuel oil inlet/outlet main pipes (2) Drain the cooling oil from the fuel valve from the main pipe. (3) Drain cooling water, fuel and lubricating oil from the pipework. (4) Remove small pipes around the engine (oil, water and air). (5) Remove the pipework and protect the openings (measures to prevent ingress of foreign objects). (6) Transport and cure the removed pipework.	(1) Storage of dismantled pipework ・ Method of storing removed pipework: - Cure openings with vinyl, etc. to prevent oil or water leakage from removed pipework or ingress of foreign matter. ・ Small-diameter pipework should be labelled with a name and number tag and stored in such a way that the combination remains the same. Photographs of work		
3. Check Maintenance Work and followup	(1) Curing of openings (2) Storage of removed pipework	(1) Prevent foreign material from opening. (ii) Clean the pipework of oil. Keep passages clear of obstructions.		

No.	(4-2)	Removal of Cylinder head ①	
1. Purpose	The cylinder head, located above the combustion chamber of diesel engines, is equipped with major equipment such as intake valves, exhaust valves, fuel injection valves and starting valves, which must be opened and inspected during partial or major rehabilitation. The body is made of special cast iron and is heavy, so special tools are required for removal and installation.		
2. Inspection Procedure	(1) Remove bonnet cover. (2) Removing valve gear unit (3) Cylinder head removal (4) Remove small pipework around the head (oil, water, air). (5) Check combustion status and gas leaks.	Remarks (1) Check before removing the head. Fuel and lubricating oil in various valves Cooling water and seawater drainage Pneumatic system piping valve operation (2) Small bore piping Remove from main equipment. Confirmation after dismantling Check after removal. Curing of openings (4) Inspection and preparation of special tools Hydraulic tools Lifting tools Lifting wire	
3. Check Item	(1) When removing the cover, record the following. Dirt on the cylinder head combustion surface Dirt on the exhaust air intake ports. Gas leakage from the head body.	Photo: Cylinder head removal	
4. Record	(1) Photograph of stained head combustion surface (2) Photographs of fouling of the upper part of the piston (3) Minimum pressure record of tie-rod bolt free		
5. Reference Documents	(1) Operation manual		
6. Notification of Safety and Trouble	Gas leakage due to cracked tie-rod bolt on War xx engine.		

No	(4－2)	Cylinder head removal②		
Item	Procedure	Method/Safety	Witness	Name
1. preparation of the work	(1) Special tools and equipment Hydraulic tightening tools for t Head lifting tools, etc. Wire ropes (2) Others (safety-related) Safety compartment ropes Safety belts	(1) Inspection points for hydraulic tightening tools ・Date of pressure gauge calibration record, damage. ・Deterioration and cracks in hydraulic hoses. (2) Wire rope inspection Wire rope inspection Twisted e.g. (PC-2-5 oil press) 88.3～93.2MPa (900～950kg／ c ㎡)		
2. implementation of the work	(1) Remove bonnet cover. (2) Removing valve gear unit (3) Bonnet removal (4) Set hydraulic jack. (5) Loosen tie rod bolts. (6) Remove hydraulic jack. (7) Install head lifting tool. (8) Head lifting removal (9) Remove and store intake air main pipe. (10) Checking the head combustion surface seat. (11) Head transport and storage	(1) Handling of hydraulic tightening tools Loosen the hydraulic jack by approximately 3 mm from where the bottom of the jacknut is located; loosen by one turn. ・If air gets into the hydraulic circuit, loosen the hose joints to release the air, as it is difficult for the hydraulic pressure to rise. Photo: Removal of Head		
3. check and follow-up after the work	(1) Curing of head openings (2) Storage of removed heads	(1) Prevent foreign objects from entering through openings and workers from falling. (2) Covered storage in a location that does not obstruct the passageway.		

No	(4-3)	Piston AP ring removal①	
1. Purpose	To reduce lubricant consumption, AP rings are fitted on the upper part of the piston and cylinder liner. When the piston is opened, the AP ring is removed to check for abnormalities, wear conditions and fouling of the combustion area.		
2. Work Procedure			Remarks
	(1) Check AP ring contamination. (2) Clean AP ring (3) Liner fixing tool installation (4) AP ring removal (5) Knock pin removal and storage (6) Remove liner fixing tool		(1) Chek Item before AP ring removal Check AP ring for dirt. Check AP ring deformation. Dirt on the upper part of the piston. (2) AP ring removal Fixation of knock pin Check after removal Scratches or damage on AP rings. Abnormal wear of cylinder liner (4) Preparation of special tools Liner fixing tools Lifting tools Lifting wire
3. Inspection Items	(1) Inspect and record the following items when the AP ring is removed. ・Carbon deposits on the AP ring. ・Liner wall wear after AP ring removal. ・AP ring positioning pin removal		Photo
4. Record	(1) Photos of AP ring staining and wear (2) Photos of staining and wear at the top of the liner (3) Photos of stained upper part of piston		
5. Reference Document	(1) Engine operating instructions.		
6. Notification safety and Trouble	・Abnormal cylinder liner wear on War xx unit.		

No	(4－3)	AP ring removal (Piston Upper)②		
Item	Procedure	Method/Safety	Witness	Name
1. Preparation of the work	(1) Preparation of special tools and equipment AP ring extraction tools Cover lifting tools, etc. Wire ropes (2) Others (safety-related) Safety section ropes Safety belts	(1) Points before AP ring removal Prepare a scaffold at the top of the piston. (2) Wear protective equipment. Wear masks. Wear work gloves.		
2. Implementation of the work	(1) Check AP ring fouling status (2) Clean the AP ring (3) AP ring extraction tool installation (4) Install liner fixing tool (5) AP ring extraction (6) Knock pin removal and storage (7) AP ring removal (8) Liner fixing tool removal (9) AP ring storage	(1) Key points when extracting AP rings. -Install fittings to prevent the liner from rising due to engine turning. -Remove and store the locating pin (do not lose it). Photo		
3. check and follow-up after inspection	(1) AP ring storage (2) Storage of tools used	(1) Storage in a place that does not obstruct traffic. (2) Storage in a designated place.		

No	(4-4)	Piston Pullout ①
1. Purpose	The piston consists of a head and a skirt. The head is made of heat- and pressure-resistant forged steel and is bolted to the skirt (made of cast iron). Cooling oil circulates inside the head. The explosive surface of the piston head must be inspected for fouling by combustion gases, cracks due to impact, etc., and the body must be dismantled and inspected.	
2. work procedures	(1) Check the upper part of the piston for fouling. (2) Install piston pull-out tool (3) Remove crankpin bolts (4) Crank pin cap removal (5) Pull out piston (6) Remove piston fittings	Remarks 1. Check before piston removal. Stains of the piston upper part Scratches on inner surface of liner Cracks in the upper part of the piston 2 Checks during piston removal Broken or sticking piston rings 3. Check after piston pull-out Scuffing of piston ring sliding surfaces Cylinder liner wall wear 4. Inspection and preparation of special tools Piston pulling tools Lifting tools Lifting wire
3. inspection checks	(1) Perform the following inspections when the piston is pulled out. Carbon deposits on the piston rings. Liner wall wear after piston withdrawal Piston sliding condition	作業写真
4. Record	(1) Tightening of crank pin bolts (2) Photo of worn parts of piston sliding parts (3) Photo of carbon deposits on piston rings (4) Photo of longitudinal scratches on cylinder liner wall	
5. Reference Documents	(1) Engine operating instructions	
6. Notification Safety and Trouble	・Piston cracks in War xx unit.	

No	(4－4)	Piston Pull-out②		
Item	Procedure	Method/Safety	Witness	Name
1. Preparation of the work	(1) Preparation of special tools and equipment. Piston pull-out tool Crank pin cap holder Wire ropes (2) Others (safety-related) Overhead crane inspection Safety section rope Safety belts	(1) When pulling out the piston Inspection before crane use Inspection of piston lifting gear Crank pin cap receiver inspection (2) Wire rope inspection Check for broken or kinked wire. (3) Wearing protective equipment Wear masks. Wear gloves.		
2. Implementation of the work	(1) Check piston combustion surface. (2) Clean piston combustion surface. (3) Install piston pull-out tool (4) Install crankpin cap receiver. (5) Remove crankpin bolts. (6) Remove crankpin cap. (7) Install metal fall prevention fitting. (8) Pulling out piston (9) Removing "metal fall protection fitting" (10) Metal removal and storage (11) Piston and connecting rod storage	(1) When the piston is pulled out. -Piston ring breakage or sticking. -Scuffing of piston ring sliding surfaces and adhesion of blow-by. -Curing of lids on each cylinder to prevent foreign objects falling into the crank chamber. Photo		
3. Checking and following up on the completion of the work	(1) Piston and connecting rod storage (2) Crank pin metal storage (3) Storage of tools	(1) Storage in a place that does not obstruct traffic. (2) Storage in a designated place.		

No.	(9-1)	Balance weight assembly ①
1. Purpose	The balance weight is mounted on the crankshaft after the main bearing base, which is fixed to the frame with tightening bolts, and the main bearing cap is fixed to the frame with jack bolts. The balance weight is in close to the crankshaft and is assembled after being carried into the crank chamber.	
2. 2. Work procedures	(1) Oil seal replacement (2) Installation of jack bolts (3) Check the gap (4) Tightening the jack bolt (5) Anti-rotation	(Balance weight assembly) (1) Install without make damage to the oil seal (2) Checking the gap Photo
3. Inspection items	(1) Check the following when installing the balance weight. ・ Check the gap ・ Installation of anti-rotation plate and anti-rotation washer	Photo
4. Record	(1) Gap measurement record	
5. Reference Documents	(1) Engine instruction manual	
6. Safety and trouble awareness	・ Damage to the crank shaft of the War Unit xx	

No.	(9-1)	Balance weight assembly ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work preparation	(1) Preparation of hydraulic tools ・ Hydraulic jack ・ Hydraulic hose ・ Hydraulic pump (2) Preparation of hanger ・ Chain block (3) Safety measures ・ Safety zone	① Hydraulic tool inspection points ・ Pressure gauge calibration date ・Check for hydraulic hose cracks ・ Hydraulic tool damage check ② Hanger inspection point ・ Visual inspection of hanging crown ③ Disseminate safety measures ・ Section rope ・ Transportation of heavy objects		
2. Implementation of this work	(1) Install the oil seal replacement tool (2) Moly coat to jack bolts and receivers (3) Jack bolt tightening (4) Checking gaps and surface (5) Installation of hydraulic equipment for final tightening (6) Hydraulic pump operation, tightening (7) the detent plate for jack bolts (8) Bolt rotation stop with toothed washer	(Balance weight mounting point) (1) Don't damage the crank shaft when inserting the balance weight into the crank chamber. (2) Check fitting from both directions (3)Installation and fixing confirmation of anti-rotation bi-plate and washer		
3. Confirmation and follow-up after work is completed	(1) Confirmation of installation of anti-rotation bracket	(1) Reconfirm the misalignment of the mating part and the tightening pressure (2) Measured value of gap between contact surfaces		

No.	(9-3)	Crank shaft inspection ①	
1. Purpose	Lubricating the crank metal and the lubricating oil inside the piston is supplied via the crank shaft. As with the crank shaft, the lubrication hole connected to the crank shaft is susceptible to crack damage due to explosion and inertial force, so inspection is performed.		
2. Work procedures	(1) PT inspection around fillet (penetration) and lubricating oil lubrication hole (2) MT inspection around fillet (penetration) and lubricating oil lubrication hole	(1) Do not damage the surface of the crank shaft body (2) Check for clogging of the crank shaft lubrication hole (3) Confirmation of scratches on the fillet Photo	
3. Inspection items	Check the crank shaft lubrication hole and fillet. - PT inspection around fillet and lubrication hole - MT inspection around fillet and lubrication hole		
4. Record	(1) PT inspection record around fillet lubrication hole (2) MT inspection record around fillet lubrication hole		
5. Reference Documents	(1) Engine instruction manual	Photo	
6. Safety and trouble awareness	・ Crank shaft lubrication hole sticking of War Unit xx		

No.	(9-3)	Crank shaft inspection ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work Preparation	(1) Preparation of test solution ・ PT test solution ・ Cleaning liquid (2) Preparation of MT inspection equipment ・ Magnetic particle flaw detector ・ Power drum (3) Safety measures ・ Safety zone	① PT inspection point ・ Check for scratches on the shaft surface ・ Check the occurrence of scratches around the lubrication hole ② Inspection equipment inspection points ・ Visual inspection, operation check ・ Check for equipment damage ③ Disseminate safety measures ・ Section rope		
2. implementation work	(1) Cleaning the crank shaft body (removing the oil film) (2) Confirmation of inspection points on the fillet (3) Check around the crank shaft lubrication hole (4) Fillet part PT inspection (5) Crank shaft lubrication hole PT inspection implementation (6) Fillet MT inspection (7) Crank shaft lubrication hole MT inspection conducted (8) Recording, judgment	(1) Check for cracks and damage in PT and MT inspections (2) There is no sticking of the crank shaft lubrication hole. Photo		
3. Confirmation and follow-up after work is completed	(1) Curing of the crank shaft body surface and lubrication holes	① Protection of the surface of the crank shaft (Wrapping of rubber sheet) ② Protection of lubrication hole		

No.	(9-4)	Crankpin wear measurement ①	
1. Purpose	Lubrication oil is supplied to the crank metal and inside the piston body via the crankshaft. The crankshaft is subject to wear inspection (cam wear) because of concerns that the piston and connecting rod may crack and damage due to explosion and inertial forces.		
2. Work procedures	(1) Cleaning the crankpin (2) Mounting measuring instrument (3) Wear measurement	(1) Do not damage the surface of the crankpin (2) Check for damage to the lead wire of the measuring instrument	
3. Inspection items	(1) Wear on the surface of the crankpin ・ Check for abnormal wear ・ Check for scratches on the surface of the crankpin	Photo	
4. Record	(1) Crankpin wear measurement record		
5. Reference Documents	(1) Engine instruction manual	Photo	
6. Safety and trouble awareness	・ War Unit xx crankpin burnout accident		

No.	(9-4)	Crankpin wear measurement ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work preparation	(1) Preparation of wear amount measuring instrument ・ Digital display ·Lead (2) Preparation for cleaning the crankpin ・ Cleaning liquid ・ Wes (3) Safety measures ・ Safety zone	① Measuring instrument inspection points ・ Digital display operation check ・ Check for sensor damage ② Cleaning equipment inspection points ・ Visual inspection ・ Confirmation of expiration date ③ Disseminate safety measures ・ Section rope		
2. Implementation of this work	(1) Cleaning the crankpin (2) Mounting measuring instrument (3) Wear measurement Photo	(Crankpin wear measurement point) (1) Clean the surface of the crankpin and check for scratches and damage. (2) If the data at the time of measurement is not stable, measure it many times and record a stable value. Photo		
Confirmation and follow-up after work is	(1) Crankpin body surface curing	① Protection of the surface of the crank shaft After measurement, wrap by the rubber sheet		

No.	(10-1)	Connecting rod non-destructive PT inspection ①	
1. Purpose	The connecting rod is connected to the crankshaft and piston and is subject to high loads due to explosion and inertia forces, which can easily cause cracks and damage to the connecting part. Non-destructive testing (PT inspection) of the connection surfaces of the large ends and serrations should be carried out.		
2. Work procedures	(1) Pretreatment (cleaning) (2) Penetration treatment, magnetization (3) Removal of penetrant (4) Development processing, application of magnetic powder (5) Observation of flaw detection surface, observation of magnetic particle pattern	(Points of non-destructive inspection) (1) Check the large end and serration surface without make damage to it. (2) Check for damage to the lead wire of the measuring instrument (3) The probing area to be checked after a specified time passed. Photo	
3. Inspection items	(1) Perform non-destructive inspection of connecting rods ・ PT inspection		
4. Record	(1) PT inspection record	Photo	
5. Reference Documents	(1) Engine instruction manual		
6. Safety and trouble awareness	・ War Unit xx connecting rod serration crack		

No	(10-1)	Connecting rod non-destructive PT inspection ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work preparation	(1) Preparation of test solution ・ PT test solution ・ Cleaning liquid (2) Preparation of MT inspection equipment ・ Magnetic particle flaw detector ・ Power drum (3) Safety measures ・ ・ Safety zone	① PT inspection point ・ Check for scratches on the shaft surface ・ Check the occurrence of scratches around the lubrication hole ② Inspection equipment inspection points ・ Visual inspection, operation check ・ Check for equipment damage ③ Disseminate safety measures ・ Section rope		
2. Implementation of this work	(1) Cleaning the connecting rod body (removing the oil film) (2) Confirmation of inspection points at the large end (3) Confirmation around the large end lubrication hole (4) Large end PT inspection (5) Connecting rod serration part PT inspection (6) Recording, judgment	(Points of non-destructive PT inspection) (1) Penetrant flaw detection PT inspection • Uses 3 types of cleaning liquid, penetrating liquid, and developing liquid • Spray the red penetrant for 10 to 20 minutes, and after drying, apply the cleaning liquid to the waste cloth and wipe it off. • Spray the developer evenly (distance about 30 cm) . Photo		
3. Confirmation and follow-up after work is completed	(1) Arrangement of equipment used (2) Connecting rod storage	① Protection of serration surface Vinyl sheet curing		

No.	(10-3)	Crankpin cap non-destructive (PT, MT) inspection ①	
1. Purpose	The crankpin is connected to the connection rod and the piston, and a large load is applied due to the explosion and inertial force, so that the connecting rod is likely to be cracked or damaged. For this reason, non-destructive inspection (PT and MT inspection) of the crankpin cap should be performed.		
2. Work procedures	(1) Pretreatment (cleaning) (2) Penetration treatment, magnetization (3) Removal of penetrant (4) Development processing, application of magnetic powder (5) Observation of flaw detection surface, observation of magnetic particle pattern	(1) Check the surface of the crankpin cap without make damage to it. (2) Check for damage to the lead wire of the measuring instrument (3) Check the flaw detection part on the magnetic particle pattern Photo	
3. Inspection items	(1) Crankpin cap non-destructive inspection ・ PT inspection ・ MT inspection		
4. Record	(1) PT inspection record (2) MT inspection record		
5. Reference Documents	(1) Engine instruction manual	Photo	
6. Safety and trouble awareness	・ Crankpin cap crack of War Unit xx		

No	(10-3)	Crankpin cap non-destructive (PT, MT) inspection ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work preparation	(1) Preparation of test solution ・ PT test solution ・ Cleaning liquid (2) Preparation of MT inspection equipment ・ Magnetic particle flaw detector ・ Power drum (3) Safety measures ・ Safety zone	① PT, MT inspection points ・ Check for scratches on the shaft surface ・ Check the occurrence of scratches around the lubrication hole ② Inspection equipment inspection points ・ Visual inspection, operation check ・ Check for equipment damage ③ Disseminate safety measures ・ Section rope		
2. Implementation of this work	(1) Cleaning the cap body (oil film) Removal) (2) Inspection point of the cap part confirmation (3) Cap part PT inspection (4) Implementation of MT inspection of cap part (5) Recording and judgment	PT (1) Penetrant flaw detection PT inspection ・ Uses 3 types of cleaning liquid, penetrating liquid, and developing liquid ・ Spray red penetrant and wait 10 to 20 minutes. After drying, apply cleaning liquid to the waste cloth and wipe it off. ・ Spray the developer evenly with a distance of about 30 cm. MT (1) Magnetic particle flaw detection MT inspection ・ After cleaning, apply magnetic particle flaw detector ・ Confirmation of magnetic particle pattern (2) Lubricating oil is applied to the entire surface after the inspection is completed. (Oxidation and corrosion prevention) Photo		
3. Confirmation and follow-up after work is completed	(1) Arrangement of equipment used (2) Crankpin cap storage			

No.	(10-4)	Piston pin non-destructive (PT, MT) inspection ①	
1. Purpose	The piston pin is connected to the connection rod and the crankshaft, and a large load is applied due to the explosion and inertial force, so that the connecting rod is likely to be cracked or damaged. For this reason, non-destructive inspection (PT and MT inspection) of the piston pin section should be performed.		
2. Work procedures	(1) Pretreatment (cleaning) (2) Penetration treatment, magnetization (3) Removal of penetrant (4) Development processing, application of magnetic powder (5) Observation of flaw detection surface, observation of magnetic particle pattern	(Points of non-destructive inspection) (1) Do not damage the surface of the piston pin (2) Check for damage to the lead wire of the measuring instrument (3) Check the flaw detection part on the magnetic particle pattern Photo	
3. Inspection items	(1) Non-destructive inspection of piston pins ・ PT inspection ・ MT inspection		
4. Record	(1) PT inspection record (2) MT inspection record	Photo	
5. Reference Documents	(1) Engine instruction manual		
6. Safety and trouble awareness	・ Piston pin crack of War Unit xx		

No	(10-4)	Piston pin non-destructive (PT, MT) inspection ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work preparation	(1) Preparation of test solution ・ PT test solution ・ Cleaning liquid (2) Preparation of MT inspection equipment ・ Magnetic particle flaw detector ・ Power drum (3) Safety measures ・ Safety zone	① PT, MT inspection points ・ Check for scratches on the shaft surface ・ Check for scratches around the lubrication hole ② Inspection equipment inspection points ・ Visual inspection, operation check ・ Check for equipment damage ③ Disseminate safety measures ・ ・ Section rope		
2. Implementation of this work	(1) Cleaning the piston pin body (removing the oil film) (2) Piston pin part PT inspection (3) MT inspection of piston pin part (4) Recording, judgment	(PT) (1) Penetrant flaw detection PT inspection ・ For cleaning liquid, penetrant, and developer ・ Use 3 types ・ Spray red penetrant and wait 10 to 20 minutes. After drying, apply cleaning liquid to the waste cloth and wipe it off. ・ Spray the developer evenly with a distance of about 30 cm. (MT) (1) Magnetic particle flaw detection MT inspection ・ After cleaning , apply magnetic particle flaw detector ・ Confirmation of magnetic particle pattern (2) Lubricating oil is applied to the entire surface after the inspection is completed. (Oxidation and corrosion prevention) Photo		
3. Confirmation and follow-up after work is completed	(1) Arrangement of equipment used (2) Piston pin storage	Vinyl sheet curing		

No.	(10-5)	Crankpin non-destructive MT inspection ①	
1. Purpose	The crankpin is connected to the connection rod and the piston, and a large load is applied due to the explosion and inertial force, so that the connecting rod is likely to be cracked or damaged. Therefore, a non-destructive inspection (MT inspection) of the crankpin portion is performed.		
2. 2. Work procedures	(1) Pretreatment (cleaning) (2) Penetration treatment, magnetization (3) Removal of penetrant (4) Development processing, application of magnetic powder (5) Observation of flaw detection surface, observation of magnetic particle pattern	(Points of non-destructive MT inspection) (1) Check the surface of the crankpin without make damage to it. (2) Check for damage to the lead wire of the measuring instrument (3) Check the flaw detection part on the magnetic particle pattern Photo	
3. Inspection items	(1) Crankpin non-destructive inspection is performed and the following Record the content. ・ MT inspection		
4. Record	(1) MT inspection record		
5. Reference Documents	(1) Engine instruction manual	Photo	
6. Safety and trouble awareness	・ Damaged crankpin of War Unit xx		

No.	(10-5)	Crankpin non-destructive MT inspection ②		
Item	Procedure	Works and Safety	Witness	Name
1. Work Preparation	(1) Preparation of test solution ・ MT test solution ・ Cleaning liquid (2) Preparation of MT inspection equipment ・ Magnetic particle flaw detector ・ Power drum (3) Safety measures ・ Safety zone	① MT inspection point ・ Check for scratches on the shaft surface ・ Check the occurrence of scratches around the lubrication hole ② Inspection equipment inspection points ・ Visual inspection, operation check ・ Check for equipment damage ③ Disseminate safety measures ・ Section rope		
2. This work implementation	(1) Cleaning the crankpin body (oil) Membrane removal) (2) Crankpin inspection points confirmation (3) Crankpin magnetic particle flaw detector Apply (4) Crankpin MT inspection (5) Recording and judgment	(1) Magnetic particle flaw detection MT inspection ・ After cleaning, apply magnetic particle flaw detector ・ Confirmation of magnetic particle pattern (2) Lubricating oil is applied to the entire surface after the inspection is completed. (Oxidation and corrosion prevention) (3) MT inspection procedure ・ Magnetize by passing a magnetization current through the metal part to check for cracks in the state of magnetic powder adhesion. ・ In recent years, fluorescent emission magnetic powder has been adopted. Photo		
3. Confirmation and follow-up after work	(1) Arrangement of equipment used	① Crankpin surface protection (Vinyl sheet curing)		

No	(12-2)	Fuel injection pump overhaul inspection ①	
1. Purpose	Fuel injection pumps are equipped with a plunger, liner, control rack and other components. The movement of the rack rotates the sleeve, which in turn rotates the plunger, thereby controlling the amount of fuel injected. Inspect these devices.		
2. Procedure	(1) Removing the connecting pipe retainer (2) Plunger guide, plunger extraction (3) Control sleeve and liner extraction (4) Cleaning of main body and parts (5) Liner and gasket replacement (6) Plunger insertion, discharge valve replacement	(Fuel injection pump inspection point) (1) Check the control rack for wear and check if the movement is normal. (2) Check Vertical scratches and damage to the plunger and liner (3) Matching with the serial number of the replacement part (4) Do not mistake the meshing of the fuel injection pump control rack. Photo	
3. Inspection Item	(1) When disassembling and inspecting the fuel injection pump, perform the following inspections. ・ Plunger and liner galling and damage ・ Status of discharge valve seat		
4. Record	・ Check for plunger and discharge valve scratches		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・ Fuel pump plunger sticking		

No	(12-2)	Fuel injection pump overhaul inspection ②		
Item	Procedure	Procedure and Safety	Witness	Name
1.. Preliminary Work	(1) Preparation of disassembly tool ・ Spanner, wrench, etc. (2) Preparation of replacement parts ・ Plunger etc. (3) Safety measures ・ Safety zone ・ Preparation for turning ・ Overhead traveling crane	① Inspection of disassembly equipment ・ Check for damage and damage to essential equipment ② Confirmation of replacement parts ・ Serial number ・ Inspection of replacement parts ③ Disseminate safety measures ・ Transportation of section ropes and heavy objects ・ Confirmation of turning signal		
2. Implementation of Work	(1) Detachment of connecting pipe pusher (2) Removing the plunger guide (3) Extracting the plunger (4) Pulling out the liner (5) Plunger and liner inspection exchange (6) O-ring replacement (7) Insert liner (8) Gasket replacement (9) Control sleeve, rack mounting (10) Plunger insertion (1.) Discharge valve replacement installation (12) Installation of connecting pipe and inspection cover (13) Storage	(Fuel pump inspection point) (1) Fuel rack movement, wear damage check Record the cylinder No o before removing the fuel pump . (3) Scratches on the surface of the plunger and liner Photo		
3. Check and follow-up	(1) Fuel pump assembly product cultivation (2) Fuel pump storage	(1) Prevention of foreign matter contamination after assembling the fuel pump ② Do not block the passage		

No	(12-4)	Fuel pump start thrusting degree adjustment ①	
1. Purpose	The combustion conditions (explosion pressure, exhaust temperature, exhaust color) change depending on the timing at which fuel is injected from the fuel injection valve of the fuel pump. The starting position of fuel injection pump is the basis for adjusting the injection timing, and proper position adjustment is necessary.		
2. Procedure	(1) Removal of fuel input pipe (2) Preparation for turning (3) Start thrusting and check the degree (4) Recording and judgment	(1) Preparation for turning (2) Start thrusting before repair and check the degree (3) Movement of fuel in the fuel input section	
3. Inspection Item	(1) When checking the fuel pump's starting point ・ Perform the following inspections. ・ Fuel pump thrust start degree	Photo	
4. Record	・ Fuel pump thrust start degree		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・ Explosive pressure failure due to poor fuel injection timing		

No	(12-4)	Fuel pump start thrusting degree adjustment ②		
Item	Procedure	Procedure and Safety	Witness	Name
1.. Preliminary Work	(1) Preparation of measurement tools ・ Lamp, pilot mirror (2) Preparation of turning device (3) Safety measures ・ Safety zone ・ Rotation direction during turning	① Inspection of measuring tools ・ Check for damage and damage to essential equipment ② Inspection of turning equipment ・ Cable abnormality check ・ Check for damage to the operation box ③ Disseminate safety measures ・ Transportation of section ropes and heavy objects ・ Confirmation of turning signal		
2. Implementation of Work	(1) Removal of fuel input pipe (2) Preparation for turning (3) Start thrusting and check the degree (4) Recording and judgment	(Measurement point at the start angle) (1) Preparation for turning (2) Check the starting point of before repair (3) Fuel condition of fuel input part - Light up from the fuel inlet/outlet pipe fitting and record the position where the light is invisible as the "beginning angle". Photo		
3. Check and follow-up	(1) Confirmation of measurement data	(1) Check the previous data (2) Comparison with the data this time		

No	(13-1)	Cylinder head exhaust valve extraction ①	
1. Objective	Remove the exhaust valve from the cylinder head. Oil and water drainage must be completed before removing the exhaust valve.		
2. Work procedure	(1) Exhaust valve extraction tool preparation and installation (2) Exhaust valve box extraction (3) Exhaust valve spring removal (4) Exhaust valve rod extraction (5) Implementation of inspection and maintenance work	① Items to check before removing the exhaust valve ・ Water removal operation completed ・ Completed oil draining operation (2) Exhaust valve extraction tool preparation ・ Valve box removal tool ・ Valve spring removal tool ③ Confirmation after removal ・ Check the contamination status of the valve box ・ Check the contamination status of the valve stem valve seat ・ Check the atrium of the valve seat	
3. Inspection items	(1) Perform the following inspections when removing the exhaust valve. ・ Water leakage from the exhaust valve box ・ Exhaust valve box, valve bar valve seat atrium ・ Check the dirt condition of the exhaust valve box and valve stem valve seat	Photo	
4. Record	・ Exhaust valve box, valve bar valve seat atrium ・ Check the dirt condition of the exhaust valve box and valve stem valve seat		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Exhaust valve blow-by at War xx Exhaust temperature rise		

No	(13-1)	Cylinder head exhaust valve extraction ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Work equipment, equipment preparation ・ Exhaust valve extraction bolt ・ Impact wrench ・ Dedicated spanner (2) Others ・ Air for leak test ・ Safety section rope ・ Safety belt	① Extraction tool inspection point ・ Check for deformation of the extraction bolt and damage to the threaded part. ・ Check the operation of the impact wrench ・ Air hose leakage		
2. Inspection and Maintenance	(1) Exhaust valve extraction tool installation (2) Exhaust valve box extraction (3) Spring disassembly tool installation (4) Exhaust valve funnel cap spring removal (5) Exhaust valve rod extraction (6) Exhaust valve bush extraction	① Points of exhaust valve disassembly ・ When disassembling the exhaust valve spring, there is a risk that the spring will bounce, so do not approach directly above your face. ・ Check the internal contamination status of the head after extraction. ・ Confirmation of abnormal carbon adhesion on the exhaust valve rod, etc. Photo		
3. Confirmation and follow-up after work	(1) Exhaust valve type storage (2) Storage of removable piping	① Exhaust valve box removes carbon deposits at the washing place (2) The exhaust valve rod cleans the oil and passes through the passage. Store in a place that does not interfere with		

No	(13-2)	Cylinder head start valve extraction ①	
1. Objective	Remove the starting valve from the cylinder head. Close air main valve and main starting valve before removing the starting valve.		
2. Work Procedure	(1) Preparation and installation of starting valve extraction tool (2) Pulling out the start valve (3) Visual Inspection of the start valve (4) Disassembly of start valve (5) Inspection and maintenance work	① Items to check before removing the start valve ・ Completed air bleeding operation ・ Air operation valve closing operation completed ② Preparation of starting valve extraction tool ・ Valve body removal tool ・ Valve spring removal tool ③ Confirmation after removal ・ Check the contamination status of the valve box ・ Check the contamination status of the valve stem valve seat ・ Check for dust biting in the valve seat	
3. Inspection items	(1) Inspection when pulling out the start valve ・ Air leakage from the start valve ・ Scratches on the starting valve stem and valve seat ・ Check the status of valve rod and valve seat stains	Photo	
4. Record	・ Starting valve rod and valve seat dust ・ Check the start valve rod and valve seat stain status		
5. Related Books	(1) Engine instruction manual		
6. Safety trouble Well	・For War xx unit, start valve for dust biting Due to startup failure		

No	(13-2)	Cylinder head start valve extraction ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Work equipment, equipment preparation ・ Starting valve extraction bolt ・ Impact wrench ・ Dedicated spanner (2) Others ・ Safety section rope ・ Safety belt	① Extraction tool inspection point ・ Check for deformation of the extraction bolt and damage to the threaded part. ・ Check the operation of the impact wrench ・ Air hose leakage		
2. Inspection and Maintenance	(1) Starting valve extraction tool installation (2) Extraction of the start valve body (3) Main body disassembly tool (4) Removing the spring for fixing the starting valve bar (5) Extraction of the start valve body piston (6) Pulling out the starting valve rod	① Disassembling the start valve ・ When disassembling the start valve spring, to be care the main body spring will jump up. ・ Check the internal contamination status of the head after extraction. ・ Confirmation of foreign material biting of the start valve rod, etc. Photo		
3. Confirmation and follow-up after work	(1) Start valve storage (2) Storage of removable piping	① Removing carbon deposits should be done at the workplace ② Disassembled parts shall be in a place where does not obstruct passage.		

No	(13-3)	Cylinder head safety valve extraction ①	
1. Objective	Remove the safety valve from the cylinder head. Before removing the safety valve, confirm the engine has been stopped.		
2. Work procedure	(1) Safety valve extraction tool preparation and installation (2) Extraction of safety valve (3) Safety valve outside inspection (4) Safety valve disassembly (5) Implementation of inspection and maintenance work	(Points and precautions when working) ① Items to check before removing the safety valve ・ Engine stop operation completed ・ Air operation valve closing operation completed ② Preparation of safety valve extraction equipment ・ Valve body removal tool ・ Valve spring removal tool ③ Confirmation after removal ・ Check the contamination status of the valve box ・ Check the contamination status of the valve stem valve seat ・ Check for dust biting in the valve seat	
3. Inspection items	(1) Perform the following inspections when removing the safety valve ・ Air leakage from the safety valve ・ Safety valve rod and valve seat scratches ・ Check the status of valve rod and valve seat stains	Photo	
4. Record	・ Safety valve rods and valve seats are caught in dust ・ Check the status of safety valve rod and valve seat stains		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Defects caused by dust biting at safety valve for War xx unit,		

No	(13-2)	Cylinder head safety valve extraction ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Work equipment, equipment preparation ・ Safety valve extraction bolt ・ Impact wrench ・ Dedicated spanner (2) Others ・ Safety section rope ・ Safety belt	① Extraction tool inspection point ・ Check for deformation of the extraction bolt and damage to the threaded part. ・ Check the operation of the impact wrench ・ Air hose leakage		
2. Inspection and Maintenance	(1) Safety valve extraction tool installation (2) Extraction of the safety valve body (3) Main body disassembly tool (4) Removing the spring for fixing the safety valve (5) Extraction of the safety valve body	① Key points for disassembling the safety valve ・ When disassembling the safety valve spring to be care spring will jump up. ・ Checking the internal contamination status of the head after extraction ・ Safety valve body Dust biting abnormality confirmation, etc. Photo		
3. Confirmation and follow-up after work	(1) Safety valve storage (2) Storage of removable piping	① Removing carbon deposits of safety valve should be conducted at the workplace ② Disassembled parts should not obstruct passage		

No	(13-4)	Cylinder head intake valve extraction ①	
1. Objective	Remove the intake valves from the cylinder head. Before removing the intake valve, confirm that the oil and water draining operation.		
2. Work procedure	(1) Preparation and installation of intake valve extraction equipment (2) Extraction of intake valve box (3) Take out the intake valve spring (4) Pulling out the intake valve rod (5) Implementation of inspection and maintenance work	① Items to check before removing the intake valve ・ Water removal operation completed ・ Completed oil draining operation ② Preparation of intake valve extraction equipment ・ Valve box removal tool ・ Valve spring removal tool ③ Confirmation after removal ・ Check the contamination status of the valve box ・ Check the contamination status of the valve stem valve seat ・ Check the atrium of the valve seat Photo	
3. Inspection items	(1) Check the following when pulling out the intake valve. ・ Water leakage from the intake valve box ・ Atrium of intake valve box and valve stem valve seat ・ Check the intake valve box and valve bar valve seat contamination status		
4. Record	・ Atrium of intake valve box and valve stem valve seat ・ Check the intake valve box and valve bar valve seat contamination status		
Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Exhaust temperature rise due to the intake valve blow-by at War xx Unit		

No	(13-4)	Cylinder head intake valve extraction ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Work equipment, equipment preparation ・ Intake valve extraction bolt ・ Impact wrench ・ Dedicated spanner (2) Others ・ Air for leak test ・ Safety section rope ・ Safety belt	① Extraction tool inspection ・ Check for deformation of the extraction bolt and damage of the threaded part. ・ Check the operation of the impact wrench ・ Air hose leakage		
2. Inspection and Maintenance	(1) Intake valve extraction tool installation (2) Extraction of intake valve box (3) Spring disassembly tool installation (4) Remove the intake valve funnel cap spring (5) Pulling out the intake valve rod (6) Extraction of intake valve bush	① Point of intake valve disassembly ・ When disassembling the intake valve spring, there is a risk that the spring will bounce, so do not approach directly above your face. ・ Check the internal contamination status of the head after extraction. ・ Confirmation of abnormal carbon adhesion on the intake valve rod, etc. Photo		
3. Confirmation and follow-up after work	(1) Intake valve type storage (2) Storage of removable piping	① Remove carbon deposits from the intake valve box at the washing place. (2) The intake valve rod cleans the oil so that it does not obstruct the passage.		

No	(13-5)	Cylinder head fuel injection valve extraction ①	
1. Objective	Remove the fuel injection valve from the cylinder head Before removing the fuel injection valve, confirm that the oil should be drained.		
2. Work procedure	(1) Removal of fuel valve cooling oil pipe (2) Removal of high fuel pressure pipe (3) Fuel injection valve extraction tool preparation and installation (4) Extraction of fuel injection valve rod (5) Fuel injection valve disassembly inspection and maintenance	① Items to check before removing the fuel injection valve ・ Water removal operation completed ・ Completed oil draining operation (2) Preparation of fuel injection valve extraction tool ・ Tools for extracting the main body (3) Confirmation after removal ・ Check the stain status at the tip of the injection valve ・ Check the contamination status of the jet ・ Check for dripping after oil at the tip of the injection valve ・ Injection pressure test before disassembly Photo	
3. Inspection items	(1) Perform the following inspections when removing the fuel injection valve. ・ Oil leak at the tip of the fuel valve ・ Staining of the tip of the fuel injection valve ・ Check the injection pressure		
4. Record	・ Injection pressure of fuel injection valve ・ Fuel injection valve spray status		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Exhaust temperature drop due to fuel injection pressure drop at War xx		

No	(13-5)	Cylinder head fuel injection valve extraction ②		
Item	Procedure	Procedure and Safety	Witness	Name
1.Preliminary work	(1) Work equipment, equipment preparation ・ Fuel valve extraction tool ・ Impact wrench ・ Dedicated spanner (2) Others ・ Confirmation of injection pressure test equipment ・ Safety section rope ・ Safety belt	① Extraction tool inspection ・ Check for deformation of the extraction bolt and damage to the threaded part. ・ Check for damage to the dedicated spanner ・ Inspection of fuel injection pressure test equipment (pressure gauge, replenishment of test oil, etc.)		
2. Inspection and Maintenance	(1) Removal of cooling oil pipe for fuel valve (2) Removal of high pressure fuel pipe (3) Fuel injection valve extraction tool installation (4) Extraction of fuel injection valve (5) Pressure test before disassembling the fuel injection valve (6) Fuel injection valve overhaul	① Points when removing the fuel injection valve ・ Injection valve body O-ring sticking ・ Carbon adhesion of injection valve tip nozzle ・ Check the internal contamination status of the head after extraction. (2) Pressure drop during injection pressure test Greater decrease than the specified pressure Photo		
3. Confirmation and follow-up after work	(1) Fuel injection valve storage (2) Storage of removable piping	(1) Fuel injection valve Nozzle is to be determine whether it can be reused as the result of pressure test after maintenance. (2) The fuel valve shall be storage to prevent interfere of passage.		

No	(13-6)	Cylinder head body cleaning inspection measurement ①	
1. Objective	The cylinder head is affected by the combustion gas and becomes dirty, corrosion, cracked, etc. After removing the valves, check the operation and inspection the corrosion.		
2. Work procedure	(1) Confirmation of removal of various valves (2) Cleaning of cylinder head body	(Points and precautions when working) ① Items to check before cleaning the cylinder head ・ Completed removing the exhaust port ・ Exhaust port carbon adhesion status ・ Contamination status of the explosion surface ・ Intake valve seat side blow-by situation ・ Exhaust valve seat surface atrium	
3. Point inspection confirmation items	(1) Perform the following inspections, when cylinder head cleaning ・ Check wear of intake/exhaust valve seat ・ Dirt status of exhaust port	Photo	
4. Record	・ Wear measurement of intake and exhaust valve seats ・ Measurement of reduction in exhaust port		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Exhaust temperature rise due to exhaust valve blow-by at War xx unit.		

No	(13-6)	Cylinder head body cleaning inspection measurement ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of cleaning and inspection tools ・ Wire grinder ・ High pressure washer (2) Others ・ Valve seat, reduction device ・ Safety section rope ・ Safety belt	① Cleaning equipment inspection points ・ Grinder function inspection ・ Washing machine function inspection ・ Check for damage to measuring equipment		
2. Inspection and Maintenance	(1) Exhaust outlet closing plate mounting (2) Confirmation of water leakage from the exhaust port (3) Ejection from the exhaust port in a cooling water tank Carbon adhesion is removed by soaking for 1 day and night) (5) Carbon removal with a high pressure washer (6) Measuring the thickness of the exhaust port (7) Wear measurement of intake/exhaust valve seat	① Points for cleaning the head body ・ Carbon adhesion on the exhaust port ・ Abnormality of explosion surface and carbon adhesion (2) Inspection of the seat valve seat of the intake / exhaust valve ・ Scratch on the seat surface Photo		
3. Confirmation and follow-up after work	(1) Cylinder head storage	(1) Require a large storage space for large parts, therefore it is necessary to secure a storage space such as in the engine room. (ii) After cleaning the oil from the head, store it in a place where it will not obstruct passage.		

No	(13-7)	Cylinder head body bolt inspection ①	
1. Objective	Since the cylinder head is damaged, corroded, cracked, etc. by the combustion gas. The cylinder head shall be checked after removing the valves and measure the corrosion, etc.		
2. Work procedure	(1) Confirmation of removal of various valves (2) Cylinder head body bolt inspection	Check followings before checking the cylinder head bolt ・ Carbon adhesion status of bolts ・ Status of stat bolt screw part ・ Tightening status of stat bolts	
3. Point inspection confirmation items	(1) Cylinder head body inspection Perform the following inspections when cleaning. ・ Inspection and tightening status of various bolts ・ Status of threaded parts of various bolts	Photo	
4. Record	・ Tightening torque		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit Cylinder Head Tightening Stat bolt tightening failure		

No	(13-7)	Cylinder head body bolt inspection ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of inspection tools ・ Spanner wrench ・ Test hammer ・ Torque Wrench (2) Others ・ Safety section rope ・ Safety belt	① Key point inspection points ・ Damage to the spanner wrench ・ Hammer damage confirmation ・ Month/year of torque wrench calibration		
2. Inspection and Maintenance	(1) Bolt tightening hammer ring (2) Confirmation of stat bolt tightening (3) Inspection of stat bolt screw part (4) Check the stat bolt tightening torque	(1) Points for checking various bolts ・ Biting on the screw part of various stat bolts (2) Check the stat bolt mounting torque ・ Check tightening with the specified torque ・ Double nut mounting Photo		
3. Confirmation and follow-up after work	(1) Cylinder head storage	(1) Require a large storage space for large parts, therefore it is necessary to secure a storage space such as in the engine room. (2) After cleaning the oil from the head, store it in a place where it will not obstruct passage.		

No	(13-8)	Cylinder head exhaust port thickness measurement ①	
1. Objective	Since the cylinder head is damaged, corroded, cracked, etc. by the combustion gas. The cylinder head shall be checked after removing the valves and measure the corrosion, etc.		
2. Work procedure	(1) Confirmation of removal of various valves (2) Measuring the thickness of the exhaust port	Items to check before measuring the thickness of the cylinder head exhaust port ・Carbon adhesion status at Port area ・Water leakage status at Port area ・ Stat bolt installation status	
3. Point inspection confirmation items	(1) Cylinder head body inspection Perform the following inspections at the time of measurement. ・ Acid corrosion status at the exhaust port ・ Port section thickness reduction status	Photo	
4. Record	・ Port thickness reduction measurement		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit Cylinder Head Exhaust Port part reduction and leakage		

No	(13-8)	Cylinder head exhaust port thickness measurement ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of measurement tools ・ Measurement caliper ・ Measurement point position board (2) Others ・ Safety section rope ・ Safety belt	① Key point inspection points ・ Damage of caliper		
2. Inspection and Maintenance	(1) Cylinder head body cleaning completed (2) Cleaning of the exhaust port is completed. (3) Confirmation of stat bolt installation (4) Measuring the thickness of the exhaust port	① When measuring the thickness of the exhaust port point ・ Check the status of port reduction ・ Comparison with the previous data ・ Estimating the amount of reduction until the next inspection (Reduced water leakage by the next inspection Propose head replacement if expected) Photo		
3. Confirmation and follow-up after work	(1) Cylinder head storage	(1) Require a large storage space for large parts, therefore it is necessary to secure a storage space such as in the engine room. (2) After cleaning the oil from the head, store it in a place where it will not obstruct passage.		

No	(13-9)	PT inspection of cylinder head explosion surface ①	
1. Objective	Since the cylinder head is damaged, corroded, cracked, etc. by the combustion gas. The cylinder head shall be checked after removing the valves and measure the corrosion, etc.		
2. Work procedure	(1) Confirmation of removal of various valves (2) PT inspection of explosion surface	① PT inspection of cylinder head explosion surface ・ Explosion surface carbon adhesion status ・ Damage status of the explosion surface ・ No water leakage from the port	
3. Point inspection confirmation items	(1) Cylinder head body inspection Perform the following inspections at the time of measurement. ・ PT inspection of head explosion surface	Photo	
4. Record	・ PT inspection of head explosion surface		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx Cylinder Head Explosion Surface Cleft		

No	(13-9)	PT inspection of cylinder head explosion surface ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of PT test agent ・ Cleaning liquid ・ Dye penetrant (2) Others ・ Safety section rope ・ Safety belt	① Points of PT inspection ・ Confirmation of completion of cleaning of the explosion surface ・ Check for damage to the explosion surface ・ Expiration date of flaw detection inspection agent		
2. Inspection and Maintenance	(1) Cylinder head body cleaning completed (2) Explosion surface cleaning completed (3) Confirmation of stat bolt installation (4) Application of cleaning liquid on the explosive surface (5) Application of flaw detection inspection agent to the explosion surface (6) Confirmation of scratches with the flaw detector on the explosive surface	① Confirmation of explosion on the explosion surface ・ PT inspection to check for flaws with probing agents. Photo		
3. Confirmation and follow-up after work	(1) Cylinder head storage	(1) Require a large storage space for large parts, therefore it is necessary to secure a storage space such as in the engine room. (2) After cleaning the oil from the head, store it in a place where it will not obstruct passage.		

No	(14-1)	Cleaning the intake valve guide under the intake/exhaust valve adjustment work ①	
1. Objective	The intake/exhaust valves installed in the cylinder head, which are affected by the combustion gas and wear out. Since stains and rough surfaces may occur, therefore the inspection, cleaning and adjustment will be performed after removing the valve.		
2. Work procedure	(1) Confirmation of intake valve removal ・ Disassembly of valve stem and guide (2) Intake valve guide cleaning (3) Cleaning of intake valve rod	① Points for removing the intake valve ・ Check the valve rod carbon adhesion status ・ Damage to valve stem and valve seat ・ Check the roughness of the intake valve seat of the cylinder head.	
3. Inspection items	(1) When aligning the intake valve Perform the following inspections ・ Method of intake valve seat, amount of wear ・ Amount of wear on the guide	Photo	
4. Record	・ Method of intake valve seat, amount of wear ・ Amount of wear on the guide		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Intake valve blow-by exhaust temperature rise on War xx unit		

No	(14-1)	Cleaning the intake valve guide under the intake/exhaust valve adjustment work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of cleaning tools ・ Cleaning liquid ・ Washing tank (2) Others ·Measuring equipment ・ Safety section rope ・ Safety belt	① Points for cleaning and inspection ・ Check the washing tank ②Points for measurement ・ Check for damage to measuring equipment		
2. Inspection and Maintenance	(1) Confirmation of intake valve removal ・ Disassembly of valve stem and guide (2) Cleaning of intake valve guide (3) Cleaning of intake valve rod (4) Remove the parts and soak them in the cleaning tank. (5) Measurement of wear of guide parts (6) O-ring inspection and replacement	① Points for removing the intake valve ・ Check the valve rod carbon adhesion status ・ Damage to valve stem and valve seat Check the roughness of the intake valve seat of the cylinder head. ・ O-ring damage confirmation ・ Damage to the guide body Photo		
3. Confirmation and follow-up after work	(1) Intake valve, guide storage	(1) Require a large storage space for large parts, therefore it is necessary to secure a storage space such as in the engine room. (2) After cleaning the oil from the head, store it in a place where it will not obstruct passage.		

No	(14-2)	Intake valve cutting and measurement under intake/exhaust valve adjustment work ①	
1. Objective	The intake/exhaust valve installed in the cylinder head is affected by the combustion gas and is worn, soiled, and roughened. Therefore, inspection, cleaning, and adjustment should be conducted after removing the valve.		
2. Work procedure	(1) Intake valve seat measurement (heavy wear amount) (2) Intake valve seat polishing (3) Measurement of intake valve rod and guide bush (4) Record	① Key points for polishing the intake valve seat ・ Check the polishing degree ② Method measurement point ・ Exceeding the permissible value of valve rod and bush gap is a factor of increased consumption of valve oil.	
3. Inspection items	(1) Perform the following inspections when aligning the intake valves. ・ Method of intake valve seat, amount of wear ・ Amount of wear	Photo	
4. Record	・ Method of intake valve seat, amount of wear ・ ・ Amount of wear		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit intake valve stairwell Exhaust temperature rise		

No	(14-2)	Intake valve cutting and measurement under intake/exhaust valve adjustment work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of PT test agent ・ Cleaning liquid ・ Dye penetrant (2) Others ・ Safety section rope ・ Safety belt	① Points of PT inspection ・ Confirmation of completion of cleaning of the explosion surface ・ Check for damage to the explosion surface ・ Expiration date of flaw detection inspection agent		
2. Inspection and Maintenance	(1) Intake valve seat measurement (heavy wear amount) (2) Intake valve seat polishing (3) Measurement of intake valve rod and guide bush (4) Record	① Intake valve seat polishing point ・ Check the polishing degree ② Method measurement point ・Excessive gap between valve stem and bush is due to increased consumption of valve oil . Photo		
3. Confirmation and follow-up after work	(1) Intake valve, bush storage	(1) Since the valve stem is long, store it in a place with no passage to prevent it from tipping over. (2) Clean the bush and store it in a place that does not obstruct the passage		

No	(14-3)	Intake valve adjustment under intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Cylinder head seat polishing (2) Cylinder head and intake valve adjustment (3) Intake valve rod, guide bush PT inspection (4) Record	① Cylinder head seat polishing point ・ Check the polishing degree ② Method measurement point ・ Measuring of seat and valve stem valve seat ・ Exceeding the permissible value causes a blow-by	
3. Point inspection confirmation items	Perform the following inspections when aligning the cylinder head and intake valve. ・ Seat thickness/wear ・ PT inspection	Photo	
4. Record	・ Seat thickness/wear ・ PT inspection		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx unit intake valve blow -by Exhaust temperature rise		

No	(14-3)	Intake valve adjustment (2)		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Preparation ・Moly coat ・Compound ・Sliding tools ・Cleaning liquid ・Dye penetrant (2) Others ・Safety section rope ・Safety belt	① Checking points for adjustment tools ・ Appearance inspection of adjustment tools ・ Combination of cylinder head and valve		
2. Inspection and Maintenance	(1) Cylinder head and intake valve are rubbed together (2) Check the status of the seat (3) Guide, valve bar seat PT inspection (4) Intake valve storage	(1) Contact area: 2/3 or more (2) There are no dents or scratches on the seat surface. (3) Measure the seat surface and it is within the allowable value Photo		
3. Confirmation and follow-up after work	(1) Cylinder head storage after intake valve adjustment	(1) The head is a large and heavy, therefore storage in a place where there is no passage. (2) Storage the intake valve stem, with curing the seat surface.		

No	(14-4)	Cleaning the exhaust valve and valve box under the intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Cleaning the exhaust valve rod (2) Cleaning the exhaust valve box (3) Measurement of intake valve rod and guide bush (4) Record	① Wear protective glasses and gas mask ・ When cleaning hard carbon with a grinder, take measures to prevent the intake of carbon dust. ②Seat cleaning point ・ To prevent dents and scratches. ・ Inspect the seat surface and check the allowable value.	
3. Point inspection confirmation items	(1) When adjustment the exhaust valve Perform the following inspections. ・ Cleaning the exhaust valve rod ・ Cleaning the exhaust valve box	Photo	
4. Record	・ Inspect the seat surface		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx Unit: exhaust valve blow-by and exhaust gas temperature rise		

No	(14-4)	Cleaning the exhaust valve and valve box under adjustment work the intake/exhaust valves ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Preparation of protective equipment ・Protective eyewear ・ Protective gas mask (2) Cleaning tools ・Grinder ・Wes (3) Others ・ Safety section rope	① Protective equipment inspection points ・ Appearance inspection of protective glasses ・ Protective dust mask appearance inspection		
2. Inspection and Maintenance	(1) Cleaning the exhaust valve rod (2) Cleaning the exhaust valve box	① Cleaning points ・ Wear a protective mask to prevent inhaling carbon debris. ② Measurement point ・Seat surface: within the allowable value Photo		
3. Confirmation and follow-up after work	(1) Storage of exhaust valve rod, exhaust valve box	① Curing and storage ② Storage to prevent interfere with passage		

No	(14-5)	Exhaust valve box water pressure test under Intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Exhaust valve box water pressure test (2) Confirmation of exhaust valve box upper thickness reduction (3) Confirmation of exhaust valve box leg thickness reduction (4) Record	(Points and precautions when working) ① Water pressure test ・Water pressure: 1.0MPa ・Pressurization time: 15 minutes ② Point ・Replace the valve box upper body if the main body thickness is significantly reduced. ・Replace the leg box on the valve seat side if the leg is significantly reduced.	
3. Point inspection confirmation items	(1) Exhaust valve box inspection and cleaning ・ Water pressure test ・ Check the upper part of the valve box body and leg reduction	Photo	
4. Record	・ Water pressure test results ・ Confirmation of reduction		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx Unit exhaust gas temperature drop due to exhaust valve box water leakage		

No	(14-5)	Exhaust valve box water pressure test under intake/exhaust valves adjustment works ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Preparation for water pressure test ・ Simple water tank ・ Air for pressure resistance test ・ Air supply hose (2) Others ・ Safety section rope	(1) Key points of water pressure test ・ Check the air pressure ・ Appearance inspection of closing equipment ・ Check the leaked part of the air hose		
2. Inspection and Maintenance	(1) Prepare test air (2) Immerse the valve box in the water tank (3) Pressurize the valve box (4) Record	(1) Water pressure test point ・ Test pressure: 1.0MPa ・ Test time: 15 minutes (2) Valve box valve seat reduction confirmation point ・ Confirmation of reduction in the upper body of the valve box ・ Confirmation of reduction in the lower legs of the valve box Photo		
3. Confirmation and follow-up after work	(1) Exhaust valve box storage	① Nourishing and storing that does not interfere with safe passage		

No	(14-6)	Polishing of exhaust valve rod measurement under Intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Exhaust valve rod seat (2) Exhaust valve rod measurement (3) Record (Exhaust valve bar seat, valve bar height)	① Points for polishing the exhaust valve rod ・ Check the polishing degree ② Method measurement point Within the allowable value of the gap between the valve stem and bush	
3. Inspection items	(1) Exhaust valve rod polishing, at the time of measurement Perform the following inspections. ・ Exhaust valve rod seat ・ Amount of wear	Photo	
4. Record	・ Exhaust valve seat ・ Measurement		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit exhaust valve stairwell Exhaust temperature rise		

No	(14-6)	Exhaust valve rod polishing and measurement under Intake/exhaust valve adjustment work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Lathe preparation ・ Power supply ・ Rotation direction (2) Preparation of measurement tools ・ Vernier micrometer ・ Micrometer	① Lathe inspection points ・ Check the condition of the polishing tip ・ Check the operation of the main unit ・ Expiration date of flaw detection inspection agent (2) Measurement tool inspection points ・ Vernier micrometer appearance inspection ・ Micrometer calibration year		
2. Inspection and Maintenance	(1) Lathe installation (2) Exhaust valve rod seat polishing (3) Exhaust valve rod measurement (4) Exhaust gas wear amount measurement (4) Record judgment	① Exhaust valve rod polishing point ・ Check the polishing degree ・ Check the wear status ② Method measurement point ・ Check within the allowable value of the valve stem seat ・ Measurement tools and appropriate measurement values		
	Stem outer diameter (mm)			
	Standard value ST / Tolerance LA / Marginal LR			
	24-0.020 / 23.2 / twenty three			
	-0.04			
	Valve bar bending allowance (mm)			
	(Dial gauge runout) LA			
	Stem center B1	0.5		
	Seat side (center of the side) B2	0.05		
3. Confirmation and follow-up after work	(1) Storage of exhaust valve rods	(1) Since the valve stem is long, the storage should be no passage to prevent fall over. ② Clean the bush and store it in a place to prevent obstruct the passage.		

No	(14-7)	Polishing of exhaust valve rod, measurement under Intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Exhaust valve box seat polishing (2) Exhaust valve box, bush measurement (3) Measurement of amount of wear (4) Record	(Points and precautions when working) ① Points for polishing the exhaust valve box ・ Check the polishing degree ② Method measurement point ・ Valve rod and bush gap are within the allowable value	
3. Inspection items	(1) When aligning the exhaust valve box ・ Exhaust valve box seat polishing ・ Measurement of exhaust valve box height wear	Photo	
4. Record	・ Exhaust valve box seat polishing, bush measurement ・ Amount of wear		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit exhaust valve stairwell Exhaust temperature rise		

No	(14-7)	Exhaust valve rod polishing and measurement under Intake/exhaust valve adjustment work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Lathe preparation ・ power supply ・ Rotation direction (2) Preparation of measurement tools ・ Vernier micrometer ・ ·Micrometer ・ ·Dial gauge	① Lathe inspection points ・ Condition of polishing tip ・ Main body operation ・ Expiration date of flaw detection inspection agent (2) Measurement tool inspection points ・ Vernier micrometer appearance inspection ・ Micrometer calibration year ・ Dial gauge calibration year		
2. Inspection and Maintenance	(1) Lathe installation (2) Exhaust valve box seat polishing (3) Valve box, bush measurement (4) Measurement of amount of wear (4) Record judgment	① Exhaust valve rod polishing point ・ Check the polishing degree ・ Check the wear status ② Method measurement point ・ Check within the allowable value of the valve stem seat ・ Calibration of measuring tools Photo		
3. Confirmation and follow-up after work	(1) Exhaust valve box storage	① The valve box is heavy and falls down. Store in no place ② Does not interfere with safe passage Store in place		

No	(14-8)	Exhaust valve adjustment under Intake/exhaust valve adjustment work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Exhaust valve box seat adjustment (2) Valve seat adjustment (3) Valve box, valve seat PT inspection (4) Valve box heat resistant paint applied	① Points of seat adjustment ・ 2/3 or more of the contact surface ・ Appropriate compound application ② Points when assembling ・ Heat resistant paint is applied to the surface of the cylinder head of the valve box.	
3. Point inspection confirmation items	(1) When aligning the exhaust valve box Perform the following inspections. ・ Exhaust valve box seat adjustment ・ Exhaust valve, exhaust valve box PT inspection	Photo	
4. Record	・ Exhaust valve box seat ・ PT test results		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit exhaust valve stairwell Exhaust temperature rise		

No	(14-8)	Exhaust valve adjustment work under Intake/exhaust valve adjustment work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Preparation ・ Moly coat ・ Compound ・ Sliding tools ・ Cleaning liquid ・ Dye penetrant (2) Others ・ Safety section rope	① Checking points for adjustment tools ・ Appearance inspection of adjustment tools ・ Check compound (3 types)		
2. Inspection and Maintenance	(1) Valve box seat adjustment (2) Valve box valve seat adjustment (3) Valve rod seat adjustment (4) Valve box and valve rod seat adjustment (5) Confirmation of seat adjustment (6) Valve box, valve rod seat PT inspection (7) Valve box heat resistant paint applied	① Points of seat adjustment ・ 2/3 or more of the contact surface of seat ・ Appropriate compound ② Points when assembling ・ Apply heat-resistant paint at contact surface of cylinder head of valve box Photo		
3. Confirmation and follow-up after work	(1) Exhaust valve rod storage	(1) The valve stem is long, therefore it should store avoid walk pass to prevent fall over.		

No	(15-1)	Pressure indicator valve inspection under various valve inspection work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Pressure indicator valve disassembly and cleaning (2) Seat adjustment (3) Assembly	① Key points for disassembly and cleaning ・ Check the contact of the seat ②Assembly point ・ Note the combination since there are many parts.	
3. Point inspection confirmation items	(1) When inspecting the pressure indicator valve ・ Scratches on the seat	Photo	
4. Record	・ Scratches on the seat ・ Amount of wear		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx Unit has air leakage from Pressure indicator valve due to defective seat		

No	(15-1)	Pressure indicator valve inspection under various valve inspection work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of disassembly tools (2) Preparation of replacement parts	① Points for checking replacement parts ・ Check the part number ・ Check for scratches on the seat surface ・ Check the size		
2. Inspection and Maintenance	(1) Pressure indicator valve disassembly (2) Cleaning the valve stem and case (3) Seat adjustment (4) Assembly (seal, O-ring replacement)	① Seat adjustment point ・ Check for scratches on the seat surface ② Parts assembly point ・ Caution for incorrect combination of parts ・ Confirmation of assembly procedure Photo		
3. Confirmation and follow-up after work	(1) Pressure indicator valve storage	place that does not interfere with passage		

No	(15-2)	Fuel valve inspection under various valve inspection work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Fuel injection pressure test (2) Fuel valve disassembly and cleaning (3) Assembly (4) Injection pressure test and adjustment * Precautions for testing Do not touch high pressure spray oil droplets ・ If high-pressure spray oil drops come into adjustment with the skin or skin, consult a medical specialist immediately. ・ Wear protective glasses	(Points and precautions when working) ① Test points ② Test procedure ・ Injection pressure: Check the injection start pressure by slowly operating the test pump lever 29.4 ± 2.9MPa ・ Pressure retention: 10 seconds or more to drop from 29.4MPa to 9.81MPa ・ Spray shape: Quickly operate the test pump lever. Spray evenly from the nozzle hole ・ oil: Quickly operate the test pump lever. Then No oil back dripping Holds 14.7MPa then no oil dripping	
3. Point inspection confirmation items	(1) When inspecting the fuel valve Perform the following inspections. ・ Injection pressure and injection status ・ Oil leakage from the nozzle		
4. Record	・ Injection pressure ・ Spray status		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・Abnormal exhaust temperature due to War Unit carbon flower , smoke emission		

No	(15-2)	Fuel valve inspection under various valve inspection work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of pressure tester ・ Test equipment ・ Check the calibration of the pressure gauge (2) Preparation of disassembly tools ·spanner ・ Dedicated equipment	① Pressure tester inspection ・ Calibration month/year of the pressure gauge ・ Check the amount of oil ・ No abnormality in the disassembly tool ② Tightening point ・ Temporary tightening: by hand and a swing with a spanner ・ Final tightening: Torque 60kgf m tightening (nut outer circumference movement distance 12 to 13mm) ・ Apply moly coat to the screw surface		
2. Inspection and Maintenance	(1) Fuel injection pressure test (2) Disassembly of fuel valve body (3) Cleaning the valve stem and case (4) Cleaning the fuel high pressure pipe (5) Seat adjustment (6) Assembly (nozzle, seal, O -ring replacement) (7) Injection pressure test and adjustment (8) Heat resistant coating [Disassembly procedure] ・ Remove the adjusting screw. ・ Pull out the spring and rod. ・ Tighten the fuel injection valve to the nozzle nut fixing tool. ・ Loosen the nut with a nozzle nut tightening spanner, align it with the needle, and remove it. ・ Remove the needle from the nozzle	① Key points of injection pressure test ・ Back dripping and spraying situation ② Fuel high pressure pipe inspection point ・ If the high pressure pipe joint (seat surface) is damaged, the fuel valve may become cause of clogged. Photo		
3. Confirmation and follow-up after work	(1) Fuel valve storage	(1) Store to prevent obstruct passage (2) Cure disassembled parts		

No	(15-3)	Inspection of start valve under various valve inspection work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Starting valve disassembly and cleaning (2) Spring measurement (3) Seat adjustment (4) Group	① Key points for disassembly and cleaning ・ Check for scratches on the seat surface ・ Confirmation of spring cracking ② Spring measurement point ・ Exceeding the permissible value of the law ・ Spring damage [Reference] Start distribution valve opening / closing timing Start: 13 - 19 degrees before the top Opening and closing: 127 - 133 degrees after the top	
3. Inspection items	(1) When disassembling and inspecting the start valve ・ Valve rod, case adjustment ・ Assembly	Photo	
4. Record	・ Start valve record		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War xx Unit start valve stuck and startup failure		

No	(15-3)	Inspection of start valve under various valve inspection work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary work	(1) Preparation of measurement tools ・ Vernier micrometer ・ Micrometer ・ Dial gauge ・ Cylinder gauge (2) Sliding tools ・ Compound	① Measurement tool inspection points ・ Vernier micrometer appearance inspection ・ Micrometer calibration year ・ Dial gauge calibration year ・ Cylinder gauge appearance inspection		
2. Inspection and Maintenance	(1) Disassembly of start valve (2) Cleaning valve stem and case (3) Valve rod, case, spring measurement (4) Seat adjustment (5) Nozzle alignment (6) Assembly (nozzle, seal, O-ring replacement) [Disassembly procedure] ・ Starting air tank main valve closed ・ Detach the main start valve connection pipe ・ Removal of start valve mounting bolt ・ Pilot valve case removal ・ Piston extraction ・ Spring fixing and removal ・ Spring and spring holder removal ・ Pilot valve removal ・ Starting valve body valve removal [Assembly point] ・ Cleaning parts with clean light oil ・ Apply high quality grease to sliding parts	① Adjustment point ・ Check the contact surface (must be 2/3 or more hits) ② Measurement point ・ Valve rod, case gap allowance exceeded ・ Spring split ③ Inspection point ・ Gasket and O-ring replacement Photo		
3. Confirmation and follow-up after work	(1) Storage of start valve	place that does not interfere with passage ② Nurture and store		

No	(15-4)	Safety valve inspection under various valve inspection work ①	
1. Objective	Since the intake/exhaust vale located cylinder head are damaged, corroded, cracked, etc. by the combustion gas. The valve shall cleaning and adjustment after removing the valves.		
2. Work procedure	(1) Safety valve disassembly and cleaning (2) Spring measurement (3) Seat adjustment (4) Group	① Key points for disassembly and cleaning ・ Check for scratches on the seat surface ・ Confirmation of spring cracking ② Spring measurement point ・ Exceeding the permissible value of the law ・ Spring damage	
3. Inspection items	(1) When inspecting the safety valve ・ Safety valve seat method and amount of wear	Photo	
4. Record	・ Safety valve record		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・War Unit intake valve blow - by, different generation		

No	(15-4)	Safety valve inspection under various valve inspection work ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of measurement tools ・ Vernier micrometer ·Micrometer ·Dial gauge ·Cylinder gauge (2) Sliding tools ·compound	① Measurement tool inspection points ・ Vernier micrometer appearance inspection ・ Micrometer calibration year ・ Dial gauge calibration year ・ Cylinder gauge appearance inspection		
2. Inspection and Maintenance	(1) Safety valve disassembly (2) Cleaning the valve stem and case (3) Valve rod, case, spring measurement (4) Seat adjustment (5) Nozzle alignment and sliding alignment (6) Assembly (nozzle, seal, O-ring replacement)	① Adjustment point ・ Check the contact surface (must be 2/3 or more) ② Measurement point ・ Valve rod, case gap allowance exceeded ・ Spring split Photo		
3. Confirmation and follow-up after work	(1) Safety valve storage	(1) Storage at place that does not interfere with passage ② Cure and store		

No	(16-1)	Intake valve installation (Cylinder head assembly work) (1)	
1. Purpose	After maintaining each valve attached to the cylinder head, each valve shall be reassembled to the cylinder head, and the cylinder head shall be reassembled.		
2. Procedure	(1) Check the cylinder head valve seat (2) Installation of intake valve guide (3) Intake valve rod installation (4) Intake valve installation Check	(Points and precautions when working) (1) Preparation of intake valve mounting equipment ・ Valve box equipment ・ Valve spring mounting tool ② Confirmation after installation ・ Check for no foreign material ・ Check the fixing status of valve stem mounting parts	
3. Inspection Item	(1) When assembling the cylinder head, perform the following inspections. ・ Check for scratches on the valve seat expression on the cylinder head and valves ・ Apply anticorrosive agent to the contact area between the head and valve	Photo	
4. Record	・ Valve bar Atrium of valve seat ・ Check the valve seat contamination status		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・ Abnormal exhaust temperature due to intake valve blow-by		

No	(16-1)	Intake valve mounting (cylinder head assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of assembly tools ・ Mounting bolts ・ Impact wrench ・ Dedicated spanner (2) Others ・ Safety section rope ・ Safety belt	(1)Assembly tool inspection points ・ Deformation of assembly tools ・ Check for damage to the thread ・ Check the operation of the impact wrench ・ Are there any differences in the combination of parts?		
2. Implementation of Work	(1) Installation of intake valve guide (2) Insertion of intake valve rod (3) Spring, intake valve funnel cap mounting (4) Spring mounting tool set (5) Cotta mounting	(1) Points when assembling ・ When installing the intake valve spring, there is a risk the funnel cap will jump when the spring mounting tool comes off. ・ Check for foreign material when installing parts Photo		
3. Check and follow-up	(1) Cylinder head storage	(1) Stored without interfere with the safety passage ② Organize the engine room and production room		

No	(16-2)	Fuel valve, start valve, safety valve, Pressure Indicator Valve installation (cylinder head assembly work) (1)	
1. Purpose	After maintaining each valve attached to the cylinder head, each valve shall be reassembled to the cylinder head, and the cylinder head shall be reassembled.		
2. Procedure	(1) Cylinder head valve seat confirmation (2) Fuel valve, start valve, safety valve, Pressure Indicator Valve installation (3) Fuel valve will be tightened to the main body by mounting bolt after mounting the high pressure pipe. (4) Pressure Indicator Valve installation (5) Tightening check after installation	(1) Items to check after installation ・ Cylinder head foreign material mixed ・ Tightening of each part	
3. Inspection Item	(1) When assembling the cylinder head, perform the following inspections. ・ Check for scratches on the valve seat surface of the cylinder head and valves ・ Application of anticorrosive agent to the head and valve fittings	Photo	
4. Record			
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	・ Start-up failure due to dust biting from the start valve		

No	(16-2)	Fuel valve, start valve, safety valve, Pressure Indicator Valve installation (cylinder head assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of mounting parts ・ Starting valve ・ Fuel valve ・ safety valve ・ Pressure Indicator Valve (2) Others ・ Mounting tool	(1) Mounting tool inspection point ・ Check for deformation of the extraction bolt and damage to the threaded part. ・ The size of the equipment used is appropriate. ・ Calibration year of torque wrench (2) Checking the soundness of mounting parts		
2. Implementation of Work	(1) Fuel valve insertion and installation (2) Insertion and installation of start valve (3) Safety valve insertion and installation (4) Pressure Indicator Valve Mounting	【point】 (1) Points for mounting parts ・ Check for foreign material mixed in the head insertion part ・ Checking the soundness of mounting parts ・ Packing status of mounting parts Photo		
3. Check and follow-up	(1) Cylinder head storage	(1) Store in a place where the aisle is not blocked. ② Organize the engine room and production room		

No	(16-3)	Exhaust valve installation (cylinder head assembly work) (1)	
1. Purpose	After maintaining each valve attached to the cylinder head, each valve shall be reassembled to the cylinder head and the cylinder head shall be reassembled.		
2. Procedure	(1) Cylinder head valve seat confirmation (2) Inserting the exhaust valve bush (3) Exhaust valve rod assembly (4) Exhaust valve box installation (5) Confirmation after installation	(1) Points at the time of assembly ・ If the tool is removed during installation of the exhaust valve spring, there is a risk that the rotor cap will pop off. ・ Check for foreign material when installing parts	
3. Point inspection confirmation items	(1) When assembling the cylinder head the following Inspection should be conducted. ・ Check for scratches on the valve seat surface of the cylinder head and valves ・ Application of anticorrosive agent to the head and valve fittings	Photo	
4. Record	・ Valve bar Atrium of valve seat ・ Check the valve seat contamination status		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Exhaust valve High exhaust temperature due to dust biting		

No	(16-3)	Exhaust valve mounting (cylinder head assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of mounting equipment ・ Spring mounting tool ・ Impact wrench ・ Dedicated spanner (2) Preparation of mounting parts ・ Rohto cap ・ Cotta	(1) Mounting tool inspection point ・ Visual inspection of equipment: Check for damage to dedicated ・ Check the operation of the impact wrench ・ Check for air hose leaks		
2. Implementation of Work	(1) Inserting the exhaust valve bush (2) Inserting the exhaust valve rod (3) Spring and funnel cap mounting (4) Spring assembly tool mounting (5) Cotta mounting (6) Water connecting pipe O-ring, connecting pipe mounting (7) Exhaust valve box insertion and installation	(1) Points of exhaust valve assembly ・ When installing the exhaust valve spring , there is a danger that the spring will pop off. ・ Check for foreign material contamination inside the head after mounting ・ Check for dust from the exhaust valve body, etc. Photo		
3. Check and follow-up	(1) Cylinder head storage	(1) Store in a place that does not interfere with the safety passage (2) Organize the engine room and production room		

No	(16-4)	Cylinder head mounting (cylinder head assembly work) (1)	
1. Purpose	After maintaining each valve attached to the cylinder head, each valve shall be reassembled to the cylinder head and the cylinder head shall be reassembled.		
2. Procedure	(1) Piston, liner upper explosion surface inspection (2) Installation of cooling water connecting pipe (3) Attaching the packing at the bottom of the head (4) Cylinder head mounting (5) Tightening the cylinder head mounting bolts	(1) Items to check when mounting the head ・ Packing insertion status ・ Packing hit status (2) Check the tightening tool ・ Check the soundness of the hydraulic jack ・ Check the tightening hydraulic pressure (3) Confirmation after tightening ・ Check the application of Moly coat to the screw part ・ Confirmation that no foreign material is mixed	
3. Inspection Item	Perform the following inspections when installing the cylinder head. ・ Explosion surface packing sheet ・ Cooling water connecting pipe	Photo	
4. Record	・ Cylinder head seat packing blow-by		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Packing seat blow-by with exhaust gas leakage		

No	(16-4)	Exhaust valve mounting (cylinder head assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Work equipment, equipment preparation ・ Hydraulic jack ·air hose ・ Wire rope ・ Hanging tools (2) Others ・ Air for leak test ・ Safety section rope ・ Safety belt	(1) Mounting tool inspection point ・ Check for leaks in hydraulic hoses ・Check for damage to the wire rope ・ Check for air hose leaks ・ Inspection of hanging tools		
2. Implementation of Work	(1) Cylinder head air blow (2) Hanger mounting (3) Explosion surface inspection, air blow (4) Water connecting pipe mounting (5) Cylinder head packing mounting (6) Cylinder head mounting (7) Apply Moly coat to the tightening nut (8) Tightening nut Skin tightening (9) Hydraulic jack set (10) Cylinder head mounting nut final tightening	(1) Cylinder head mounting point ・ Check the torque of the tightening nut ・ Tighten with specified pressure ・ Moly coat is applied to the screw part (Example of tightening hydraulic pressure) PC2-5 organization ・ Temporary tightening 44.1.MPa (450kgf / ㎠) ・ Final tightening 88.3-93.2MPa (900-950kgf / ㎠) Photo		
3. Check and follow-up	(1) Cylinder head upper part nutrient	(1) Cultivate the cylinder head so that it does not contain foreign material.		

No	(17-1)	Main start valve inspection (engine start air system assembly work) (1)	
1. Purpose	Check the main start valve and start air distribution valve, etc.		
2. Procedure	(1) Disassembly of main start valve (2) Pull out the piston and clean the main body (3) Spring removal inspection (4) Cleaning of removed parts (5) Parts assembly	(1) Items to check when inspecting the main start valve ・ Piston valve damage check ・ Check for scratches and damage on springs and seats ・ Piston contamination status ・ Seat surface hit status	
3. Point inspection confirmation items	(1) Cylinder head body inspection Perform the following inspections when cleaning. ・ Piston valve sticking check ・ Check for scratches and damage on the seat surface	Photo	
4. Record	・Check Main start valve abnormal		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Engine start failure due to start valve sticking		

No	(17-1)	Main start valve inspection (engine start air system assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of overhaul inspection tools ・ Dedicated spanner ・ Cleaning equipment (2) Preparation of replacement parts ·Spring ・ Pilot valve	(1) Equipment inspection points ・ Check for damage to equipment ・ Cleaning equipment damage check ・ Check damages on replacement parts		
2. Implementation of Work	(1) Removal of main start valve cover (2) Pulling out the piston valve (3) Spring, spring holder removal (4) Pilot valve, main body valve removal (5) Inspection of valves, valve seats, and springs (6) Cleaning parts (7) Gasket and O-ring replacement (8) Apply grease to the sliding parts (9) Pilot valve, valve, spring mounting (10) Piston valve insertion (11) Cover, pilot valve mounting	【point】 (1) Points for cleaning the head body ・ Check carbon adhered to the exhaust port ・ Abnormality of explosion surface and carbon adhesion (2) Inspection of the seat valve seat of the intake/exhaust valve ・ Check for scratches due to blow-by on the seat surface Photo		
3. Check and follow-up	(1) Organize the tools used	(1) Return the tool to its original position ② Arrangement around the engine		

No	(17-2)	Governor equipment inspection (engine start air system assembly work) (1)	
1. Purpose	The governor device drive structure consists of a drive pinion gear and a bevel gear. Inspect the governor drive gear and coupling mechanism.		
2. Procedure	(1) Governor drive gear removal (2) Bearing bush removal (3) PT inspection (4) Measurement (5) Assembly	(1) Confirmation of preparation before inspection ・ Mounting position of hanging equipment ・ Check the location ② Drive device ・ Check for scratches on the gear ・ Check for scratches on the drive shaft	
3. Inspection Item	(1) Cylinder head body inspection Perform the following inspections when cleaning. ・ PT inspection of drive shaft and gear ・ Measurement record of axis and gear	Photo	
4. Record	・ PT inspection ・ Measurement record (bush, thrust backlash)		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification			

No	(17-2)	Maneuvering device inspection (engine start air system assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of disassembly tools ・ Special equipment ・ Hanging tools ・ Wire rope (2) Preparation of PT test agent (3) Preparation of measuring tools ・ Dial gauge ・ Magnet base	(1) Equipment inspection points ・ Damage check for special equipment ・ Check for damage to hanging devices ・ Wire rope broken wire ②Measuring tool inspection point ・ Dial gauge calibration year		
2. Implementation of Work	(1) Gear mechanism storage cover lid removal (2) Extraction of horizontal axis (3) Removal of governor device installation stand (4) Governor device bevel gear removal (5) Bearing bush removal (6) Removal of bevel gear (7) Governor drive shaft extraction (8) Shaft bush removal inspection cleaning (9) Bearing bush PT inspection and measurement (10) Governor drive shaft, bevel gear mounting (11) The following restoration is performed in the reverse of removal (including gear backlash measurement).	(1) Points for overhaul ・ Consider the crane position and hanging location in advance. (2) Axis and gear inspection points ・ Checking shafts, bushes, and scratches ・ Thrust amount Photo		
3. Check and follow-up	(1) Storage of removed parts	(1) Store in a place that does not interfere with traffic ② Cultivate so that foreign substances do not fill up		

No	(17-3)	Inspection the starting air distribution valve (engine starting air system assembly work) (1)	
1. Purpose	Inspection the starting air distribution valve, etc. for the starting valve,		
2. Procedure	(1) Confirmation of air removal from each cylinder (2) Disassembly of starting air distribution valve (3) Cleaning of starting air distribution valve (4) Starting air distribution valve assembly	(1)Distribution valve inspection point ・ Clogged air piping ・ Distribution valve internal contamination status ・ Check for scratches on the rotary valve ・ Scratch condition of sliding part of valve case	
3. Inspection Item	(1) Perform the following inspections when inspecting the starting air distribution valve. ・Check rotary valve sticking ・ Scratch condition on the seat surface	Photo	
4. Record	・ Check for abnormalities in the starting air distribution valve		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Start when the engine starts Engine start failure due to malfunction of the air distribution valve		

No	(17-3)	Inspection the starting air distribution valve (engine starting air system assembly work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of disassembly measurement tools ・ Dedicated spanner ・ Measuring instrument (2) Others ・ Safety section rope ・ Safety belt	(1) Equipment inspection points ・ Damage check for spanners and calipers		
2. Implementation of Work	(1) Removal of the air inlet pipe of each cylinder (2) Removal of distribution valve cover (3) Extraction of rotary valve (4) Valve case removal (5) Cleaning parts (6) Inspection of rotary valve and valve case (7) Apply rotary valve grease (8) Cleaning of air pipes (9) Valve case mounting (10) Distribution valve cover mounting (1) Air outlet mounting piping	(1) Thickness measurement point of the exhaust port ・ Thickness reduction status of the port ・ Comparison with the previous data ・ Estimate the amount of thickness loss at the next inspection (Propose head replacement if thinning leak is expected by the next inspection) Photo		
3. Check and follow-up	(1) Organize the tools used	(1) Return the tool to its original position ② Arrangement around the engine		

No	(20-1)	Turbocharger Removal (Turbocharger, air cooler disassembly and inspection work) (1)	
1. Purpose	The turbocharger consists of a turbine and a blower (compressor element). Exhaust gas is guided to the turbine through the nozzle ring. The blower is driven by the exhaust gas. It is necessary to inspect the intake duct, etc.		
2. Work process	(1) Removing the intake duct (2) Turbocharger lubrication oil drainage (3) Removal of lubricating oil line (4) Thermometer, pickup removal (5) Storage	(1) Point of removing the intake duct ・ Check the crane position ・ Check that the wire rope is broken (2) Attached device removal point ・ To prevent damage on the thermometer, pickup, etc.	
3. Inspection Item	(1) Perform the following inspections when removing the turbocharger. ・ Turbocharger filter stain ・ Staining of the intake duct	Photo	
4. Record	・ Turbocharger filter stain ・ Staining of the intake duct		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Surging caused by turbocharger filter contamination		

No	(20-1)	Turbocharger Removal (Turbocharger, air cooler disassembly and inspection work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Crane preparation ·Overhead traveling crane (2) Preparation of hanging equipment ・ Wire rope ・ Shackle (3) Others ・ Safety section rope ・ Safety belt	(1) Points for checking hanging tools ・ Broken wire ・ Check for shackle cracks		
2. Implementation of Work	(1) Removing the intake duct (2) Turbocharger lubrication oil drainage (3) Removal of lubricating oil line (4) Thermometer, pickup removal (5) Storage	(1) Point when removing the intake duct ・ Check the position of the overhead crane ・ Check the hanging position (2) Instrumentation equipment removal point ・ Remove the thermometer and pickup by cultivating the detector. Photo		
3. Check and follow-up	(1) Organize the tools used	(1) Return the tool to its original position ② Arrangement around the engine		

No	(20-2)	Air cooler removal (Turbocharger, air cooler overhaul work) (1)	
1. Purpose	The air cooler for sending air to the engine combustion chamber should be removed mud, seaweed, etc. from the internal tube through which seawater passes , for maintains cooling efficiency.		
2. Procedure	(1) Removal of cooling water input piping (2) Removal of one part of the intake connecting pipe (3) Removal of air cooler (4) Removal of air inlet duct	(1) Points for removing the air cooler ・ Check the crane position ・ Check that the wire rope is broken (2) Attached device removal point ・ Be careful not to damage the thermometer, temperature sensor, etc.	
3. Inspection Item	(1) Perform the following inspections when aligning the intake valves. ・ Staining condition of cooler tube ・ Clogged inside the tube	Photo	
4. Record	・ Staining condition of cooler tube ・ Clogged inside the tube		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	Air supply temperature rises due to tube clogging of air cooler		

No	(20-2)	Air cooler Removal (Turbocharger and air cooler overhaul work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Crane preparation ・Overhead traveling crane (2) Preparation of hanging equipment ・ Wire rope ・ Shackle (3) Others ・ Safety section rope ・ Safety belt	(1) Points for checking hanging tools ・ Wire rope broken wire ・ Check for shackle cracks		
2. Implementation of Work	(1) Removal of cooling water input piping (2) Removal of air cooler mounting bolts (3) Removal of air cooler (4) Removal of air inlet connection pipe	(1) Points when removing the air cooler ・ Check the position of the overhead crane ・ Check the hanging position (2) Instrumentation equipment removal point ・ Remove the thermometer and pickup by cultivating the detector. Photo		
3. Check and follow-up	(1) Cooler transportation and storage	(1) Be careful not to fall over when transporting to clean the cooler tube. ② Store in a place that does not interfere with the safety passage		

No	(20-3)	Turbocharger overhaul (Turbocharger and air cooler overhaul work) (1)	
1. Purpose	The turbocharger consists of a turbine and a blower (compressor element) . Exhaust gas is guided to the turbine through the nozzle ring. The blower is driven by the exhaust gas . It is necessary to inspect the intake duct , etc.		
2. Procedure	(1) Blower input case removal (2) Turbine end cover removal (3) Blower bearing removed (4) Turbine bearing removal (5) Blower shaft extension pipe mounting (6) Without turbine rotor (7) Nozzle ring removal	(1) Points for removing the turbocharger ・ Check the crane position ・ Check for broken wires ② Confirmation point ・ Staining status of the input case ・ Rotor shaft damage check	
3. Inspection Item	(1) Perform the following inspections when disassembling the turbocharger. ・ Staining status of the input case ・ Rotor shaft damage check ・ Nozzle ring stain status	Photo	
4. Record	・ Staining status of the input case ・ Rotor shaft damage check		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification	output drops to 2000KW with the output of a turbocharger . Blower and turbine blade damage found by inspection		

No	(20-3)	Turbocharger disassembly (Turbocharger, air cooler disassembly and inspection work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of turbocharger disassembly machine ・ Blower extraction device ・ Extension pipe (2) Preparation of hanging equipment ・ Wire rope ・ Shackle (3) Others ・ Safety section rope ・ Safety belt	(1) Points for checking hanging tools ・ Broken wire ・ Check for shackle cracks		
2. Implementation of Work	the blower input case the cover on the blower side (3) Turbine end cover removal the pump disk on the blower side the pump disk on the turbine side (6) Blower side bearing extraction device set (7) Extraction of the bearing device on the blower side (8) Turbine side bearing extraction device set preparation (9) Extraction of bearing equipment on the turbine side (10) Turbine bearing fixing tool, extension pipe mounting (1) Remove the blower outlet case (12) Blower shaft extension pipe mounting, lifting and fixing Pull out the rotor shaft (to the blower side) (14) Removal of extension pipe (15) Turbine input case removal (16) Removing the shroud ring (17) Removing the nozzle ring (18) Storage	【point】 (1) Turbocharger removal point ・ Be careful not to damage the equipment due to dropping parts due to high-level work. ② Inspection points ・ Check for stains on the input case and damage to the rotor shaft ・ Corruption status of the input case Photo		
3. Check and follow-up	(1) Turbocharger transportation and storage	Do not knock down or drop the turbocharger when transporting it. ② Store in a place that does not interfere with the safety passage		

No	(20-4)	Turbocharger cleaning, measurement (Turbocharger, air cooler overhaul work) (1)	
1. Purpose	The turbocharger consists of a turbine and a blower (compressor element). Exhaust gas is guided to the turbine through the nozzle ring. The blower is driven by the exhaust gas. It is necessary to inspect the intake duct , etc.		
2. Procedure	(1) Equipment cleaning (shaft, case, etc.) (2) Thickness measurement (3) PT inspection (4) Measurement record, judgment	(1) Key points for cleaning equipment ・Check for scratches on the shaft Check the stain status of the case ② Inspection and measurement points ・ Case thickness measurement ・ Rotor shaft and other PT inspections	
3. Inspection Item	(1) Perform the following inspections when inspecting the turbocharger. ・ Turbine case thickness measurement ・ PT inspection, gap measurement	Photo	
4. Record	・ Turbine case thickness measurement ・ PT inspection, gap measurement		
5. Reference Document	(1) Engine instruction manual		
6. Safety trouble Well known	Turbocharger main body surging generation (different sound, vibration): Caused by contamination of the turbocharger turbine blower		

No	(20-4)	Turbocharger cleaning and measurement (Turbocharger and air cooler overhaul work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of measuring tools ・ Vernier micrometer ·Micrometer (2) Preparation of PT test agent ・ Cleaning liquid ・ Dye penetrant	(1) Points of PT inspection ・ Confirmation of cleaning completion of inspection surface ・ Check for damage on the inspection surface ・ Expiration date of flaw detection inspection agent		
2. Implementation of Work	(1) Rotor shaft cleaning (2) Nozzle ring cleaning (3) Shroud ring cleaning (4) Turbine input case steam cleaning (5) Labyrinth bush replacement (6) Turbine input case thickness measurement (7) Recording and judgment (8) Rotor shaft PT inspection (9) Turbine blade PT inspection (10) Impeller PT inspection (1) Nozzle ring PT inspection (12) Diffuser part PT inspection (13) Storage	(1) Equipment cleaning point ・ Confirmation of scratches on the shaft ・ Check the stain status of the case ② Inspection and measurement points ・ Measurement of case thickness (confirmation within allowable value) ・ Rotor shaft and other PT inspections (Confirmation of crack damage) Photo		
3. Check and follow-up	(1) Turbocharger transportation and storage	(1) Be careful not to fall or fall during transportation ② Store in a place that does not interfere with the safety passage		

No	(20-5)	Air cooler disassembly and cleaning (in the Turbocharger and air cooler disassembly and inspection work) (1)	
1. Purpose	The air cooler for sending air to the engine combustion chamber should be removed mud, seaweed, etc. from the internal tube through which seawater passes , for maintains cooling efficiency.		
2. Procedure	Removal of air inlet cover Wash with chemicals (3) Insert the tube fin (4) Anti-rust coating (5) Installation of air inlet cover	(1) Air cooler cleaning ・ Check for cracks in the cooler body and lid ・ Check for clogging of the cooler tube) Removal of attached equipment careful not to damage the thermometer, temperature sensor, etc.	
3. Inspection Item	(1) Perform the following inspections when cleaning the air cooler. ・ Contamination of air and cooling passages ・ Water pressure test	Photo	
4. Record	・ Contamination of air and cooling passages ・ Water pressure test		
5. Reference Document	(1) Engine instruction manual		
and trouble notificati	Air supply temperature rise due to tube clogging of air cooler		

No	(20-5)	Air cooler disassembly and cleaning (in the Turbocharger and air cooler disassembly and inspection work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of measuring tools ・ Vernier micrometer ・Micrometer (2) Preparation of PT test agent ・ Cleaning liquid ・ Dye penetrant	(1) Points of PT inspection ・ Confirmation of cleaning completion of inspection surface ・ Check for damage on the inspection surface ・ Expiration date of flaw detection inspection agent		
2. This work implementation	(1) Removing the air inlet cover (2) Removal of cooling water input lid (3) Chemical cleaning (cooling passage) (4) Washing the chemical adhesion part (5) Input case fin inspection and cleaning (6) Cooling water passage air blow (7) Air passage air blow (8) Inside the main body, inside the lid, rust preventive coating (9) Cooling water input lid mounting (10) Installation of air inlet duct	(1) Disassembly and cleaning points ・ Check for cracks on the inside of the main body and lid ・ Clogged cooler tube ・ Pollution status of air passages ・ Check for foreign material in the cooling water passage Photo		
3. Check and follow-up	(1) Air cooler transportation and storage	(1) Be careful of falling and falling during transportation ② Store in a place that does not interfere with the safety passage		

No	(20-6)	Turbocharger assembly (Turbocharger, air cooler overhaul work) (1)	
1. Purpose	The turbocharger consists of a turbine and a blower (compressor element). Exhaust gas is guided to the turbine through the nozzle ring. The blower is driven by the exhaust gas. It is necessary to inspect the intake duct , etc.		
2. Procedure	(1) Turbocharger assembly (2) Turbocharger air duct, lubricating oil piping installation (3) Thermometer and pickup mounting	(1) Points of Turbocharger assembly ・ Check the crane position ・ Check for broken wires (2) Attached equipment mounting point careful not to damage the thermometer, temperature sensor, etc.	
3. Inspection Item	(1) When assembling the turbocharger Perform the following inspections. ・ Impeller and casing gap measurement ・ Blower shaft end, end cover surface measurement ・ Turbine and blower shaft core measurement	Photo	
4. Record	・ Impeller and casing gap measurement ・ Blower shaft end, end cover surface measurement ・ Turbine and blower shaft core measurement		
5. Reference Document	(1) Engine instruction manual		
6. Safety and trouble notification			

No	(20-6)	Turbocharger assembly (Turbocharger, air cooler overhaul work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of turbocharger assembly ・ Extension pipe ・ Dedicated fixture (2) Preparation of hanging equipment ・ Wire rope ・ Shackle (3) Measuring tool ・Dial gauge ・ Magnet base	(1) Points for checking hanging tools ・ Wire rope broken wire ・ Check for shackle cracks ②Measuring tool inspection point ・ Dial gauge calibration year		
2. Implementation of Work	(1) Shroud ring mounting (2) Nozzle ring mounting (3) Turbine input case mounting (4) Blower side extension pipe mounting (5) Turbine shaft fixing tool, extension pipe mounting (6) Rotor insertion push (7) Impeller and back plate gap measurement (8) Judgment (9) Blower outlet case mounting (10) Removal of extension pipe Measurement of gap between impeller and casing (12) Judgment (13) Inserting turbine bearing equipment (14) Inserting the pump disk on the turbine side (15) Turbine input case removal (16) Turbine side fixing tool mounting (17) Blower side bearing device installation (18) Measurement between the end of the shaft on the blower side and the end cover surface (19) Pump disk runout measurement (20) Measurement between the turbine side and blower side	(1) Points of Turbocharger assembly ・ Check the crane position ・ Check wire kink (2) Attached equipment mounting point Caution for damage to the thermometer and temperature sensor Photo		

	shaft cores (21) Turbine , blower side end cover mounting (22) Intake duct, lubricating oil piping, accessory installation			
3. Check and follow-up	the turbocharger and air cooler	(1) Clean up the patrol inspection passage		

No	(20-7)	Air cooler assembly (Turbocharger, air cooler overhaul work) (1)	
1. Purpose	The air cooler for sending air to the engine combustion chamber should be removed mud, seaweed, etc. from the internal tube through which seawater passes , for maintains cooling efficiency.		
2. Procedure	(1) Air cooler body mounting (2) Air cooler air duct installation (3) Air cooler cooling water piping installation	(1) Points for installing an air cooler ・ Check the crane position ・ Check that the wire rope is broken (2) Attached equipment mounting point ・ Be careful not to damage the thermometer, temperature sensor, etc.	
3. Inspection Item	(1) Perform the following inspections when installing the air cooler. ・ Main body damage check ・ Tube and fin damage check	Photo	
4. Record	・ Main body damage check ・ Tube and fin damage check		
5. Reference Document	(1) Engine instruction manual		
and trouble notificati	Air cooler tube Contamination of air supply temperature rise		

No	(20-7)	Air cooler assembly (Turbocharger, air cooler overhaul work) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Crane preparation ・Overhead traveling crane (2) Preparation of hanging equipment ・ Wire rope ・ Shackle (3) Others ・ Safety section rope ・ Safety belt	(1) Points for checking hanging tools ・ Wire rope broken wire ・ Check for shackle cracks		
2. Implementation of Work	(1) Installation of air inlet duct (2) Air cooler installation (3) Tightening the air cooler mounting bolts (4) Installation of cooling water input piping	【point】 (1) Points for installing an air cooler ・ Check the position of the overhead crane ・ Check the hanging position (2) Instrumentation equipment mounting point ・ Remove the thermometer and pickup by cultivating the detector. Photo		
3. Check and follow-up	(1) Clean up around supercharger and air cooler	(1) Clean up the patrol inspection passage		

No	(23-1)	Purifier, main filter work (lubricating oil purifier inspection) ①	
1. Purpose	Lubricating oil and Oil Purifiers are high-speed centrifuge type. Clean the internal rotating part, maintain the drive unit, and disassemble and maintain the bearings.		
2. Procedure	(1) Purifier overhaul (2) Cleaning the bowl and body (3) Bearing and brake pad replacement (4) Assembly (5) Lubricating oil replacement	(Points and precautions when working) ① Matters before disassembling the purifier ・ Operation power off ・ Lubricating oil supply valve closed ② Preparation of disassembly tools ・ Extraction tool ・ Measuring tools	
3. Inspection Item	(1) When disassembling and inspecting the purifier body, perform the following inspections. ・ Check contamination inside the screw and body ・ Wear of bearings, packing, and brake pads	Photo	
4. Record	・ Condition of contamination inside the rotating body and body ・ Abrasion status of bearings, packing, and brake pads		
5.Reference Document	(1) Engine instruction manual		
6.Safety and trouble notification	Fuel service tank level low alarm is generated due to abnormal separation of Oil Purifier.		

No	(23-1)	Purifier, main filter work (lubricating oil purifier inspection) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of purifier disassembly tool ・ Special equipment ・ Wrench ・ Various spanners, etc. (2) Preparation of replacement parts (3) Preparation of hanging equipment ・ Chain block ・ Wire	① Equipment inspection points ・ Deformation of specialized equipment and damage to screws ② Proper replacement parts ③ Hanging tool Check for broken wire		
2.Implementation of work	(1) Lubrication oil drainage (2) Remove the cooling water pipe, replace the cooling water or treat (3) Frame hood disassembly (4) Disassembly of bowl hood and disc stack (5) Disassembly of bowl body and operation mechanism (6) Disassembling the operating water device (7) Disassembly Vertical drive device (8) Disassembly of Horizontal drive device (9) Cleaning bowl hood and disc tack (10) Inspection and cleaning of drive unit parts (11) Bearing replacement (12) Brake pad replacement (13) Flat drive unit assembly (14) Vertical drive unit assembly (15) Operation water device assembly (16) Bowl body, operation mechanism assembly (17) Frame hood assembly (18) Replacement water, conditioning water pipe mounting (19) Lubricating oil supply (20) Operation water tank cleaning (21) Cleaning the sludge discharge pipe	① Overhaul ・ Disassembly procedure ・ Internal rotation shaft damage ・ Attachments on each part ・ Internal pollution status (2) Specifications and model number of replacement parts Photo		

3. Follow-up after the work	(1) Arrangement of tools (2) Arrangement and storage of removable piping	① Arrange the tools to their original position (2) Clean the connecting pipes and store them so that they do not interfere with the passage.		

No	(23-2)	Purifier, main filter overhaul (Oil Purifier inspection) ①	
1. Purpose	Lubricating oil and Oil Purifiers are high-speed centrifuge type. Clean the internal rotating part, maintain the drive unit, and disassemble and maintain the bearings.		
2. Procedure	(1) Purifier overhaul (2) Cleaning the bowl and body (3) Bearing and brake pad replacement (4) Assembly (5) Lubricating oil replacement	① Matters before disassembling the purifier ・ Operation power off check ・ Lubricant refueling valve closing check ② Preparation of disassembly tools ・ Extraction tool ・ Measuring tools	
3. Inspection Item	(1) When disassembling and inspecting the purifier body, perform the following inspections. ・ Condition of contamination inside the rotating body and body ・ Abrasion status of bearings, packing, and brake pads	Photo	
4. Record	・ Condition of contamination inside the rotating body and body ・ Abrasion status of bearings, packing, and brake pads		
5.Reference Document	(1) Engine instruction manual		
6.Safety and trouble notification	Low fuel service tank level due to abnormal separation of Oil Purifier		

No	(23-2)	Purifier, main filter overhaul (Oil Purifier inspection) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of purifier disassembly tool ・ Special equipment ・ Wrench ・ Various spanners, etc. (2) Preparation of replacement parts (3) Preparation of hanging equipment ・ Chain block ・ Wire rope	① Equipment inspection points ・ Deformation of specialized equipment and damage to internal threads of the main body ② Check replacement part, equipment type. ③ Check hanging tool ・ Check broken wire		
2.Implementation of work	(1) Fuel oil drainage (2) Cooling water (replacement. Conditioning) Pipe removal (3) Frame hood disassembly (4) Disassembly of bowl hood and disc stack (5) Bowl body, operation mechanism disassembly (6) Disassembling the operating device (7) Vertical drive disassembly (8) Disassembly of flat drive device (9) Cleaning bowl hood and disc tack (10) Inspection and cleaning of drive unit parts (11) Bearing replacement (12) Brake pad replacement (13) Flat drive unit assembly (14) Vertical drive unit assembly (15) Operation water device assembly (16) Bowl body, operation mechanism assembly (17) Frame hood assembly (18) Replacement water, conditioning water pipe mounting (19) Lubricating oil supply (20) Operation water tank cleaning (21) Cleaning the sludge discharge pipe	① Check points for overhaul ・Disassembly procedure ・ Internal rotation shaft damage ・ Attachments on each part ・ Internal pollution status (2) Specifications and model number of replacement parts Photo		

3. Follow-up after the work	(1) Arrangement of tools (2) Arrangement and storage of removable piping	(1) Arrange the tools to their original position (2) Store the connecting pipes in a place that does not obstruct the passage after cleaning.		

No	(23-3)	Purifier, main filter overhaul (lubricating oil K-8 filter inspection) ①	
1. Purpose	After the fuel and lubricating oil of the diesel engine are cleaned by a purifier, and the K-8 filter remove sludge. Therefore K-8 filter shall be inspected and cleaned.		
2. Procedure	(1) K-8 filter disassembly (2) Element, body inspection and cleaning (3) O-ring replacement (4) Strainer assembly	① Matters before disassembling the K-8 filter ・Power off ・Lubricating oil supply valve closed ② Preparation of disassembly tools ・Extraction tool ・Measuring tools	
3. Inspection items	(1) Perform the following inspections when disassembling the K-8 filter. ・Element ・Abnormality inside the main body mechanism	Photo	
4. Record	・Element body ・Abnormality inside the main body mechanism		
5.Reference Document	(1) Engine instruction manual		
6.Safety and trouble notification	Filter cannot be backwashed		

No	(23-3)	Purifier, main filter work (lubricating oil K-8 filter inspection) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of K-8 filter disassembly tool ・Special equipment ・Wrench ・Various spanners, etc. (2) Preparation of replacement parts (3) Preparation of hanging equipment ・Chain block ・wire	① Equipment inspection points ・Deformation of specialized equipment and damage to internal threads of the main body ② Is the replacement part appropriate? ③ Is the hanging tool appropriate? ・Broken wire		
2.Implementation of work	(1) No internal pressure on the strainer (2) Strainer input valve closed (3) Open the air bleeding valve (4) Backwash lotion discharge valve open (residual oil discharge) (5) Removing the piping attached to the upper lid cover (6) Remove element restraint (7) Removal of element packing (8) Removing the O-ring (9) Cleaning inside the filter (10) Element cleaning (11) Backwash system inspection, bearing replacement (12) O-ring replacement (13) Drive bearing, oil seal replacement (14) Element and packing mounting (15) Element restraint mounting (16) O-ring mounting (17) Top cover mounting, attached piping mounting (18) Backwash valve closed (19) Air bleeding valve closed (20) Strainer input valve open (21) Air bleeding, oil filling	【point】 ① Key points for overhaul ・Disassembly procedure ・Internal element damage ・Attachments on each part ・Internal pollution status (2) Specifications and model number of replacement parts Photo		

3. Follow-up after the work	(1) Arrangement of tools (2) Arrangement and storage of removable piping	① Arrange the tools to their original position (2) Clean the connecting pipes and store them so that they do not interfere with the passage.		

No	(25-2)	Heat exchanger related overhaul (lubricant cooler inspection) ①
1. Purpose	Primary and secondary cooling water and lubricating oil in diesel engines are cooled in special coolers. Inspect and clean the internal tubes of the cooler, as fouling or blockages reduce cooling efficiency.	
2. Procedure	(1) Upper part Water room cover removal (2) Check and clean the cooling passage inside the cooler (3) Water pressure test of cooling water tube (4) Anti-rust coating on the cooling water passage (5) Installation of upper water chamber cover Check and clean the lubricant passage of the cooler (7) Clean the lubricating oil passage with chemicals, and re-inspect before assemble. (Including manhole cover mounting)	(Points and precautions when working) Point of intake valve seat retouch ・Check Retouch angle ② Method measurement point ・Exceeding the permissible gap between valve rod and bushing causes increasing dynamic valve oil consumption.
3. Inspection items	(1) When inspecting the lubricating oil cooler Perform the following inspections. ・Cooling water passage inspection ・Water pressure test	Photo
4. Record	・Cooling water passage inspection ・Water pressure test	
5.Reference Document	(1) Engine instruction manual	
and trouble notificati	- Lubricating oil cooler tube damaged Lubricating oil mixed water spilled into the sea area	

No	(25-2)	Heat exchanger related overhaul (lubricant cooler inspection) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation of disassembly tools ・ Special equipment ・ Impact wrench ・ Various spanners, etc. (2) Preparation of replacement parts ・ Protective zinc	① Equipment inspection points ・Deformation of specialized equipment and damage to pump threads ・Operation of impact wrench ・ Air hose leakage ② Check replacement parts type		
2.Implementation of work	(1) Removing the upper water room cover (2) Inspection and cleaning of the cooling water passage (3) Water pressure test (4) Painting of cooling water passage (5) Installation of upper water chamber cover (6) Inspection of lubricating oil passage (removal of manhole cover) (7) Circulation pump set for cleaning (8) Cleaning of lubricating oil passages with chemicals (9) Re-inspection of lubricating oil passage, (10) Manhole cover mounting (11) Assembly	【point】 ① Inspection point ・ Corruption of passages ・ Scale adhesion status ・ Anti-tactile zinc status ・ Tube status Photo		
3. Follow-up after the work	(1) Organize around the cooler	(1) Cleaning around the cooler (2) When transferring cleaning equipment, transfer it so that it does not obstruct other work passage.		

No	(29-1)	Preparatory work before starting the engine (crank chamber inspection) ①
1. Purpose	After maintenance of diesel engines, inspect the inside of the crank chamber before flushing the lubricating oil and inspect the small bore pipework around the engine.	
2. Procedure	(1) Inspection and cleaning of the inside of the crank (2) Crank chamber door packing replacement (3) Installation of piping around the engine (4) Gasket and O-ring replacement	① Points for inspection and cleaning ・ Thoroughly disseminate the work inside the crank chamber ・ Turning off the power of the turning device ・ Turning device entanglement prevention measures (Turning device depositioning, confirmation communication signal)
3. Inspection items	(1) When inspecting the inside of the crank Perform the following inspections. ・ Foreign material mixed ・ Tools left ・ Internal inspection and cleaning	Photo
4. Record	・ Foreign material mixed ・ Tools left	
5.Reference Document	(1) Engine instruction manual	
6.Safety and trouble notification	Crack on clank case due to deterioration over time (Countermeasures: stop hole repair, hardener treatment)	

No	(29-1)	Preparatory work before starting the engine (crank chamber inspection) ②		
Item	Procedure	Procedures and security measures	Witness	Name
1. Preliminary Work	(1) Preparation for internal inspection ・ Kerosene cleaning ・ Wes (2) Others ・ Safety section rope	① Points of inspection ・ Turning off the power of the turning device ・ Staining condition inside the crank chamber ・ Tools left inside the crank chamber		
2.Implementation of work	(1) Crank chamber door open (2) Cleaning the inside of the crank (3) Crank interior inspection (4) Leakage in the crank chamber (5) Crank pin bolt inspection (6) Cylinder liner sliding part inspection (7) Replacement of crank chamber door packing (8) Crank chamber door mounting	① Crank chamber ・ Foreign material mixed ・ Oil spill ② Turning device ・ Thorough operation signals ・ Power on / off operation Photo		
3. Follow-up after the work	(1) Arrangement of tools	(1) Cleaning around the cooler (2) When transferring cleaning equipment, transfer it so that it does not obstruct other work passage.		

No.	(29-6)	Preparatory work before starting the engine (generator insulation resistance measurement test) ①	
1. Purpose	Before the start of commissioning after the diesel engine maintenance, the generator and exciter insulation resistance both of high and low voltage circuits shall be inspected.		
2. Procedure	[Measurement circuit and judgment criteria] (1) High pressure circuit ・ Generator fixed circuit (6.6KV circuit) ・ Generator cable (6.6KV circuit) (2) Low voltage circuit ・ Generator rotor and excitation circuit (circuit of 500V or less) ・ Field winding circuit of exciter (3) Judgment criteria LV: 5MΩ or more at 1000V megger HV: 100MΩ or more at 500V megger (4) Insulation resistance measurement record	① Measurement point ・ Calibration month/year of insulation resistance measuring instrument ・ No voltage of measurement circuit ② Precautions for measurement ・ Wearing insulating gloves ・ Use of insulating mats and insulating sheets	
3. Check Item	・ Calibration year of insulation resistance measuring instrument ・ Insulation resistance measurement record	Photo	
4. Record	・ Calibration year of insulation resistance measuring instrument ・ Insulation resistance measurement record		
5.Reference Document	(1) Generator instruction manual		
6.Safety and trouble notification	Insulation resistance measurement value 1 MΩ or less (The decrease in insulation due to a long-term shutdown) Countermeasures: Thermal drying, generator cleaning		

No	(29-6)	Preparatory work before starting the engine (generator insulation resistance measurement test) ②		
Item	Procedure	Procedures and security measures	Witness	Name
1. Preliminary Work	(1) Preparation for insulation resistance measurement ・ Insulation resistance measuring instrument ・ Electroscope ・ Insulation sheet, mat (2) Others ・ Safety section rope ・ Alarm during test	① Measurement points ・ Insulation resistance measuring instrument calibration month/year ・ Certification year of voltage detector ・ Insulation sheet and mat inspection month/year		
2.Implementation of work	(1) High pressure circuit: From Generator stator winding the generator cable ・ Check NO VOLTAGE at Measurement circuit with voltage detector ・ Insulation measuring instrument range to 1000V ・ Check earth of Insulation resistance measuring instrument ・ Measurement; 1 minute ・ Record Insulation resistance measurement ・ Discharge after test (2) Low voltage circuit: Generator rotor winding ~ Exciter rotor ・ Check No voltage ・ Insulation measuring instrument range to 500V ・ Check earth of Insulation resistance measuring instrument ・ Measurement; 1 minute ・ Record Insulation resistance ・ Discharge after test	① Measurement point ・ Insulation resistance measuring instrument calibration month/year ・ No voltage of measurement circuit ② Precautions for measurement ・ Wearing an insulating bag mats and insulating sheets Photo		

	(3) Low voltage circuit: Excitation field winding ・ Insulation measuring instrument range to 500V ・ Check earth of Insulation resistance measuring instrument ・ Measurement; 1 minute ・ Record Insulation resistance measurement ・ Discharge after test			
3. Follow-up after the work	(1) No voltage in high-voltage circuit (2) Re-connection of circuit after test	(1) No voltage when connecting the circuit (2) Cable and wire connection		

No	(30-1)	Engine test run, performance test (engine no-load test operation) ①	
1. Purpose	After all the maintenance work of the diesel engine is completed, perform a test run with no load operation and confirm that the engine operates normally.		
2. Test run procedure	[Test run procedure] (1) Air run before startup (2) Test run at 25% engine speed (manual start) (for 5 to 10 minutes) (3) Crank interior point (4) Test run at 100% engine speed (moving start) (for 20 to 30 minutes) (5) Check crank chamber (6) Check abnormal temperatures and pressure of each part	(Points and precautions when working) ① No-load test point ・ Amount of air filling in the air tank ・ Air bleeding of fuel oil system ② Temperature measurement point ・ Measurement with an outside line sensor ・ Measurement immediately after rotation stop	
3. Inspection Item	(1) At the time of engine no-load test, perform the following inspections. ・ Crank shaft and spindle related temperature ・ Temperature inside the piston cylinder ・ Temperature of lubricating oil, cooling water, and heavy oil	Photo	
4. Record	・ Crank shaft and spindle related temperature ・ Temperature inside the piston cylinder ・ Temperature of lubricating oil, cooling water, and heavy oil		
5.Reference Document	(1) Engine instruction manual		
6.Safety and trouble notification	Engine start failure (Cause: Start-up with fuel handle closed)		

No	(30-1)	Engine test run, performance test (engine no-load operation) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation for starting the engine ・Check for air tank 2.5Mpa or more ・Lubricating oil pump priming and engine turning (2) Others ・ Safety section rope ・ Safety belt	① Points of test run ・ Amount of air for starting ・ Priming and turning ・ Fuel oil-based air bleeding ・ Engine governor rotation control		
2.Implementation of work	(1) Preparation for manual startup ・Site auxiliary equipment manually start ・ Turning end deposition ・ Open fuel handle ・ Opening the air source valve ・ Announce Manual Operation ・ Start valve open ・ Engine speed increase (0 to 150rpm) (2) Start of operation ・Speed control with governor ・ Engine speed increase (150 rpm) ・ Start of mating operation (5-10 minutes) ・ End of mating operation ・ Fuel handle closing position ・ Engine rotation stop (3) Crank interior point ・ Lubricating oil priming pump stop ・ Air main valve closed ・ Crank chamber lid removal inner point ・ Bearing temperature, no leakage	① No-load point ・Check the pressure inside the air tank ・ Air bleeding of fuel oil system ② Temperature measurement point ・ Measurement with an outside line sensor ・ Measurement immediately after rotation stop Photo		

3. Follow-up after the work	Check after finishing the internal work	(1) Inspection left equipment, waste cloth, etc. inside (2) Lubricating oil priming and turning after inspection		

No	(30-2)	Engine test run, performance test (engine parallel load test operation) ①	
1. Purpose	After all the maintenance work of the diesel engine is completed, perform a test run with no load operation and confirm that the engine operates normally. Synchronization to the Grid and perform load test .		
2. Test run procedure	(1) Automatic engine start (2) Synchronization to Grid (3) Test operation with an engine load of 25% (30 minutes driving alignment) (4) Test with an engine load of 50% (Test for 60 minutes) (5) Engine stop, crank interior point (Crank shaft, spindle temperature measurement) (6) Engine restart, system parallel (7) Test at engine load 75, 100% (75%: 60 minutes 100%: 2 hours test)	① No-load test point ・ Amount of air filling in the air tank ・ Air bleeding of fuel oil system ② Temperature measurement point ・ Measurement with an outside line sensor ・ Measurement immediately after rotation stop	
3. Inspection items	(1) When adjusting the engine load Perform the following inspections. ・ Crank shaft and spindle related temperature ・ Temperature inside the piston cylinder ・ Temperature of lubricating oil, cooling water, and heavy oil	Photo	
4. Record	・ Crank shaft and spindle bearing temperature ・ Temperature inside the piston cylinder ・ Temperature of lubricating oil, cooling water, and heavy oil		
5.Reference Document	(1) Engine instruction manual		

6.Safety and trouble notification	- Unit engine start failure (Cause: Start-up with fuel handle closed)

No	(30-2)	Engine test run, performance test (engine parallel load test operation) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation for starting the engine ・Pressure of 2.5Mpa or more in the air tank ・ Lubricating oil pump priming and engine turning (2) Others ・ Safety section rope ・ Safety belt	① Points of test run ・ Air pressure for starting ・ Priming and turning ・ Fuel oil system air bleeding ・ Rotation speed control by the governor device of the engine		
2.Implementation of work	(1) Automatic engine start (2) Engine system parallel (3) Test operation with an engine load of 25% (30 minutes) (4) Test with an engine load of 50% (60 minutes) (5) Stop the engine and inspect the inside of the crank. (Crank shaft, spindle temperature measurement) (6) No engine abnormality (7) Automatic engine startup, system parallel (8) Test with 75% load (1 hour) (9) Test with 100% load (2 hours) (10) Engine stop, check crank inside (Crank shaft, spindle temperature measurement)	【point】 ① No-load test point ・ Check the pressure inside the air tank ・ Air bleeding of fuel oil system ② Temperature measurement point ・ Measurement with an outside line sensor ・ Measurement immediately after rotation stop Photo		
3. Follow-up after the work	Check after finishing the internal work	① Inside inspection for left equipment, waste cloth, etc. (2) Lubricating oil priming and turning after inspection		

No	(30-3)	Test run, performance test (performance test) ①	
1. Purpose	After the maintenance of the diesel engine is completed, perform a test run with no load operation to confirm that the engine operates normally. Perform the final performance test after synchronizing to the Grid and performing load test.		
2. Procedure	(1) Automatic engine start (2) Engine system parallel (3) Performance test at engine load of 50, 75 and 100% ・ 50%: 30 minute performance test ・ 75%: 60 minutes performance test ・ 100%: 120 minute performance test (4) Main measurement items related to performance (Measurement of power generation power and fuel consumption) (5) Main engine measurement items (Exhaust temperature, cylinder explosion pressure) (6) Performance evaluation (Improvement of fuel consumption rate at 100% load)	① Performance test points ・ Confirmation of signal to start the test ・ Reading of Watt meter and flow meter ・ Decrease exhaust temperature ・ Improvement of fuel consumption rate ② Temperature and pressure measurement points ・ Measure 5 minutes or more after reaching the rated load. ・ Constant load operation when measuring explosive pressure	
3. Inspection Item	Make the following measurements during the engine performance test. ・ Power generation and fuel consumption ・ Exhaust temperature, cylinder explosion pressure ・ Temperature of lubricating oil, cooling water, and heavy oil	Photo	
4. Record	・ Power generation and fuel consumption ・ Exhaust temperature, cylinder explosion pressure ・ Temperature of lubricating oil, cooling water, and heavy oil		
5.Reference Document	(1) Engine instruction manual		
6.Safety and trouble notification	- Fuel consumption increase (Cause: Misreading of fuel consumption)		

No	(30-3)	Engine test run, performance test (engine performance test) ②		
Item	Procedure	Procedure and Safety	Witness	Name
1. Preliminary Work	(1) Preparation before performance test ・ Stopwatch ・ Explosion pressure measuring instrument ・ Bar thermometer (2) Others ・ Signal whistle ・ Communication device (site)	① Key points of performance test ・ Signal to start the test ・ Reading of Watt meter and flow meter ・ Check exhaust temperature decreasing ・ Improvement of fuel consumption rate ② Temperature and pressure measurement points ・ When measuring the explosion pressure, use a work gloves, etc. to measure the high temperature and pressure.		
2.Implementation of work	(1) Automatic engine start (2) Synchronization to Grid (3) Load for Performance Test ・ 50%: 30 minutes ・ 75%: 60 minutes ・ 100%: 120 minutes (4) Main measurement items related to performance ・ Power generation ・ Fuel consumption ・ Supercharger intake air temperature and pressure ・ Supercharger rotation speed ・ Air cooler intake air temperature, etc. (5) Main engine measurement items ・ Exhaust gas temperature ・ Cylinder explosion pressure (6) Performance evaluation (Improvement of fuel consumption rate at 100% load)	① Performance test points ・ Signal to start the test ・ Reading of meter and flow meter ・ Decrease exhaust temperature ・ Improvement of fuel consumption rate ②Temperature and pressure measurement points ・ Measure after 5 min or more from reached rated load ・ Measuring of explosion pressure shall be conducted under continuous load operation. Photo		

3. Follow-up after the work				
(1) Intake valve, bush storage		(1) Since the valve stem is long, store it in a place where people cannot pass so that it will not fall over. ② Clean the bush and store it in a place that does not obstruct the passage.		

4. Spare Parts Procurement Plan and Budget Scale

4. Spare parts procurement and budget measures

（1）Spare parts procurement

For the next OH implementation, the LEC will need to purchase spare parts shown in Tables 1 and 2, and urgent budget measures and orders will be required. Since the amount fluctuates due to fluctuations in exchange rates, raw material prices, transportation costs, etc., it is recommended to obtain the latest quotation from the parts distributor.

Table 1 Spare parts that need to be procured for 12,000 hours OH (Engine)

No.	Items	Qty
	CYLINDER BLOCK	
977592330	O-ring for push rod	40
	CYLINDER HEAD	
9BA324101	Gasket for cylinder head	16
377882171	Gasket FV (special thickness 0.2mm)	64
	STOPPER SV	
977618250	Gasket	24
	STARTING VALVE	
977618250	Gasket for starting air valve	9
V4A327300	Gasket for starting air valve	8
	INDICATOR COCK	
E42026200	Gasket (10pcs/pack)	11
	SAFETY VALVE * CYL	
V0J328500	Gasket	64
	PIPING *FO	
A60250350	O-ring	32
	INJECTION PIPE	
977561360	Spherical washer	72
977561680	Spherical washer	72
	CW OUTLET PIPING	
E41319100	Gasket (10pcs/pack)	8
	INJECTION VALVE	
934325700	Parallel pin for fuel injector (10pcs/pack)	14
P8410498A	**ECP (Engine Control Panel)**	
P98A4000B	Pressure regulating valve NMR-3S	4
	Pressure gauge 0.6MPa	5
	Pressure gauge 1.0MPa	2
	Pressure gauge 1.0MPa for FO	3
	Pressure gauge 0.4MPa	8
	Pressure gauge 6.0MPa	3
	Pressure gauge 4.0MPa	6
	Exh. Pyrometer for 38142500B	44
P7912481A	LUBE OIL MAIN FILTER K8E7RVZ	
G2	Pressure gauge 1.6MP	6
F12	Pressure gauge 1.0MP	3
F-11	Solenoid valve unit	3
F-12	Air filter unit	3
F10	Automatic ball valve unit	3
P7912481A	SLUDGE CHECKER OF LUBE OIL MAIN FILTER	
	O-ring	4
P7902543A	FUEL OIL PRIMARY FILTER PFC/L-N75SL/2-X	

No.	Items	Qty
	Element	6
	Pressure gauge	6
P7903008A	F.O.SECONDARY FILTER K8FE3VZS	
G4	Pressure gauge 1.6MP	6
F3	Pressure gauge 1.0MP	1
F4	4 Way solenoid valve	3
F2	Automatic ball valve unit	3
P7907002A	FUEL OIL THIRD FILTER UNI/FV43-X	
	Element	6
P8630477A	3S15A AIR COMPRESSOR	
	Safety valve 2nd assembly	1
P9051004A	WATER TREATMENT UNIT	
	Filter bag	60
	INTAKE & EXHAUST VALVE GRINDING	
	GRINDING STONE(WA60K)	8
	GRINDING STONE(GC120H)	5
	Pressure gauges	
P8904611A	**FO CIRCULATING PUMP DHT-M32 01P4609A**	
	Pressure gauge	3
	Compound gauge	3
P8905007A	**HFO BOOSTER PUMP DHT-M32 01P4608**	
	Pressure gauge	3
	Compound gauge	3
P8905008A	**SO BOOSTER PUMP DHT-M32 01P4610A**	
	Pressure gauge	3
	Compound gauge	3
P8906083A	**HFO TRANSFER PUMP DHLT-M40 01P4600A**	
	Pressure gauge	3
	Compound gauge	3
P9806085A	**DO UNLOADING PUMP DHT-M65 01P4611A**	
	Pressure gauge	3
	Compound gauge	3
P8925009A	**FO DRAIN PUMP DHT-M15 01P4605A**	
	Pressure gauge	3
	Compound gauge	3
P8924143A	**SPARE PARTS LIST FOR SLUDGE PUMP HNP-201 (852A2B6253Y2)**	
	Pressure gauge	3
	Compound gauge	3
P8934410A	**LO PRIMING PUMP**	
	Pressure gauge	3
	Compound gauge	3
P8937012A	**LO TRANSFER PUMP DHT-M32 01P4607A**	
	Pressure gauge	3
	Compound gauge	3
P8914920A	**LT WATER CIRCULATING PUMP 150x100 ISC-3215H 01P4603A**	
	Pressure gauge	3
	Compound gauge	3
P8918228A	**TREATED WATER PUMP S25H-M32 01P4601A**	
	Pressure gauge	3
	Compound gauge	3
P8924140A	**SPARE PARTS LIST FOR WASTE OIL PUMP & OILY WATER PUMP(852A2B6253Y2)**	
	Pressure gauge	3

No.	Items	Qty
	Compound gauge	3
P8650022A	**AIR RECEIVER 800L HT-35706**	
	Pressure gauge 75φx 6MPa	3
	Safety valve	3
P8630477A	**AIR COMPRESOORE 3S15A 3S15A-0011-AA**	
	1st pressure gauge	2
	2nd pressure gauge	2
	3rd pressure gauge	2
	LO pressure gauge	2
P9050055A	**15ppm BILGE SEPARATOR PARE PARTS LIST**	
	Pressure gauge T3/8X75X0.6mpA KPAA125060	2

Table 2 Spare parts that need to be procured for 12,000 hours OH (Purifier)

No.	Model	Items	Qty
1	N1FO	FRICTION PULLEY	1
2		FRICTION BOSS	1
3	N2FO	THREE WAY SOLENOID VALVE	1
4		ORIFICE GP30G	1
5		NUT	1
6		FRICTION PULLEY	1
7	N1LO	REVOLUTION SENSOR CABLE	1
8		FRICTION PULLEY	1
9		FRICTION BOSS	1
10		THREE WAY SOLENOID VALVE	1
11	N2LO	FRICTION PULLEY	1
12		FRICTION BOSS	1
13		MULTI-MONITOR	1
14	N3LO	REVOLUTION SENSOR CABLE	1
15		SOCKET SET SCREW	1
16		ORIFICE	1
17		FRICTION PULLEY	1
18		FRICTION BOSS	1
19		THREE WAY SOLENOID VALVE	1
20		THREE WAY SOLENOID VALVE	1
21		TEFLON TUBE	1
22		ELBOW CONNECTOR	4
23		LEVEL GAUGE	1
24		GEAR PUMP COMPLETE	1
25		SAFETY JOINT	1
26		NUT	1
27		AIR FILTER REGULATOR	1

Also, for the 16,000 hours overhaul, based on the overhaul experience of the same type of engine in Sierra Leone, it is assumed that spare parts of about 1.5 million USD will be required. The required parts and quantity will be changed depending on the condition of the engine.

（2）Procurement of tools and consumables

We have not received a reply from the manufacturer regarding the procurement of tools and consumables for 12,000 hours OH based on the results of 8,000 hours OH. From the OH results of the same type engine

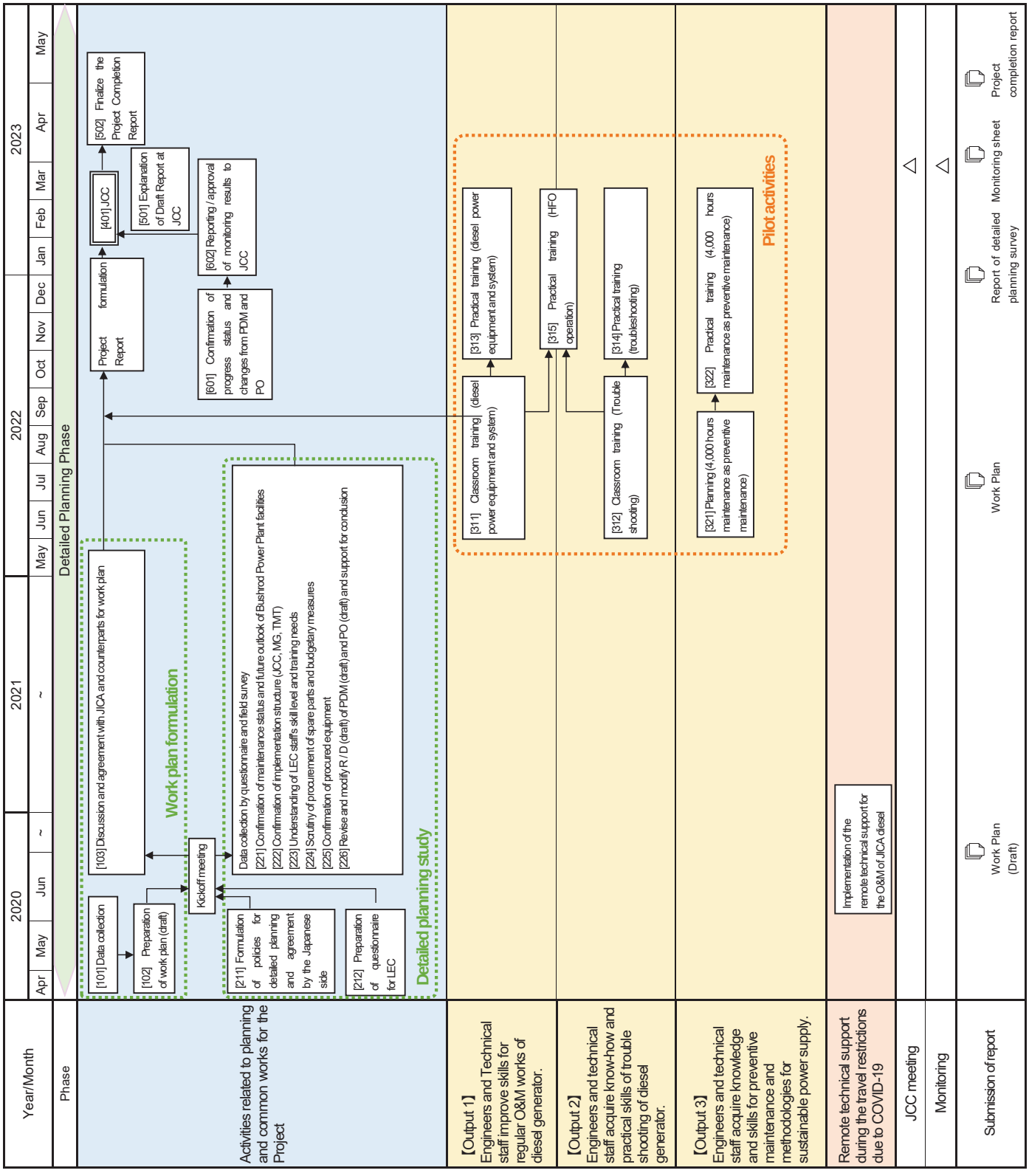
in Sierra Leone, it is assumed that the items shown in Table 3 will be required for 12,000 hours OH and 16,000 hours OH respectively. Although there are some fluctuations in items and quantities, the amount is expected to be around 40 thousand USD (excluding transportation costs).

Table 3 Tools and consumables list (draft)

No	Item	Qty
1	GRINDING STONE(WA60K) 6 pcs 3.5Months	6
2	GRINDING STONE(GC120H)	6
3	GRINDING WHEEL(INTAKE)	12
4	GRINDING WHEEL(EXHAUST)	12
5	CLEANER 420ML	60
6	PENETRANT 420ML	30
7	DEVELOPER 420ML	15
8	LAPPING COMPOUND #60 (CAUSE) 250G/CAN	8
9	LAPPING COMPOUND #120 (MEDIUM) 250G/CAN	4
10	LAPPING COMPOUND #240 (FINE) 250G/CAN	4
11	ROLL PAPER #120	8
12	ROLL PAPER #240	8
13	ROLL PAPER #400	8
14	SAND PAPER SHEET #60 50SHEETS/PACK	4
15	SAND PAPER SHEET #180 50SHEETS/PACK	4
16	SAND PAPER SHEET #400 50SHEETS/PACK	4
17	LOC TITE	8
18	LOCTITE #271 50CC/BOTTLE	8
19	THREE BOND #1211	80
20	THREE BOND #1521　150G	60
21	SWAN BOND #8000	4
22	MOLYKOTE G PASTE 2KG/CAN	6
23	SMOCON PASTE 1.5KG/CAN	6
24	RED LEAD COMPOUND (CONTACT CHECK PASTE)	6
25	METARON *M	25
26	GASKET SHEET T=1,1270X1270	3
27	GASKET SHEET T=2,1270X1270	3
28	MOTOR DRIVEN HYDRAULIC PUMP（AC230V)	2
29	WEIGHT MEASURE (SPRING TYPE) FOR V-BELT TENSION	2
30	PISTON RING COMPRESSORE FOR AIR COMPRESSOR	2
31	PISTON RING PLYER (L)	2
32	PISTON RING PLYER (S)	2
33	PLYER (SMALL & NEEDLE TYPE)	2
34	HEXAGON WRENCH SET (BALL POINT TYPE)	2
35	CALIPER 0-150MM	2
36	SCALE (FLAT) 0-150MM	4
37	FILLER (THICKNESS) GAUGE SET 0.04-0.30MM	4
38	MAGNET STAND (BASE)	4
39	BRUSH TB-2020 (METAL HANDLED BRUSH)	40
40	SCRAPER T45	8
41	SCRAPER BLADE 4PCS/PACK	4
42	EV SEAT EXTRACTOR	2
43	RING	2
44	EXTRACTING TOOL*EV	2
45	PIECE	2

5. Work Flow Chart

5. Work flow chart



6. Experts Dispatch Record

6. Experts Dispatch Record

First Site Activity (Preparation of Maintenance, Survey)

Name	In charge	Work Item	in-out
Kyoji FUJII	Chief Advisor / Technical Planning and Management	・Training Plan Discussion ・Courtesy call to Ministry ・Current Configuration Confirmation of Power Plant ・Electrical Facility Inspection	May 16, 2021 – July 11, 2021
Yoshiharu TAKAHASHI	Mechanical Engineer 2	・Current Configuration Confirmation of Power Plant ・Trouble Confirmation ・Spare Parts and Tools Inventory Work	May 16, 2021 – June 14, 2021
Mikiko IWAGO	Assistant Mechanical Engineer	Support of the work above	May 16, 2021 – July 11,2021

Second Site Activity (Pilot Activity: Classroom Training)

Name	In charge	Work Item	in-out
Hiromi NAKANO	Mechanical Engineer 3	・Classroom Training ・Tag System Training	June 19, 2022 – July 8, 2022
Tatsuhiro URABE	Technical Planning and Management Assistant	・Classroom Training ・Spare Parts and Tools Inventory Work	Same as above
Toshio OYAGI	Electrical Engineer	・Classroom Training	Online (June 20, 2022 – 24)
Mikiko IWAGO	Assistant Mechanical Engineer	・Classroom Training ・Procurement of Materials for Training ・Spare Parts and Tools Inventory Work	June 18, 2022 – July 3, 2022
Kenji SAKEMURA	Assistant Mechanical Engineer 2	・Classroom Training ・Tag System Training	June 19, 2022 – July 8, 2022

Third Site Activity (Pilot Activity: 8,000OH Maintenance Training)

Name	In Charge	Work item	in-out
Kyoji FUJII	Chief Advisor / Technical Planning and Management	・8,000 OH maintenance Kick-off Meeting ・OH Work item and Schedule Confirmation	August 4, 2022 – August 12, 2022
Noboru MATSUMURA	Mechanical Engineer	・OH Support	Remote work During OH period
Toshio OYAGI	Electrical Engineer	・OH Support	Same as above
Tatsuhiro URABE	Technical Planning and Management Assistant	・OH Instruction	August 4, 2022 – September 22, 2022
Mikiko IWAGO	Assistant Mechanical Engineer	・OH Instruction	September 17, 2022 – November 18, 2022

Third Site Activity (Pilot Activity: 2nd Classroom Training and JCC)

Name	In Charge	Work item	in-out
Kyoji FUJII	Chief Advisor / Technical Planning and Management	・JCC ・Summary of the project	March 4, 2023 – March 13,2023
Hiromi NAKANO	Mechanical Engineer 3	・2nd Classroom training	February 27, 2023 – March 13, 2023
Mikiko IWAGO	Assistant Mechanical Engineer	・2nd Classroom training ・JCC	February 28, 2023 – March 11, 2023
Atsushi KUBOTA	Assistant Mechanical Engineer 3	・2nd Classroom training	February 27, 2023 – March 13, 2023

7. Major Meeting Minutes

Liberia Electricity Company (LEC)			
Date & Time :	30th June, 2020 (18:00-20:00 JST)		
Location :	Skype Meeting		
Attendance from LEC			
Name	Title		
Terence John Richardson	Excutive Director / Generation		
Abu Dekontee Sanso Sr.	Director / Generation		
Doveflee Kollie	Thermal Plan Manager		
Emile Karngar Sr.	Mt. Coffee Hydro Plant Acting Manager		
Attendance from JICA HQ			
Name	Title	Sector	
Daisuke Iijima	JICA team leader, HQs		
Shunsuke Yamashita	JICA deputy team leader, HQs		
Attendance from JICA Liberia F/O			
Name	Title	Sector	
Akihira Sano			
Attendance from JICA Ghana Office			
Name	Title	Sector	
Masashi Yamamoto			
Attendance from the JICA Experts (YEC)			
Name	Title		
Kyoji Fujii	Chief Advisor / Technical Planning and Management		
Noboru Matsumura	Mechanical Engineer		
Toshio Oyagi	Electrical Engineer		
Tatsuhiro Urabe	Assistant Technical Planning		
Mikiko Iwago	Assistant Mechanical Engineer		
Alfred N. Suah (PMS)	Local Project Coordinator		
Documents presented by LEC			
	Name of Documents		Media
	-		
Documents submitted by the JICA Experts			
	Name of Documents		Media
(1)	Draft Work Plan		PPT
(2)	Draft Work Plan		PDF
Discussions content	1	Main Point	
	2	Current Management System of LEC under working remotely	
	3	Concerns	

	Discussion	**Action by**
1.	**Main Point**	
(1)	JICA, LEC and JICA experts confirmed that LEC needs to conduct 4,000 hours periodical maintenance as soon as possible. Although the maintenance has been postponed due to the global COVID-19 pandemic, we need to make some efforts to proceed with this project.	LEC, JICA, JICA experts
(2)	JICA and JICA experts told LEC that it seemed difficult to travel to Liberia for the time being due to the COVID-19 pandemic. The work schedule will be modified respond to the travel ban due to the COVID-19 pandemic. The experts assumed that the travel ban will be ended in the end of 2020 and we will be able to travel to Liberia in January 2021. Based on this assumption, the experts proposed to conduct first field survey in January 2021 and conduct 4,000 hours maintenance	LEC, JICA, JICA experts

	from April to June 2021. See the draft work plan for the details of tentative schedule.	
(3)	On the other hand, LEC recognized that two JICA diesel engines of this project have the highest reliability in the power generation facilities owned by Liberia. Therefore, LEC wanted to conduct the maintenance from September to October 2020 so that they can operate them during the dry season from November 2020. After the discussion with JICA and the experts, LEC understood that the above schedule was not realistic due to the fact that the experts cannot travel to Liberia due to the COVID-19 pandemic. However, considering the current power supply system in Liberia, LEC considered that it seemed difficult to supply the power to the area around Bushrod power plant from other generation facilities and conduct the maintenance during the dry season. Therefore, LEC proposed to implement the maintenance after middle of June when Mt. Coffee hydro power plant starts full operation even if the travel could be resumed in January 2021.	LEC
(4)	In Liberia, the construction of the international interconnection line called CLSG is underway as a new power supply means, but the expected commencement time has been significantly postponed to December 2020, and the further postponement is expected. If the construction of CLSG would be completed as planned in December 2020, the maintenance of the diesel engines will be possible during the dry season. However, if it will be delayed, the importance of diesel engine during the dry season becomes extremely high, which will be a major obstacle to people's lives because the large scaled load shedding will be required.	LEC
(5)	Regarding the operating time of the diesel engines at the present time, LEC confirmed 4,172 hours for unit 1 and 4,570 hours for unit 2. As a matter of fact, the operating time of both engines exceeds 4,000 hours. The experts told LEC as follows; - It is necessary to perform early maintenance from the viewpoint of preventive maintenance. - It is desirable to stop operation until the 4,000 hours maintenance is completed. - If it will be operated during the dry season, the risk of damage of the parts will be increased and additional spare parts may be needed accordingly. - The next maintenance will be conducted from the viewpoint of breakdown maintenance rather than preventive maintenance.	JICA experts, LEC
(6)	LEC recognized that they must take responsibility for procuring SVs, spare parts, consumables and tools. However, the financial situation of LEC has been severe for a long time, and it has been getting worse due to the COVID-19 pandemic. Therefore, the budget has not been secured at this point, and there is no prospect of the procurement. Regarding the spare parts fees and consumables/tools fees, LEC acknowledged that they already received the quotation and needed to pay 94,154 USD for the 4,000 hours maintenance. For that, LEC were willing to make an effort to incorporate it into the budget for next fiscal year. On the other hand, LEC recognized that World Bank (WB) and Millennium Challenge Corporation Liberia (MCC Liberia) intend to limit their support to the renewable energy field and there was no prospect of their support to thermal power generation field at this time.	LEC
(7)	JICA understood the LEC management situation and the power supply system in Liberia and proposed that JICA will bear the cost for SVs dispatching cost, spare parts fee and consumables/tools fee and ask the experts to supervise the procurement. LEC accepted the proposal and promised to submit a letter to JICA to request JICA financial	JICA

	support with their financial statement as evidence. Also, the letter will specify that LEC will be responsible for the procurement of all necessary things after the 4,000 hours maintenance.	
(8)	In addition, LEC and JICA requested the experts to consider the precautions and risks of continuing to operate the diesel engines more than 4,000 hours without periodical maintenance and support LEC remotely until the first field survey. The experts proposed LEC to have another meeting to discuss this matter and LEC responded that they will cooperate generously and make the engineers attend next meeting. Such remote technical cooperation will be considered.	LEC, JICA, JICA experts
(9)	The experts requested LEC to answer to the questionnaire which will be shared by the experts after this meeting.	LEC, JICA experts
2.	**Current Management System of LEC under working remotely**	
(1)	The management consultants hired under the management contract returned to each country due to the COVID-19 pandemic and currently work remotely. LEC local staffs and the management consultants have had meeting every day by using online tools and the local staffs have being making action every day. Mr. Richardson, Executive Director / Generation, has been working remotely from South Africa.	LEC
3.	**Concerns**	
(1)	Synchronizing operation problem of Generation are still critical issue in Liberia.	LEC
(2)	HFO purifier is always the biggest challenge for LEC even though the Bushrod power plant had reliable operation last year.	LEC
(3)	It's not good to operate the engines over 4,000 hours. LEC should pay attention to the exhaust gas temperature and the combustion valve. The contamination deposit will accumulate in the exhaust valve sheets and intake valve sheets, and then those valve sheets will have big damage.	JICA experts
	End of Minutes	
	Submitted by :	JICA Expert
	Approved by :	JICA Expert
	Date:	

Minutes of Joint Coordinating Committee Meeting	
Date and time	March 9th, 2023 10:30 am ~ 11:30 am (Liberian time)
Venue	Board room, Liberia Electricity Corporation
Attendees	Ministry of Mines and Energy Mr. Wilmot Thompson, Deputy Minister Liberia Electricity Corporation Mr. Monie Captan, Chairman of the Board, Acting CEO Mr. Adam S. Sheriff, Chief Financial Officer Engr. Doveflee E. Kollie, Senior Generation Manager Japan International Cooperation Agency (JICA) Mr. Nishikawa Hironori, Energy and Mining Group, JICA HQs Mr. Momita Yasuaki, JICA Ghana Office Mr. Nakamura, JICA Liberia Field Office JICA Expert Team Mr. Fujii Kyoji, Chief Advisor/ Power Development Planning Ms. Mikiko Iwago, Assistant Mechanical Engineer

Main Points Discussed

1. Opening remarks by CEO, LEC

- JICA (Niigata) generators are very reliable and have played a key role in LEC's power supply. LEC is very grateful to the Government of Japan and JICA.
- Recently, a large scale industrial customer requested LEC to supply power for them. They will buy electricity at higher price than the LEC's ordinary electricity tariff. With this circumstances, LEC will continue operating JICA generators and revenue from the industrial customer enables LEC to purchase spare parts for upcoming 12,000 and 16,000 hours overhaul.
- LEC has already achieved its commercial loss reduction target in the first quarter of 2023 to reduce the loss from 41% to 31%. LEC will set higher target for further reduction of the losses.
- Installation of electricity meters is the key element in reducing commercial losses. Even though the World Bank and other donors have assisted LEC to procure meters, LEC is still in short of meters and further assistance is necessary.

2. Presentation by JICA Expert Team

[CEO, LEC]

- LEC will implement proposed actions to be taken such as preparation of LEC's own manuals and keeping repair records and ledgers, etc.

Main Points Discussed
● LEC will incorporate the cost of spare parts for overhaul into its budget and tariff. LEC will obtain the quotation for spare parts as soon as possible to fix and avoid the escalation of the price. ● LEC's management understands the importance of digitalizing information on operation and maintenance of diesel power plants and sharing the information among related departments. **3. Overhaul training in Sierra Leone** [JICA HQs] ● Since April is the beginning of Japan's fiscal year, disbursement of fund is not possible at the beginning of April. Therefore, LEC's staffs will leave Liberia on April 10th and return at the beginning of June. [CEO, LEC] ● Who will bear the commuting cost from the accommodation to Kingtom Power Plant? [JICA HQs] ● JICA will pay daily allowance to LEC's staffs during their stay in Sierra Leone. The commuting cost shall be covered by the daily allowance. JICA will insure LEC's staffs from the date of departure to the date of return to Liberia. [CEO, LEC] ● What will be covered by the insurance? [JICA Liberia FO] ● Travel related accidents and medical expenses during the travel will be covered by the insurance according to the insurance policy in standard insurance package (not all expenses to be covered). [End]

8. Procurement Record

8. Procurement Record

The spare parts and tools shown below are provided to LEC through this project.

(1) Spare parts for 4,000 hours overhaul

No.	Description	Quantity	
	*CYLINDER HEAD		
1	GASKET FOR CYLI-NDER HEAD	32	pcs
	*TURBOCHARGER(TPL65-A10)		
2	SPARE PARTS KIT *1	4	pcs
3	SPARE PARTS KIT *2	4	pcs
	HEAVY FUEL OIL PURIFIER		
4	*O-RING	2	pcs
5	*DRAIN NOZZLE	4	pcs
6	*O-RING	2	pcs
7	*O-RING	2	pcs
8	*O-RING	2	pcs
9	*O-RING	2	pcs
10	*MAIN SEAL RING	2	pcs
11	*BUSH	2	pcs
12	*O-RING	8	pcs
13	*O-RING	8	pcs
14	*O-RING	4	pcs
15	*VALVE SHEET	4	pcs
16	*O-RING	4	pcs
17	*PACKING	2	pcs
18	*TONGUED WASHER	8	pcs
19	*O-RING	4	pcs
20	*PACKING	2	pcs
21	*SHEET PACKING	2	pcs
22	*O-RING	2	pcs
23	*O-RING	2	pcs
24	*SHEET PACKING	6	pcs
25	*SHEET PACKING	2	pcs
26	*SHEET PACKING	2	pcs
	LUBE OIL PURIFIER		
27	*O-RING	3	pcs
28	*DRAIN NOZZLE	6	pcs
29	*O-RING	3	pcs
30	*O-RING	3	pcs
31	*O-RING	3	pcs
32	*O-RING	3	pcs
33	*MAIN SEAL RING	3	pcs
34	*BUSH	3	pcs
35	*O-RING	12	pcs
36	*O-RING	12	pcs
37	*O-RING	6	pcs
38	*VALVE SHEET	6	pcs
39	*O-RING	6	pcs
40	*PACKING	3	pcs

41	*TONGUED WASHER	12	pcs
42	*O-RING	6	pcs
43	*PACKING	3	pcs
44	*SHEET PACKING	3	pcs
45	*O-RING	3	pcs
46	*O-RING	3	pcs
47	*SHEET PACKING	9	pcs
48	*SHEET PACKING	3	pcs
49	*SHEET PACKING	3	pcs

No.	Description	Quantity	
1	O-RING FOR L.O FILTER	2	pcs
2	SPRING FOR L.O FILTER	2	pcs
3	STEEL BALL FOR L.O FILTER	2	pcs
4	COUPLING BOLT,BUSH FOR H.F.O BOOSTER PUMP	8	pcs
5	GASKET FOR D.O. TRANSFER PUMP	2	pcs
6	GLAND PACKING FOR L.T. WATER CIRCULATING PUMP	1	pcs
7	OIL SEAL FOR L.T. WATER CIRCULATING PUMP	2	pcs
8	BALL BEARING FOR L.T. WATER CIRCULATING PUMP	2	pcs
9	COUPLING BOLT,BUSH FOR L.T. WATER CIRCULATING PUMP	8	pcs
10	1ST CRANK PIN METAL FOR AIR COMPRESSOR	2	pcs
11	V-BELT FOR AIR COMPRESSOR	5	pcs
12	O-RING FOR AIR COMPRESSOR	1	pcs
13	O-RING FOR AIR COMPRESSOR	1	pcs
14	COALESCER FOR 15PPM BILGE SEPARATOR	1	pcs
15	OIL SEAL FOR INCINERATOR UNIT	1	pcs
16	ATOMIZER FOR INCINERATOR	2	pcs
17	OIL SEAL 15357 FOR INCINERATOR UNIT	4	pcs
18	OIL SEAL 15327 FOR INCINERATOR UNIT	2	pcs
19	OIL SEAL 25408 FOR INCINERATOR UNIT	1	pcs
20	O-RING S63 FOR INCINERATOR UNIT	1	pcs
21	O-RING P18 FOR INCINERATOR UNIT	2	pcs
22	O-RING S53 FOR INCINERATOR UNIT	4	pcs
23	FUSE ELEMENT 5A FOR INCINERATOR UNIT(A FAC30X5A)	2	pcs
24	FUSE ELEMENT 10A FOR INCINERATOR UNIT(A FAC30X10A)	2	pcs
25	FUSE ELEMENT 20A FOR INCINERATOR UNIT(A FAC30X20A)	6	pcs
26	FUSE FOR MD-SX OIL MIST DETECTOR	2	pcs
27	MECHANICAL SEAL FOR D.O. BOOSTER PUMP	2	pcs
28	BALL BEARING FOR D.O. BOOSTER PUMP	2	pcs
29	O-RING FOR D.O. BOOSTER PUMP	2	pcs
30	GASKET FOR D.O. BOOSTER PUMP	4	pcs
31	COUPLING BOLT,BUSH FOR D.O. BOOSTER PUMP	8	pcs
32	MECHANICAL SEAL FOR F.O. DRAIN PUMP	1	pcs
33	BALL BEARING FOR F.O. DRAIN PUMP	1	pcs
34	GASKET FOR F.O. DRAIN PUMP	2	pcs
35	FELT RING FOR F.O. DRAIN PUMP	2	pcs
36	COUPLING BOLT,BUSH FOR F.O. DRAIN PUMP	4	pcs
37	PACKING FOR L.O. OIL COOLER	4	pcs
38	O-RING FOR L.O. OIL COOLER	4	pcs

(2) Tools and consumables for 4,000 hours overhaul

No.	Description	Quantity	
001	*GRINDING STONE(WA60K)	4	pcs
002	*GRINDING STONE(GC120H)	4	pcs
003	*GRINDING WHEEL(INTAKE)	4	pcs
004	*GRINDING WHEEL(EXHAUST)	4	pcs
005	*CLEANER 420ML	36	pcs
006	*PENETRANT 420ML	9	pcs
007	*DEVELOPER 420ML	9	pcs
008	*LAPPING COMPOUND #60 (CAUSE) 250G/CAN	6	pcs
009	*LAPPING COMPOUND #120 (MEDIUM) 250G/CAN	4	pcs
010	*LAPPING COMPOUND #240 (FINE) 250G/CAN	4	pcs
011	*ROLL PAPER #120 25MM X 36.5M	4	pcs
012	*ROLL PAPER #240 25MM X 36.5M	4	pcs
013	*ROLL PAPER #400 25MM X 36.5M	4	pcs
014	*SAND PAPER SHEET #60 230MM X 280MM 50SHEETS/PACK	4	pcs
015	*SAND PAPER SHEET #180 230MM X 280MM 50SHEETS/PACK	4	pcs
016	*SAND PAPER SHEET #400 230MM X 280MM 50SHEETS/PACK	4	pcs
017	*LOCTITE #271 50CC/BOTTLE	2	pcs
018	*THREE BOND #1211	25	pcs
019	*THREE BOND #1521	10	pcs
020	*SEAL END NO. 515 (250 G / TUBE)	2	pcs
021	*SWAN BOND * 8000	2	pcs
022	*RUSCOAT 1KG/CAN	2	pcs
023	*MOLYKOTE G PASTE 500G/CAN	2	pcs
024	*SMOCON PASTE 1.5KG/CAN	2	pcs
025	*RED LEAD COMPOUND (CONTACT CHECK PASTE)	2	pcs
026	*METARON * M (OIL REMOVING POWDER)	40	pcs
027	*PIKAL(METAL POLISHING MATERIAL)	20	pcs
028	*NIIGATA COAT *800 (1KG / CAN)	2	pcs
029	*ANTI-SEIZE LUBRICANT (300CC / 1 CAN)	2	pcs
030	*GASKET SHEET 1.27M X 1.27M X T=1	8	pcs
031	*GASKET SHEET 1.27M X 1.27M X T=2	4	pcs
032	*TAPE -339000-RD-00-50X25(ADHESIVE CLOTH TAPE: RED)	20	pcs
033	*SCRUBBING PAD 7447S/B(20PCS/BOX) #320	4	pcs
034	*SCRUBBING PAD 7448S/B(20PCS/BOX) #600	4	pcs
035	*PAINT MARKER- PX20.13 (PINK COLOR)	20	pcs
036	*BLUE SHEET FOR DISASSEMBLY AREA 0.9M X 100M	4	pcs
037	*PLASTIC ROLL (CURING MAT) 1.0M X 100M	6	pcs
038	*HAND GRINDING STONE (ROUGH) 150 X 50 X 25	4	pcs
039	*HAND GRINDING STONE (MEDIUM) 150 X 50 X 25	4	pcs
040	*HAND GRINDING STONE (SMOOTH) 150 X 50 X 25	4	pcs
041	*BACK UP RING LARGE(150) FOR HYDRAULIC JACK MAIN BEARING	20	pcs
042	*BACK UP RING SMALL (P70) FOR HYDRAULIC JACK MAIN BEARING	20	pcs
043	*O-RING (LARGE) FOR HYDRAULIC JACK MAIN BEARING	20	pcs
044	*O-RING (SMALL) FOR HYDRAULIC JACK MAIN BEARING	20	pcs
045	*BACK UP RING (LARGE) FOR CYLINDER HEAD HYDRAULIC JACK	20	pcs
046	*BACK UP RING (SMALL) FOR CYLINDER HEAD HYDRAULIC JACK	20	pcs
047	*O-RING (LARGE) FOR CYLINDER HEAD HYDRAULIC JACK	20	pcs
048	*O-RING (SMALL) FOR CYLINDER HEAD HYDRAULIC JACK	20	pcs
049	*BRUSH TB-2020 (METAL HANDLED BRUSH)	20	pcs
050	*SCRAPER T45	8	pcs

051	*SCRAPER BLADE 4PCS/PACK	4	pcs
052	*CHAIN BLOCK 0.5TON	4	pcs
053	*CHAIN BLOCK 1.0 TON	2	pcs
054	*WIRE ROPE 6MM X 4M	8	pcs
055	*WIRE ROPE 8MM X 4M	8	pcs
056	*WIRE ROPE 10MM X 4M	6	pcs
057	*NYLON STRING 25MM X 5M	6	pcs
058	*NYLON STRING 35MM X 5M	6	pcs
059	*NYLON STRING 50MM X 5M	6	pcs
060	*EYE BOLT M6	8	pcs
061	*EYE BOLT M8	8	pcs
062	*EYE BOLT M10	8	pcs
063	*EYE BOLT M12	8	pcs
064	*EYE BOLT M16	8	pcs
065	*EYE BOLT M20	4	pcs
066	*SHACKLE 11MM	4	pcs
067	*SHACKLE 13MM	4	pcs
068	*SHACKLE 16MM	4	pcs
069	*TAP SET (M8)	2	pcs
070	*TAP SET (M10)	2	pcs
071	*TAP SET (M12)	2	pcs
072	*TAP SET (M16)	2	pcs
073	*TAP (M20)	2	pcs
074	*HANDLE FOR TAP SMALL	2	pcs
075	*HANDLE FOR TAP MEDIUM	2	pcs
076	*HANDLE FOR TAP LARGE	2	pcs
077	*REMOVER/ EXTRACTOR SPIRAL (5 PCS/ 1 SET)	2	pcs
078	*REMOVER/ EXTRACTOR SQUARE (5 PCS/ 1 SET)	2	pcs
079	*DIES (M8)	2	pcs
080	*DIES (M10)	2	pcs
081	*DIES (M12)	2	pcs
082	*DIES (M16)	2	pcs
083	*DIES (M20)	2	pcs
084	*HANDLE (STOCK) FOR DIES 25	2	pcs
085	*HANDLE (STOCK) FOR DIES 38	2	pcs
086	*HANDLE (STOCK) FOR DIES 50	2	pcs
087	*EYE NUT M10	4	pcs
088	*EYE NUT M12	4	pcs
089	*EYE NUT M16	4	pcs
090	*AIR REEL (20M) AC-220	2	pcs
091	*AIR REEL (20M) LC-220	2	pcs
092	*SOCKET FOR HOSE 20SH	8	pcs
093	*PLUG FOR HOSE 20PH	8	pcs
094	*SOCKET FOR SET SCREW 20PM	8	pcs
095	*SOCKET FOR SET SCREW 20SM	8	pcs
096	*AIR DUSTER TD-50 LEVER TYPE WITH COUPLER PLUG	4	pcs
097	*COMBINATION SPANNER TCS-14S 14PCS/SET	2	pcs
098	*SCRAPER TS-203 Y DIAGONAL TYPE	8	pcs
099	*SPONGE HBNT-75E HYBRID NET SPONGE	40	pcs
100	*HAMMER PL-10 PLASTIC	2	pcs
101	*SINGLE RING SPANNER (CURVED) 24MM A	2	pcs
102	*SINGLE RING SPANNER (CURVED) 24MM B	2	pcs
103	*SINGLE RING SPANNER (CURVED) 30MM A	2	pcs

104	*SINGLE RING SPANNER (CURVED) 30MM B	2	pcs
105	*SPUD SPANNER (30MM) OFFSET TYPE	2	pcs
106	*SPUD SPANNER (30MM) RATCHET TYPE	2	pcs
107	*GEAR WRENCH (FLEXIBLE-CONBINATION TYPE) A	1	pcs
108	*GEAR WRENCH (FLEXIBLE-CONBINATION TYPE) B	1	pcs
109	*FLEX COMBI WRENCH A	1	pcs
110	*FLEX COMBI WRENCH B	1	pcs
111	*SOCKET 12 CORNRER TYPE A	1	pcs
112	*SOCKET 12 CORNRER TYPE B (DEEP)	1	pcs
113	*UNIVERSAL JOINT A	1	pcs
114	*UNIVERSAL JOINT B	1	pcs
115	*FLEXIBLE BALL JOINT A	1	pcs
116	*FLEXIBLE BALL JOINT B	1	pcs
117	*RATCHET HANDLE A	1	pcs
118	*RATCHET HANDLE B	1	pcs
119	*SPINNER HANDLE A	1	pcs
120	*SPINNER HANDLE B	1	pcs
121	*HYDRAULIC HOSE SET FOR HAND PUMP	1	pcs
122	*HYDRAULIC HOSE SET FOR DISTRIBUTOR	1	pcs
123	*TRANSFORMER A FOR VALVE GRINDER AC220V～240V/AC100V 3.0KVA	1	pcs
124	*TRANSFORMER B FOR VALVE GRINDER AC220V～240V/AC100V 1.5KVA	1	pcs
125	*SOCKET WRENCH SET	1	Pcs
126	*DEEP SOCKET (12PT) 19*83L	1	Pcs
127	*DEEP SOCKET (13PT) 24*83L	1	Pcs
128	*RATCHET HANDLE (FLEXIBLE HEAD)	1	Pcs
129	*RATCHET OFFSET WRENCH L=291 MM	1	Pcs
130	*DOUBLE-END RATCHET WRENCH (CLAW TYPE)	1	Pcs
131	*SINGLE RING WRENCH (OFFSET) 19*L215	1	Pcs
132	*SINGLE RING WRENCH (OFFSET) 24*L248	1	Pcs
133	*SINGLE RING WRENCH (OFFSET) 19*L207	1	Pcs
134	*SINGLE RING WRENCH (OFFSET) 24*L250	1	Pcs
135	*SINGLE OFFSET WRENCH (WITH PICK END) 19*L337	1	Pcs
136	*SINGLE OFFSET WRENCH (WITH PICK END) 24*L375	1	Pcs
137	*RATCHET SPINNER 12.7*L336	1	pcs

(3) Additional Spare parts for 8,000 hours overhaul

No	Description	Quantity	
	*PISTON		
001	COMPRESSION RING	32	pcs
002	COMPRESSION RING	32	pcs
003	COMPRESSION RING	32	pcs
004	OIL SCRAPER RING	32	pcs
	*A/C		
005	*TUBE CLEANING OF PIPES FOR A/C	2	pcs
006	*PLUG FOR PIPING OF A/C	80	pcs
007	*GASKET FOR A/C HEADER (1)	4	pcs
008	*GASKET FOR A/C HEADER (2)	4	pcs
009	*GASKET FOR A/C CASING	4	pcs

010	*O-RING FOR AIR COOLER	4	pcs
011	*GASKET FOR A/C FLANGE	8	pcs
012	*GASKET FOR FITTING JIG	4	pcs

No	Description	Quantity	
001	O-RING FOR LO PURIFIER	3	pcs
002	O-RING FOR LO PURIFIER	6	pcs
003	O-RING FOR LO PURIFIER	3	pcs
004	O-RING FOR LO PURIFIER	3	pcs
005	O-RING FOR LO PURIFIER	6	pcs
006	O-RING FOR LO PURIFIER	3	pcs
007	O-RING FOR LO PURIFIER	3	pcs
008	WASHER FOR LO PURIFIER	3	pcs
009	WASHER FOR LO PURIFIER	3	pcs
010	O-RING FOR LO PURIFIER	6	pcs
011	SPRING RETAINER FOR LO PURIFIER	18	pcs
012	SPRING FOR LO PURIFIER (6PCS/1SET)	3	sets
013	BEARING FOR LO PURIFIER	3	pcs
014	O-RING FOR LO PURIFIER	3	pcs
015	O-RING FOR LO PURIFIER	3	pcs
016	PLATE SPRING FOR LO PURIFIER	3	pcs
017	BEARING FOR LO PURIFIER	3	pcs
018	BALL BEARING FOR LO PURIFIER	3	pcs
019	SPRING RETAINER (LOWER) FOR LO PURIFIER	3	pcs
020	STEEL BALL FOR LO PURIFIER	3	pcs
021	COLLAR FOR LO PURIFIER	3	pcs
022	SPRING (LOWER) FOR LO PURIFIER	3	pcs
023	BOLT FOR LO PURIFIER	9	pcs
024	BEARING FOR LO PURIFIER	6	pcs
025	BEARNG NUT FOR LO PURIFIER	3	pcs
026	BEARING WASHER FOR LO PURIFIER	3	pcs
027	SNAP RING FOR LO PURIFIER	3	pcs
028	OIL SEAL FOR LO PURIFIER	3	pcs
029	O-RING FOR LO PURIFIER	3	pcs
030	COLLAR FOR LO PURIFIER	3	pcs
031	FRICTION CLUTCH FOR LO PURIFIER	18	pcs
032	O-RING FOR LO PURIFIER	3	pcs
033	OIL SEAL OR LO PURIFIER	3	pcs
034	COLLAR (2) FOR LO PURIFIER	3	pcs
035	O-RING FOR LO PURIFIER	3	pcs
036	OIL SEAL FOR LO PURIFIER	3	pcs
037	BUSH FOR LO PURIFIER	12	pcs
038	SAFETY CONNECTOR FOR LO PURIFIER	3	pcs
039	SHEET PACKING FOR LO PURIFIER	6	pcs
040	DIAPHRAGM ASS'Y FOR LO PURIFIER	15	pcs
041	PILOT SPRING FOR LO PURIFIER	15	pcs
042	PLUNGER FOR LO PURIFIER	15	pcs
043	PLUNGER SPRING FOR LO PURIFIER	15	pcs
044	O-RING FOR HFO PURIFIER	2	pcs
045	O-RING FOR HFO PURIFIER	4	pcs
046	O-RING FOR HFO PURIFIER	2	pcs
047	O-RING FOR HFO PURIFIER	2	pcs

048	O-RING FOR HFO PURIFIER	4	pcs
049	O-RING FOR HFO PURIFIER	2	pcs
050	O-RING FOR HFO PURIFIER	2	pcs
051	WAHER FOR HFO PURIFIER	2	pcs
052	NUT FOR HFO PURIFIER	2	pcs
053	O-RING FOR HFO PURIFIER	4	pcs
054	SPRING RETAINER (UPPER) FOR HFO PURIFIER	12	pcs
055	SPRING (UPPER) FOR HFO PURIFIER	2	pcs
056	BEARING FOR HFO PURIFIER	2	pcs
057	O-RING FOR HFO PURIFIER	2	pcs
058	O-RING FOR HFO PURIFIER	2	pcs
059	SPRING PLATE FOR HFO PURIFIER	2	pcs
060	BEAING FOR HFO PURIFIER	2	pcs
061	BALL BEARING FOR HFO PURIFIER	2	pcs
062	SPRING RETAINER (LOWER) FOR HFO PURIFIER	2	pcs
063	STEEL BALL FOR HFO PURIFIER	2	pcs
064	COLLAR FOR HFO PURIFIER	2	pcs
065	SPRING (LOWER) FOR HFO PURIFIER	2	pcs
066	BOLT FOR HFO PURIFIER	6	pcs
067	BARING FOR HFO PURIFIER	4	pcs
068	BEARING NUT FOR HFO PURIFIER	2	pcs
069	BEARING WASHER FOR HFO PURIFIER	2	pcs
070	SNAP RING FOR HFO PURIFIER	2	pcs
071	OIL SEAL FOR HFO PURIFIER	2	pcs
072	O-RING FOR HFO PURIFIER	2	pcs
073	COLLAR FOR HFO PURIFIER	2	pcs
074	FRICTION CLUTCH FOR HFO PURIFIER	8	pcs
075	O-RING FOR HFO PURIFIER	2	pcs
076	OIL SEAL FOR HFO PURIFIER	2	pcs
077	COLLAR FOR HFO PURIFIER	2	pcs
078	O-RING FOR HFO PURIFIER	2	pcs
079	OIL SEAL FOR HFO PURIFIER	2	pcs
080	BUSH FOR HFO PURIFIER	4	pcs
081	SAFETY JOINT FOR HFO PURIFIER	2	pcs
082	SHEET PACKING FOR HFO PURIFIER	4	pcs
083	BUSH FOR HFO PURIFIER	2	pcs
084	BUSH FOR HFO PURIFIER	2	pcs
085	DIAPHRAGM ASS'Y FOR HFO PURIFIER	10	pcs
086	PILOT SPRING FOR HFO PURIFIER	10	pcs
087	PLUNGER FOR HFO PURIFIER	10	pcs
088	PLUNGER SPRING FOR HFO PURIFIER	10	pcs
089	O-RING FOR STRAINER	10	pcs
090	STATER FOR SLUDGE PUMP	5	pcs
091	O-RING FOR SLUDGE PUMP G50	5	pcs
092	O-RING FOR SLUDGE PUMP DIA 23	20	pcs
093	O-RING FOR SLUDGE PUMP P16	5	pcs
094	PA SEALFOR SLUDGE PUMP	10	pcs

(4) Additional tools and consumables for 8,000 hours overhaul

Line	Description	Quantity	
001	*TORQUE WRENCH L=665	1	Pcs
002	*TORQUE WRENCH L=1390	1	Pcs

003	TOOL* MAIN BEARING METAL	1	Pcs
004	*EXTRACTOR FOR MAIN BEARING METAL	1	Pcs
005	*BAR FOR EXTRACTOR OF MAIN BEARING METAL	1	Pcs
006	*O-RING (10PCS/1PACK) FOR EXTRACTOR OF MAIN BEARING METAL	1	Pcs
007	*BAR FOR CRANK PIN BOLT (= SPANNER HANDLE)	1	Pcs
008	EXTRACTING TOOL* I, EV SPRING	1	Pcs
012	*BOLT (FOR FV TEST UNIT)	4	Pcs
013	*NOZZLE TESTER (FOR FV TEST UNIT)	1	Pcs
014	BRACKET	1	Pcs
015	PLATE	1	Pcs
016	*BOLT (FOR FIP ROLLER GUIDE EXTRACTOR)	1	Pcs
017	*STUD BOLT (FOR FIP ROLLER GUIDE EXTRACTOR)	4	Pcs
018	*NUT (FOR FIP ROLLER GUIDE EXTRACTOR)	4	Pcs
026	*IEV SEAT GRINDER	1	Pcs
027	*GRINDING STONE FOR IEV SEAT GRINDER	10	Pcs

*** Parts of A/C Jig***			
Line	Description	Quantity	
001	*A/C LEAKAGE TEST TOOLS BY AIR (SIMPLE)	2	Pcs
002	*1 TUBE CUTTER	2	Pcs
003	*2 TUBE REAMER	1	Pcs
004	*3 UNION A	4	Pcs
005	*4 UNION B	4	Pcs
006	*5 HALF UNION	12	Pcs
007	*6 COUPLER FEMALE	8	Pcs
008	*7 COUPLER MALE	8	Pcs
009	*8 NUT COUPLER FEMALE	8	Pcs
010	*9 NUT COUPLER MALE	8	Pcs
011	*10 STOP VALVE A	8	Pcs
012	*11 STOP VALVE B	8	Pcs
013	*12 NEEDLE VALVE	8	Pcs
014	*13 BRAIDED TUBE	2	Pcs
015	*14 UNION C	12	Pcs
016	*15 HALF UNION	12	Pcs
017	*16 BITE TYPE FITTING	8	Pcs
018	*17 COPPER PIPE	3	Pcs
019	*18 SEAL TAPE	15	Pcs
020	*19 AIR HOSE REEL	1	Pcs
021	*20 TEST PUMP FOR WATER PRESSURE	1	Pcs
022	*21 DRILL 3MM	2	Pcs
023	*22 DRILL 6MM	2	Pcs
024	*23 DRILL 8.2MM (PT/8)	2	Pcs
025	*24 DRILL 8.5MM (PS1/8)	2	Pcs
026	*25 DRILL 8.7MM (PF1/8)	2	Pcs
027	*26 DRILL 10MM	2	Pcs
028	*27 DRILL 11.0MM (PT1/4)	2	Pcs
029	*28 DRILL 11.5MM (PS1/4)	2	Pcs
030	*29 DRILL 11.7MM (PF1/4)	2	Pcs
031	*30 HOLE SAW 18 MM A	1	Pcs
032	*31 HOLE SAW 18 MM B	1	Pcs
033	*32 TAP PT1/8 A	2	Pcs
034	*33 TAP PS1/8	1	Pcs

035	*34 TAP PF1/8　B	1	Pcs
036	*35 TAP PT1/4	2	Pcs
037	*36 TAP PS1/4	1	Pcs
038	*37 TAP PF1/4	2	Pcs
039	*38 TAP HANDLE (SMALL)	1	Pcs
040	*39 TAP HANDLE (MIDDLE)	1	Pcs
041	*40 PRESSURE GAUGE　0-1.0MPA	3	Pcs
042	*41 COCK FOR GAUGE G1/4	3	Pcs
043	*42 SIPHON PIPE	2	Pcs
044	*43 BALL VALVE *FEMALE-FEMALE 1/4	4	Pcs
045	*44 BALL VALVE *FEMALE-MALE　1/4	4	Pcs
046	*45 BALL VALVE *MALE-MALE　1/4	4	Pcs
047	*47 NPPLE 8A*6A　1/4*1/8	7	Pcs
048	*48 THREE WAY JOINT A	5	Pcs
049	*49 THREE WAY JOINT B	5	Pcs
050	*50 THREE WAY JOINT C	5	Pcs
051	*51 NIPPLE R1/4	5	Pcs
052	*52 COUPLING SOCKET FOR HOSE	4	Pcs
053	*53 COUPLING PLUG FOR HOSE	4	Pcs
054	*54 FLANGE 5K-150A	2	Pcs

Additional Tools for 8000h OH		
No.	Description	Quantity
1	Cylinder Head Jig and Special Tool Fabrication	1
2	EV Seat Ring and Special Tool Fabrication	1

9. Remote Technical Support Record

9. Remote Technical Support Record

(1) September 2020

Data information from LEC and evaluation

Note; Maintenance intervals and inspection items are subject to change with engine running hours, maximum engine load, kind of fuel oil / lubrication oil to be used, frequency of engine starts / stops, kind of load such as low load and varying load, and quality of maintenance.

Legend: **LO:** Lubricating Oil, **FO**: Fuel Oil, **JW**: Jacket Water, **RA**: Rocker Arm **MCP**: Motor Control Panel **LECP**: Local Engine Control Panel **FIP**:Fuel Injection Pump

A: Good
B: Partially good
C: Bad

Fill up date and by

Date :
By :

Interval	No.	Items for maintenance and inspection work	Result	Remarks	Checking point
Daily check	1	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other	A		・In automatic position? ・Opening/ closing in normal position?
	2	Pressure of starting air receiver	A		・Within normal range of approx. 2.2 to 3.0MPa?
	3	Leakage on compressor air system (starting air receiver, LECP pressure regulator	B (1)	Pressure regulating valve repaired once/twice	・NO leakage?
	4	Volume/ level of cooling water (primally, secondary) in cooling towers, each expansion tanks, radiators and others	A		・Level=volume is normal? To be filled in proper level?
	5	Surrounding conditions of engine/ chimney/ control panel/ power distribution panel / battery panel/ MCP room and others	B (2)	Overhead light in engine room are all off and there are no DC lights in some areas during power outage	・NO oily, dirty and dusty? ・NO spilled liquid? ・NO abnormal smell?
	6	Condition of auto lube oil priming (if provided)	A	This is not matter for DG set but facility/ building	・Timer operation properly work? ・Confirm pressure establishment at LECP
	7	Insulation (worming) system working (automatic) (if provided)	A		Confirm jacket water temperature kept 15-30deg.C
Weekly check	1	Water leakage from the cooling water system	A	Fill up on correct/ suitable	Water leakage from pipes, each connecting portion and or equipment (tanks, coolers, pumps) itself, etc.?
	2	Tank and sump level — Water expansion tank	A		・Level is normal? To be filled in proper level? ・NO dirty? ・NO mix with water and or fuel oil? ・NO abnormal smell? (Lube oil with fuel oil?) ・NO abnormal vapor or mist?
		LO — Sump tank, oil pan	A		
		LO — Hydraulic governor/ actuator	A		
		LO — Turbocharger	B (3)	Continuous oil leaks from Turbocharger	
		LO — Air compressor	B (4)	Air leaks from high pressure valve	
		LO — Fuel injection pump (integrated type)	A	N/A	
		LO — Generator bearing	A		
		LO — Rocker arm lube oil tank (RA lubrication independent type)	A	N/A	
		FO — FO service tank, Buffer tank and Storage tank	A		
	3	Oil leakage from lube oil and fuel oil system	A		Oil leakage from pipes, each connecting portion and or equipment(tanks, coolers, pumps) itself, etc.?
	4	Air leakage from starting air system	B (5)	Continuous air leaks from compressor tank drain valve	Air leakage from pipes, each connecting portion and or equipment(tanks, LECP) itself, etc.?
	5	Drain discharge from starting air receiver and drain separator at LECP	B (6)		After discharge drain, compressed air must be charged to normal range.
	6	Drain discharge from miscellaneous equipment such as Air filter Fuel filter, and FO service tank, Buffer tank and Storage tank	A	Fill up details	After drain discharge, air vent must be carried out.
	7	Manual cleaning for FO and LO filter (auto clean type) if provided	A		Turn handle more than 2 revolution.
	8	Movement of fuel injection pump rack	A		Moving smoothly?

This had been reported on site visit Nov-2019

Please inform much more details of leakage point (start and wet/ accumulated)

Please inform much more details of leakage point

Data information from LEC and evaluation

Note; Maintenance intervals and inspection items are subject to change with engine running hours, maximum engine load, kind of fuel oil / lubrication oil to be used, frequency of engine starts / stops, kind of load such as low load and varying load, and quality of maintenance.

Legend: **LO:** Lubricating Oil, **FO**: Fuel Oil, **JW**: Jacket Water, **RA**: Rocker Arm **MCP**: Motor Control Panel **LECP**: Local Engine Control Panel **FIP**:Fuel Injection Pump

A: Good
B: Partially good
C: Bad

Fill up date and by

Date :
By :

Interval	No.	Items for maintenance and inspection work	Result	Remarks	Checking point
Weekly check	9	Tension of driving V-belt (cooling tower, radiator, air compressor, ventilation etc.)if provided	A		NO loose? Adjust tensions if loose. **Note: Motor CB should be off during checking!**
	10	Battery charger	A		Proper specific gravity, level of electrolyte and voltage?
Monthly check	1	Confirm good starting and running (No load for 5 to 10 minutes)	A		No abnormal heat and/or sound? All indication at EIP/ ECP shows normal?
	2	Looseness on connecting portions of driven equipment such as generator, air compressor, pump, etc..	A		Not looseness?
	3	Lube oil volume/ level/ flow on generator bearing	A		Check oil level by sight glass and flow sight. To be filled in proper level? To be adjusted needle screw or orifice.
	4	Oil leakage from generator bearings	A		NO oil leakage?
	5	Slip-ring and commutator condition if provided	A		NO surface rough, dusty, dirtiness and rusty?
	6	Tightening of bolts, nuts and foundation bolts / nuts for engines and auxiliary equipment	A		NO loose?
	7	Lubrication on starting air distributor, starting motor, fuel/governor linkage/lay shaft & FIP rack	A		Check volume and put clean grease and or oil.
	8	Cleaning of fuel oil filter	A		Handling for manual blow off
	9	Air vent of lube oil filter , lube oil cooler, lube oil heater (if provided)	A		Air vent/ breeding during lube oil priming.
	10	Cleaning of TC air filter (primary screen or fiber filter)	A		Depend on condition but every 3month regularly.
	11	Dirtiness of terminals of battery	A		Being clean?
Check before running	1	Conduct Daily, Weekly, Every 2weeks and Monthly action	A		NO abnormality?
	2	Lubrication to each valve gear (rocker arm) lubrication oil device	A		To lubricate with clean oil.
	3	Moving check and lubrication of fuel/governor linkage/ lay shaft & FIP rack	A		To confirm whether fuel/governor linkage/ lay shaft & FIP rack moves smoothly by operating a fuel handle.
	4	Indication of tachometer and pressure gauge	A 7	Fuel pressure gauges abnormal (not working)	NO abnormal?
	5	Indications of each thermometer	A		NO abnormal?
	6	Priming with lubricating oil	A		Pressure is established when lubrication oil priming pump runs with a pressure gauge at instrument panel ?
	7	Turning of flywheel	A		1.Open indicator cock. 2. Fuel handle on "STOP" position 3. To be done during lubrication oil priming pump operation.
	8	Air run	A		**・Turning gear/ apparatus must be disengaged !!** ・Confirm any abnormal discharge/ exhaust (water, fuel oil etc.). ・Close indicator cock after finished air run.
	9	Volume/ level of each water, fuel and lube oil	A		・Level=volume is normal? To be filled in proper level?

Replace with new

Data information from LEC and evaluation

Note; Maintenance intervals and inspection items are subject to change with engine running hours, maximum engine load, kind of fuel oil / lubrication oil to be used, frequency of engine starts / stops, kind of load such as low load and varying load, and quality of maintenance.

Legend: **LO:** Lubricating Oil, **FO**: Fuel Oil, **JW**: Jacket Water, **RA**: Rocker Arm **MCP**: Motor Control Panel **LECP**: Local Engine Control Panel **FIP**:Fuel Injection Pump

A: Good
B: Partially good
C: Bad

Fill up date and by

Date :
By :

Interval	No.	Items for maintenance and inspection work	Result	Remarks	Checking point
Check before running	10	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other handles	A		・In automatic position? ・Opening/ closing in normal operation position?
	11	Drain discharge from starting air receiver and drain separator at LECP	A		・Within range of 2.2 to 3.0MPa? ・Drain discharge from starting air receiver and drain separator. ・After discharge drain, compressed air must be charged to normal range.
	12	Confirmation of safety	A		・Fuel handle on "RUN/START" position. **・Nobody close to rotation portion!** **・Double check for turning gear/ apparatus must be disengaged !!**
Check during running	1	In the case of automatic start ･･･ Starting engine with test button. Remote start on GCP and Manual start at engine side	A		"Start" and No-load running to be done for 5 to 10 minutes.
	2	Condition of surroundings	A		NO leakage of water / oil / fuel/ air and exhaust gas?
	3	Condition of various piping systems	A		NO leakage of water / oil / fuel/ air and exhaust gas from connecting portion?
	4	Indication of pressure gauge and temperature	A		NO abnormal? Within normal range?
	5	Indication of tachometer	A		NO abnormal such as hunting?
	6	Exhaust gas color. Oil mist color and volume. Any abnormal smell	A		NO abnormality compared to usual and previous running?
	7	Vibration and noise	B 87	Vibration and a bit of smoke mostly on unit 1 when ever loaded at 4500KW. Sometime on Unit 2 also.	NO abnormality compared to usual and previous running?
	8	Indicator cock	A		NO leakage?
	9	Temperature of each bearings (main bearings and generator bearings)	A		NO abnormal?
	10	If running continuously, take all log data every 1-2hours	A		All parameter is normal?
Check after running	1	Stop status with remote stop button on LECP/GCP/ fuel handle/ lever operation	A		Reliable stopping?
	2	Pressure in starting air receiver	A		NO leakage?
	3	Check of battery	A		Proper specific gravity, level of electrolyte and voltage?
	4	Operation of battery charger	A		Battery to be equal charge followed by own operation manual.
	5	Drain discharge from starting air receiver	A		Check drain condition.
	6	Drain discharge from drain separator at LECP	A		Check drain condition.

・Please inform much more details with photo.
If smoke means from exhaust gas at chimney, FV nozzle tip may most suspected.
・If smoke means lagging at turbocharger around.
・Is it smoke can see only few hours or all the running time?

Smoke from lagging?

Exhaust gas color different?

Unit 1&2

Remarks; ・Inspection other than the above, interval shall be confirmed followed by instruction manual of each equipment.
・For the safety reasons and avoid from un-expected starting, following should be kept on stand by position.
*Main outlet valve of starting air receiver must be normally closed.
*Engine fuel handle(stop handle) shall be in stop position.

LOG DATA SHEET 1

Engine Type 16V28HLX
Engine No. Unit 1: 57671
Unit 2: 57672

TC:TPL65-A10(CA15/TA14)

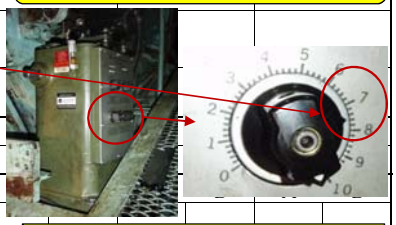
Date ; Fill up

			STD	Limit (Alarm/Trip)	Unit No.1	Unit No.2	Unit No.	Unit No.	Unit No.
Date			–	–	09.30.20	09.30.20			
Recorded Time		Hr.min	–	–	10:04-12:00	12:30-13:15			
Total running hour		Hrs	–	–	41-85	45-19			
Generator Output		kWe	(4,000-4,500)	5,500	4000	4000			
Load Ratio		%	80-90	110	80%	80%			
Frequency		Hz	50	47.5-52.5	50.0	50.0			
Engine Speed		min^{-1}	750	(775)	760	755			
Power Factor		—	80		0.90	0.90			
Generator eff.		%	96.5						
Fuel Oil Consumption		l/h	–	–	Actual	Actual			
Fuel Oil Consumption		kg/h	–	–	Actual	Actual			
Spec. Fuel Oil Consumption at 100% load		g/kW.h							
〃 converted ISO conditions (Gen terminal end)		g/kW.h	@100% 210.0						
Governor Load Indicator		–	8.0	10.0	10.0	10.0			
Fuel Handle Pointer		–	7.5	8.0	6.0	6.0			
Max. Combustion Pressure			@100%		A B	A B			
No. 1 Cyl.	No. 1 Cyl.	MPa	20.0						
No. 2 Cyl.	No. 2 Cyl.	MPa	20.0						
No. 3 Cyl.	No. 3 Cyl.	MPa	20.0						
No. 4 Cyl.	No. 4 Cyl.	MPa	20.0						
No. 5 Cyl.	No. 5 Cyl.	MPa	20.0						
No. 6 Cyl.	No. 6 Cyl.	MPa	20.0						
No. 7 Cyl.	No. 7 Cyl.	MPa	20.0						
No. 8 Cyl.	No. 8 Cyl.	MPa	20.0						
			Dev. Max. 0.7MPa						
Average		MPa							
Exhaust Gas Temperature					A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	℃		480	382 398	388 397			
No. 2 Cyl.	No. 2 Cyl.	℃		480	392 400	386 389			
No. 3 Cyl.	No. 3 Cyl.	℃		480	381 402	395 390			
No. 4 Cyl.	No. 4 Cyl.	℃		480	385 394	416 388			
No. 5 Cyl.	No. 5 Cyl.	℃		480	390 383	396 386			
No. 6 Cyl.	No. 6 Cyl.	℃		480	386 383	383 367			
No. 7 Cyl.	No. 7 Cyl.	℃		480	378 373	384 388			
No. 8 Cyl.	No. 8 Cyl.	℃		480	370 378	400 373			
				Dev. Max 60deg	22 29	32 30			
Average		℃			383 389	394 385			
Fuel Injection Pump Rack			@100%		A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	mm	31.0		29.0 29.0	26.0 27.0			
No. 2 Cyl.	No. 2 Cyl.	mm	31.0		28.0 28.0	27.0 27.0			
No. 3 Cyl.	No. 3 Cyl.	mm	31.0		28.0 29.0	26.0 27.0			
No. 4 Cyl.	No. 4 Cyl.	mm	31.0		27.0 28.0	26.0 27.0			
No. 5 Cyl.	No. 5 Cyl.	mm	31.0		27.0 28.0	26.0 27.0			
No. 6 Cyl.	No. 6 Cyl.	mm	31.0		27.0 29.0	25.0 27.0			
No. 7 Cyl.	No. 7 Cyl.	mm	31.0		27.0 28.0	25.0 26.0			
No. 8 Cyl.	No. 8 Cyl.	mm	31.0		26.0 28.0	26.0 26.0			
				Dev. Max. 3mm	3.0 1.0	2.0 1.0			
Average		mm			24.7 25.3	23.2 23.9			
Jacket Water									
Pressure (Eng. Inlet)		MPa	0.2-0.3	0.10	0.250	0.250			
Temperature (Eng. Inlet)		℃							
Temperature (Eng. Outlet)		℃	80-90	95/100	79.0	79.0			
Cooler Cooling Water			0.15-0.25						
Press. (Eng. Inlet)		MPa		0.05	0.180	0.180			
Temp. (Charge A/C Inlet)		℃		49	32.0	33.0			
Temp. (L.O. Cooler Inlet)		℃			68.0	70.0			
Temp. (L.O. Cooler Outlet)		℃			49.0	50.0			
Temp. (J.W. Cooler Inlet)		℃			40.0	39.0			
Temp. (J.W. Cooler Outlet)		℃			50.0	50.0			

Tachometer

A little bit bigger error than Unit No.2. . Follow up

Min 10min duration and use hydrometer which had benn hand over on Nov-2019.



Please fill up with load indicator. Due to this is load limit point.

This is reference photo for understanding load indicator shows not 10 but 7.6 only by

Please fill up on next report on Oct-2020.

On Unit 1 A8 cylinder: FIP rack deviation is bigger but exh. gas temp. deviation is normal range. Follow up for any development on next report on

Please fill on CW temp. at LOC inlet. This is LO temp. at LOC inlet.

This is some different with commissioning test data. Please check each location of

LOG DATA SHEET 2

(2/2)

Engine Type 16V28HLX
Engine No. Unit 1: 57671
Unit 2: 57672

TC:TPL65-A10(CA15/TA14)

Date ; Fill up

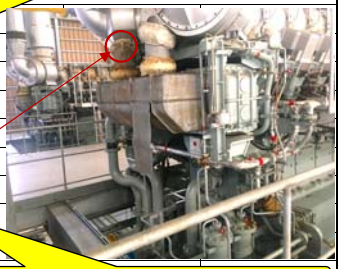
			STD	Limit	Unit No.		Unit No.		Unit No.		Unit No.	
Date							09.30.20					
Recorded Time		Hr.mi					13:20-14:00					
Total running hour		Hrs					45-21					
Generator Output		kWe	(4,000-4,500)	5,500	4000		4000					
Load Ratio		%	80-90	110	80%		80%					
Lubricating Oil												
Pressure (Main Bearing)		MPa	0.5-0.6	0.45/0.40	0.500		0.510					
Temperature(Cooler Inlet)		℃			68.0		70.0					
Temperature(Cooler Outlet)		℃			49.0		50.0					
Temperature(Eng. Inlet)		℃	50-60	65/70	57.0		54.0					
Temperature(Eng. Outlet)		℃			50.0		50.0					
Fuel Oil Pressure		MPa	0.3-0.6	0.25	faulty meter		faulty meter					
Fuel Oil Temperature		℃		(HFO 150)	52.0		49.0					
Turbo Charger					A	B	A	B	A	B	A	B
Charge Air Pressure		MPa	(0.23)		0.150		0.140					
T/C Oil Pressure		MPa	0.18-0.25	0.13/0.11	0.10?	0.18	0.15	0.14				
Speed		min^{-1}		30,180	23000	24000	23000	24000				
Exhaust gas Temperature	(T/C Inlet)	℃		650	500	519	524	518				
	(T/C Outlet)	℃			378	388	394	393				
Air Temperature	(Air Filter Inlet)	℃	20-40	40								
	(A/C Inlet)	℃										
	(A/C Outlet)	℃		60								
	(Engine inlet)	℃		60	62.0		63.0					
AC efficiency		%	80-90	60-70								
Back Pressure		mmAq		200	N/A	N/A	N/A	N/A				
Intake air press diff		mmAq		50								
Main Bearing Temperature			Alarm 95 & Trip100deg.C									
Thrust		℃	20	-	62		62					
No.1	No.6	℃	20	20	79	80	76	80				
No.2	No.7	℃	20	20	80	83	80	78				
No.3	No.8	℃	20	20	81	78	81	80				
No.4	No.9	℃	20	20	82	81	81	76				
No.5	No.10	℃	20	20	82		80					
Generator			@100%									
Voltage		V	6,600		6600		6600					
Current	(R)	A	547		380		360					
	(S)	A	547		390		360					
	(T)	A	547		400		380					
Excitation Voltage		V	39～40.7		30		30					
Excitation Current		A	5.6		4.5		4.5					
Stator Coil Temp.	(U)	℃			64		66					
	(V)	℃			63		66					
	(W)	℃			64		67					
Frame Temperature		℃			--		--					
Air Temperature	(Inlet)	℃			--		--					
	(Outlet)	℃			--		--					
Bearing Lube Oil. Pressure		MPa	-		--		--					
Bearing Lube Oil. Temp. (Inlet)		℃	-		--		--					
Bearing Temperature	Coupling side	℃			52		60					
	Opposite Coupling side	℃			54.0		58.0					
Barometric Pressure		hPa			N/A		N/A					
Humidity		%		88	N/A		N/A					
Room Temperature		℃	28	20-40	N/A		N/A					
Ambient temp.		℃	28	20-40	N/A		N/A					

0.50MPa is lower. Follow up for any development on next report on Oct-2020.

What is this temp.?

Please take data on fuel oil filter outlet instead

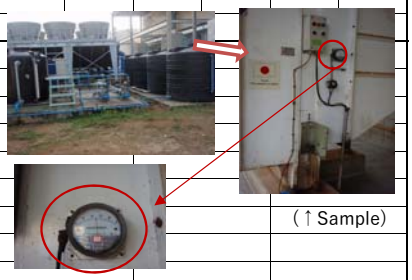
Pressure looks lower. Follow up for any development on next report on Oct-2020.
Also LO press TC A-bank on Unit 1 is



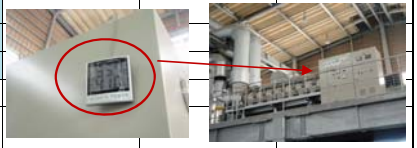
Please fill up on next report on Oct-2020

Calculation by temp. of CW at AC inlet , Air temp at AC inlet/ outlet accordingly

Please fill up on next report on Oct-2020 attached with oil bath intake air filter ↓



(↑Sample)



↑See digital hang on indication at LECP on site and fill up on next report on Oct-2020.

＊ A/C ･･･ Air Cooler J.W ･･･ Engine Jacket Water L.O. ･･･ Lubricating Oil
＊ Fuel oil consumption above shows figure converted to calorific value of 42700kL/kg also reduced injection pump & injection nozzle drain volume.
＊ Exhaust gas temperature are measured by mercury thermometer.

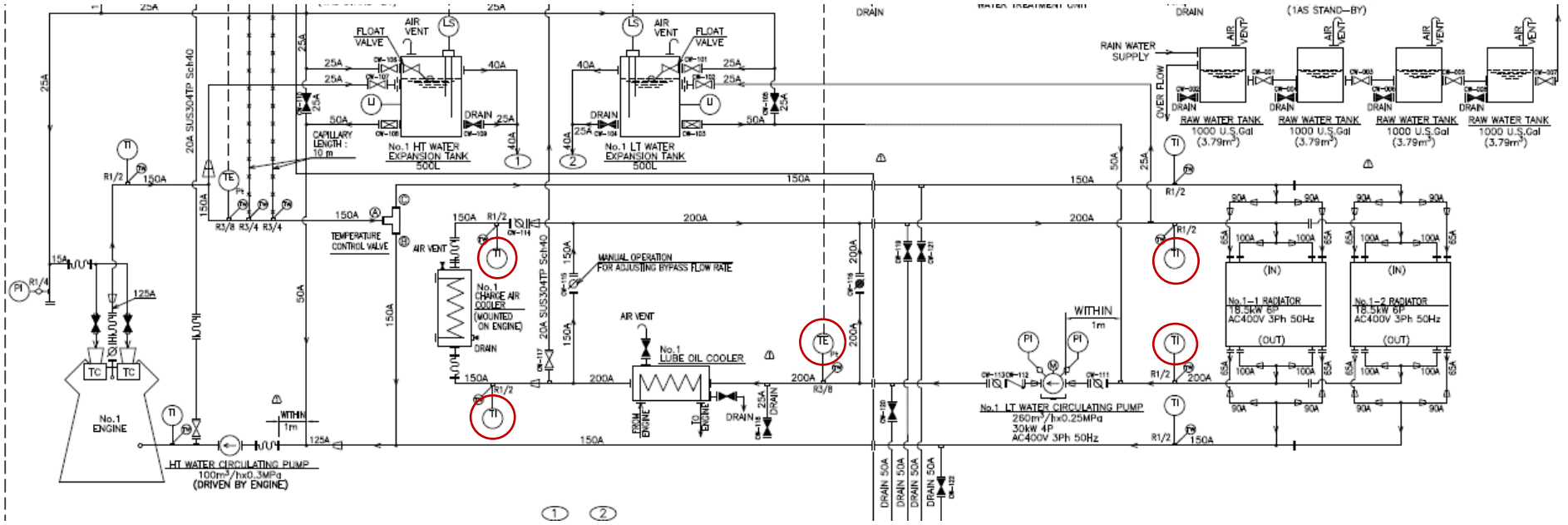
Evaluation list from data 30-Sep-2020 on LEC Unit 1&2

(DGの呼び名をUnit 1, Unit 2にしました。)

	Description	Action/ remedy	Date done and result
1. Check sheet			
NO date on log sheet		Please fill up date	
Collection missing , correct wrong data,		Please fill up and corrected	
List from condition B: Partially good		-	
①	Daily -3: Air leakage pressure regulating valve at LECP	This had been reported on Nov-2019 on site visit report.	
②	Daily-5: Overhead light	これは設備の事ですのでIPS所掌外になります。	
③	Weekly-2: Turbocharger: LO leaks	This is place to Item 3 for oil leakage. And please inform much more details such as same or bigger since it had been reported on Nov.-2019.	
④	Weekly-2: Air compressor: Air leaks from high pressure valve	This is place to item 4 for air leakage. Please inform more details of leakage point with photo.	
⑤	Weekly-4: Air leaks from compressor tank drain valve	Same as above.	
⑥	Weekly-5 ?????	NO written. Please describe details.	
⑦	Before running-4: Fuel pressure gauge abnormal (not working).	Replace with new （not workingとの事から、あえてLECP内のダンパー調整は表現していません）	
⑧	During running-7: Vibration and bit of smoke	Please inform much more details smoke on where? Lagging on TC or exhaust gas color? How long dose it performed all the running time or higher load period?	
2. Log data			
	Engine speed: DG1 760min-1/ DG2 755min-1	A little bit bigger error than Unit No.2. . Follow up for any development on next report on Oct-2020.	
	Fuel consumption l/h: NO data	Min 10min duration and use hydrometer which had been hand over on Nov.-2020.	
	Fuel consumption kg/h: NO data	-ditto-	
	Governor Load Indicator: 10.0	Please fill up with load indicator. Due to this is load limit point.	

Evaluation list from data 30-Sep-2020 Page 2/4

	Description	Action/ remedy	Date done
	Max. Combustion Pressure: NO data	Please fill up on next report on Oct-2020.	
	Fuel Injection Pump Rack deviation: Unit 1 A8 cylinder max 3.0mm (deviation max は2.0ではなく3.0㎜が正でしたので訂正しました)	FIP rack deviation is bigger but exh. gas temp. deviation is normal range. Follow up for any development on next report on Oct-2020.	
	Cooling water temperature: Data wrong?	This is some different with commissioning test data. Please check each location of thermometer on piping diagram below.	
	① Temp. (Charge A/C Inlet)	Indicate position on piping diagram below	
	② Temp. (Charge A/C Outlet)	Indicate position on piping diagram below	
	③ Temp. (L.O. Cooler Inlet)	Indicate position on piping diagram below	
	④ Temp. (L.O. Cooler Outlet)	Indicate position on piping diagram below	
	⑤ Temp. (J.W. Cooler Inlet)	Indicate position on piping diagram below	
	⑥ Temp. (J.W. Cooler Outlet)	Indicate position on piping diagram below	



Evaluation list from data 30-Sep-2020 on LEC Unit 1&2

	Description	Action/ remedy	Date done
	Lube oil pressure eng.. Inlet: 0.50MPa is lower	Follow up for any development on next report on Oct-2020.	
	Lube oil temperature (Engine Outlet): 50deg.C ?	Explain position on thermometer.	
	Fuel oil pressure: faulty meter	Please take data on fuel oil filter outlet instead	
	Turbocharger: Lube oil pressure is lower. Particulary Unit 1 A-bank.	Please check again and follow up for any development on next report on Oct-2020.	
	Turbocharger: Charge air press is lower	Follow up for any development on next report on Oct-2020.	
	Air temp at AC inlet: NO data	Please fill up on next report on Oct-2020. So that auto calculation by temp. of CW at AC inlet , Air temp at AC inlet/ outlet accordingly.	
	Intake air press diff at oil bath air intake filter: NO data	Please fill up on next report on Oct-2020 attached with oil bath intake air filter	
	Humidity and room temperature: NO data	See digital hang on indication at LECP on site and fill up on next report on Oct-2020.	
3	Site engine data evaluation table:		
	Main bearing temperature may it be +2deg by site commissioning data 75%/100%. It is similar with shop test data which means own characteristic. And follow up for any development on next report on Oct-2020.		
	Charge air pressure on Jul. and Sep. 2020 is similar and still slightly lower than site commissioning data. And follow up for any development on next report on Oct-2020.		
	Turbo charger speed on Jul. and Sep. 2021 is similar and still slightly higher than site commissioning data. And follow up for any development on next report on Oct-2020.		
	Exhaust gas temperature at cylinder outlet is 386/ 390deg C on 80% which is +39/49 than site commissioning data. May it be 413/ 422deg C on 100% which is +27/30 deg by site commissioning data 75%/100%. They are increasing due to efficiency down by contamination and or combustion?		
	Governor load indication reading is wrong. Please correct on next report on Oct-2020.		

Evaluation list from data 30-Sep-2020 on LEC Unit 1&2

4. General comment

Check sheet:

Generally impressed normal and no serious problem except some smoke and vibration. Please inform much more details smoke on where? Lagging on TC or exhaust gas color? How long dose it performed all the running time or higher load period?

Log data:

Generally shows normal but some value/ data are collection missing , correct wrong data. Please fill up and correct on next report on Oct-2020.

Some data/value is lower and follow up for any development on next report on Oct-2020.

Site engine data evaluation table:

It is comparison table between shop test, commissioning and site data. Some are little bit lower and or higher. Please follow up for any development on next report on Oct-2020.

-End-

(2) October 2020

Check list (Stand-by / Normal operation)

Note; Maintenance intervals and inspection items are subject to change with engine running hours, maximum engine load, kind of fuel oil / lubrication oil to be used, frequency of engine starts / stops, kind of load such as low load and varying load, and quality of maintenance.

Legend: **LO:** Lubrication Oil, **FO**: Fuel Oil, **JW**: Jacket Water, **RA**:Rocker Arm **MCP**: Motor Control Panel **EIP**:Engine Instrument Panel **ECP**:Engine Control Panel, **FIP**:Fuel Injection Pump

A: Good
B: Partially good
C: Bad

Date : 10/23/2020
By : Jordan V. Jannell & Aron Juloto

Interval	No.	Items for maintenance and inspection work	Result	Remarks	Checking point	
Daily check	1	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other handles	A		・In automatic position? ・Opening/ closing in normal position?	
	2	Pressure of starting air receiver	A		・Within normal range of approx. 2.2 to 3.0MPa?	
	3	Leakage on compressor air system (starting air receiver, EIP/ECP pressure regulator	A		・NO leakage?	Solved leakage? How did it?
	4	Volume/ level of cooling water (primally, secondary) in cooling towers, each expansion tanks, radiators and others	A		・Level=volume is normal? To be filled in proper level?	
	5	Surrounding conditions of engine/ chimney/ control panel/ power distribution panel / battery panel/ MCP room and others	A	Except for the somkey condition on unit 1 when loaded @ 4500KW and oil Leaks from Turbocharger	・NO oily, dirty and dusty? ・NO spilled liquid? ・NO abnormal smell?	Please inform details on leakage condition/ point with photo. Also how is smokey such as duration, smell, mist and no problem for fire accident?
	6	Condition pf auto lube oil priming (if provided)	A		・Timer operation properly work? ・Confirm pressure establishment at EIP/ECP	
	7	Insulation (worming) system working (automatic) (if provided)	A		Confirm jacket water temperature kept 15-30deg.C	
Weekly check	1	Water leakage from the cooling water system	A		Water leakage from pipes, each connecting portion and or equipment(tanks, coolers, pumps) itself, etc.?	
	2	Tank and sump level — LO: Water expansion tank	A		・Level is normal? To be filled in proper level? ・NO dirty? ・NO mix with water and or fuel oil? ・NO abnormal smell? (Lube oil with fuel oil?) ・NO abnormal vapor or mist?	 samle photo
		LO: Sump tank, oil pan	A			
		LO: Hydraulic governor/ actuator	A			
		LO: Turbocharger	A			
		LO: Air compressor	A			
		LO: Fuel injection pump (integrated type)	A			
		LO: Generator bearing	A			
		LO: Rocker arm lube oil tank (RA lubrication independent type)	A			
		FO: FO service tank, Buffer tank and Storage tank	A			
	3	Oil leakage from lube oil and fuel oil system	B	Continous oil leaks from Turbocharger pipes flanges. Require special tools for proper tightening	Oil leakage from pipes, each connecting portion and or equipment(tanks, coolers, pumps) itself, etc.?	Please inform us what kind of special tools are required in addition
	4	Air leakage from starting air system	B	Air leaks from High pressure valve	Air leakage from pipes, each connecting portion and or equipment (tanks, LECP/ECP) itself, etc.?	Please point actual valve with photo
	5	Drain discharge from starting air receiver and drain separator at EIP/ ECP	B	A	After discharge drain, compressed air must be charged to normal range.	Somewhere on this photo ?

Check list (Stand-by / Normal operation)

	6	Drain discharge from miscellaneous equipment such as air filter fuel filter, and FO service tank, Buffer tank and Storage tank	A		After drain discharge, air vent must be carried out.	
	7	Manual cleaning for FO and LO filter (auto clean type) if provided	A		Turn handle more than 2 revolution.	
	8	Movement of fuel injection pump rack	A		Moving smoothly?	
Weekly check	9	Tension of driving V-belt (cooling tower, radiator, air compressor, ventilation etc.)if provided	A		NO loose? Adjust tensions if loose. **Note: Motor CB should be off during checking!**	
	10	Battery charger	A		Proper specific gravity, level of electrolyte and voltage?	
Monthly check	1	Confirm good starting and running (No load for 5 to 10 minutes)	A		No abnormal heat and/or sound? All indication at EIP/ ECP shows normal?	
	2	Looseness on connecting portions of driven equipment such as generator, air compressor, pump, etc..	A		Not looseness?	
	3	Lube oil volume/ level/ flow on generator bearing	A		Check oil level by sight glass and flow sight. To be filled in proper level? To be adjusted needle screw or orifice.	
	4	Oil leakage from generator bearings	A		NO oil leakage?	
	5	Slip-ring and commutator condition of	A		NO surface rough, dusty, dirtiness and rusty?	
	6	Tightening of bolts, nuts and foundation bolts / nuts for engines and auxiliary equipment	A		NO loose?	
	7	Lubrication on starting air distributor, starting motor, fuel/governor linkage/lay shaft & FIP rack	A		Check volume and put clean grease and or oil.	
	8	Cleaning of fuel oil filter	A		Handling for manual blow off	
	9	Air vent of lube oil filter , lube oil cooler, lube oil heater (if provided)	A		Air vent/ breeding during lube oil priming.	
	10	Cleaning of TC air filter (primary screen or fiber filter)	A		Depend on condition but every 3month regularly.	
	11	Dirtiness of terminals of battery	A		Being clean?	
Check before running	1	Conduct Daily, Weekly, Every 2weeks and Monthly action	A		NO abnormality?	
	2	Lubrication to each valve gear (rocker arm) lubrication oil device	A		To lubricate with clean oil.	
	3	Moving check and lubrication of fuel/governor linkage/ lay shaft & FIP rack	A		To confirm whether fuel/governor linkage/ lay shaft & FIP rack moves smoothly by operating a fuel handle.	
	4	Indication of tachometer and pressure gauge	C	To be replace on both units. Currently taking readings from fuel primaray filters.	NO abnormal?	Please purchace genuine parts
	5	Indications of each thermometer	B	Some are not indicating readings (Air Cooler, etc)	NO abnormal?	Please purchace genuine parts
	6	Priming with lubricating oil	A		Pressure is established when lubrication oil priming pump runs with a pressure gauge at instrument panel ?	
	7	Turning of flywheel	A		1.Open indicator cock. 2. Fuel handle on "STOP" position 3. To be done during lubrication oil priming pump operation.	

sample photo

Check list (Stand-by / Normal operation)

	8	Air run	A		・**Turning gear/ apparatus must be disengaged !!** ・Confirm any abnormal discharge/ exhaust (water, fuel oil etc.). Close indicator cock after finished air run.	
	9	Volume/ level of each water, fuel and lube oil	A		・Level=volume is normal? To be filled in proper level?	
Check before running	10	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other handles	A		・In automatic position? ・Opening/ closing in normal operation position?	
	11	Drain discharge from starting air receiver and drain separator at EIP/ ECP	A		・Within range of 2.2 to 3.0MPa? ・Drain discharge from starting air receiver and drain separator. ・After discharge drain, compressed air must be charged to normal range.	
	12	Confirmation of safety	A		・Fuel handle on "RUN/START" position. **・Nobody close to rotation portion!** **・Double check for turning gear/ apparatus must be disengaged !!**	
Check during running	1	In the case of automatic start ・・・ Starting engine with test button. Remote start on GCP and Manual start at engine side	A		"Start" and No-load running to be done for 5 to 10 minutes.	
	2	Condition of surroundings	A		NO leakage of water / oil / fuel/ air and exhaust gas?	
	3	Condition of various piping systems	A		NO leakage of water / oil / fuel/ air and exhaust gas from connecting portion?	
	4	Indication of pressure gauge and temperature	A		NO abnormal? Within normal range?	
	5	Indication of tachometer	A		NO abnormal such as hunting?	
	6	Exhaust gas color. Oil mist color and volume	A		NO abnormality compared to usual and previous running?	
	7	Vibration and noise	B	Vibration and a bit of smoke mostly on unit 1 when ever loaded at 4500KW. Sometime on Unit 2 also. So we currently running and maintening the load @ 4000KW (please see attached photos.	NO abnormality compared to usual and previous running?	**Please show mentioned portion by photos. Also measure vibration with meter which supplied and used on commissioning test. If poosible with short movie/ sound.** **Please check tightening of all installation bolts/ nuts accordingly.** **Follow up above comment of Daily check-5 accordingly.**
	8	Indicator cock	A		NO leakage?	
	9	Temperature of each bearings (main bearings and generator bearings)	A		NO abnormal?	
	10	If running continuously, take all log data every 1-2hours	A	Log data are taken on every hour	All parameter is normal?	
Check after running	1	Stop status with remote stop button on EIP/ECP/GCP/ fuel handle/ lever operation	A		Reliable stopping?	
	2	Pressure in starting air receiver	A		NO leakage?	
	3	Check of battery	A		Proper specific gravity, level of electrolyte and voltage?	
	4	Operation of battery charger	A		Battery to be equal charge followed by own operation manual.	
	5	Drain discharge from starting air receiver	A		Check drain condition.	

Check list (Stand-by / Normal operation)

	6	Drain discharge from drain separator at EIP/ ECP	A		Check drain condition.

Remarks; ・Inspection other than the above, interval shall be confirmed followed by instruction manual of each equipment.
・For the safety reasons and avoid from un-expected starting, following should be kept on stand by position.
*Main outlet valve of starting air receiver must be normally closed.
*Engine fuel handle(stop handle) shall be in stop position.

LOG DATA SHEET 1

(10/23)

Engine Type 16V28HLX
Engine No. JICA 1: 57671
JICA 2: 57672

TC:TPL65-A10(CA15/TA14) Date ; 2020/10/23

			STD	Limit	Unit No.1	Unit No.2	Unit No.1	Unit No.2	Unit No.
Date			–	–	10.28.20	10.23.20	09.30.20	09.30.20	
Recorded Time		Hr.min	–	–	13:00–14:20	13:00–16:00	10:04–12:00	12:30–13:15	
Total running hour		Hrs	–	–	41–89	45–22	41–85	45–19	
Generator Output		kWe	4,000–4,500	5,500	4000	4000	4000	4000	
Load Ratio		%	80–90	110	80%	80%	80%	80%	
Frequency		Hz	50	51	50.0	50.0	50.0	50.0	
Engine Speed ①		min^{-1}	750	775	760	760	760	755	
Power Factor		—	80		0.90	0.90		0.90	
Generator eff.		%	96.5						
Fuel Oil Consumption ②		l/h	–	–	#REF!	#REF!			
Fuel Oil Consumption		kg/h	–	–	#REF!	#REF!			
Spec. Fuel Oil Consumption at 100% load		g/kW.h			#REF!	#REF!	–		
〃 converted ISO conditions (Gen terminal end)		g/kW.h	@100% 210.0				–		
Governor Load Indicator		–	8.0	10.0	8.2	7.8	10.0	10.0	
Fuel Handle Pointer		–	7.5	8.0	6.5	6.0	6.0	6.0	
Max. Combustion Pressure ③			@100%		A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	MPa	20.0						
No. 2 Cyl.	No. 2 Cyl.	MPa	20.0						
No. 3 Cyl.	No. 3 Cyl.	MPa	20.0						
No. 4 Cyl.	No. 4 Cyl.	MPa	20.0						
No. 5 Cyl.	No. 5 Cyl.	MPa	20.0						
No. 6 Cyl.	No. 6 Cyl.	MPa	20.0						
No. 7 Cyl.	No. 7 Cyl.	MPa	20.0						
No. 8 Cyl.	No. 8 Cyl.	MPa	20.0						
			Dev. Max. 0.7MPa						
Average		MPa							
Exhaust Gas Temperature					A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	℃		480	378 401	368 403	382 398	388 397	
No. 2 Cyl.	No. 2 Cyl.	℃		480	402 412	391 398	392 400	386 389	
No. 3 Cyl.	No. 3 Cyl.	℃		480	386 414	397 391	381 402	395 390	
No. 4 Cyl.	No. 4 Cyl.	℃		480	386 398	398 394	385 394	416 388	
No. 5 Cyl.	No. 5 Cyl.	℃		480	382 401	400 389	390 383	396 386	
No. 6 Cyl.	No. 6 Cyl.	℃		480	392 387	381 371	386 383	383 367	
No. 7 Cyl.	No. 7 Cyl.	℃		480	381 384	387 388	378 373	384 [illegible]	
No. 8 Cyl.	No. 8 Cyl.	℃		480	380 380	394 378	370 [illegible]		
				Diff. Max. 60deg	24 34	32 32	22 29	32 30	
Average		℃			386 357	390 349	383 389	394 385	
Fuel Injection Pump Rack			@100%		A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	mm	31.0		27.0 27.0	26.0 27.0	29.0 29.0	26.0 27.0	
No. 2 Cyl.	No. 2 Cyl.	mm	31.0		27.0 27.0	26.0 27.0	28.0 28.0	27.0 27.0	
No. 3 Cyl.	No. 3 Cyl.	mm	31.0		26.0 27.0	26.0 27.0	28.0 29.0	26.0 27.0	
No. 4 Cyl.	No. 4 Cyl.	mm	31.0		26.0 27.0	26.0 27.0	27.0 28.0	26.0 27.0	
No. 5 Cyl.	No. 5 Cyl.	mm	31.0		26.0 27.0	26.0 27.0	27.0 28.0	26.0 27.0	
No. 6 Cyl.	No. 6 Cyl.	mm	31.0		27.0 27.0	26.0 27.0	27.0 29.0	25.0 27.0	
No. 7 Cyl.	No. 7 Cyl.	mm	31.0		26.0 26.0	26.0 26.0	27.0 28.0	25.0 [illegible]	
No. 8 Cyl.	No. 8 Cyl.	mm	31.0		27.0 26.0	26.0 27.0	26.0 28.0	[illegible] 26.0	
			Diff. Max. 3mm		1.0 1.0	0.0 1.0	3.0 1.0	2.0 1.0	
Average		mm			23.7 23.9	23.1 24.0	24.7 25.3	23.2 23.9	
Jacket Water									
Pressure (Eng. Inlet)		MPa	0.2–0.3	0.1	0.230	0.240	0.250		
Temperature (Eng. Inlet)		℃			40.0	38.0			
Temperature (Eng. Outlet)		℃	80–90	95	80.0	80.0	79.0		
Cooler Cooling Water			0.15–0.25		0.17				
Press. (Eng. Inlet)		MPa		0.05	0.170	0.180	0.180	.180	Dec–12–2017
Temp. (Charge A/C Inlet) ④		℃		49	36.0	33.0	32.0	33.0	42.0
Temp. (L.O. Cooler Inlet) ⑤		℃			70.0	64.0	[illegible]	70.0	47.0
Temp. (L.O. Cooler Outlet) ⑥		℃			50.0	48.0	49.0	50.0	37.0
Temp. (J.W. Cooler Inlet) ⑦		℃			40.0	37.0	40.0	39.0	
Temp. (J.W. Cooler Outlet) ⑧		℃			80.0	75.0	50.0	50.0	

Watching if 760 is steady or not

Please measure actual fuel flow as comparison purpose. Specific Fuel Oil Consumption may lecture on first 4K maintenance at site.

Please measure with peak pressure gauge and fill up on next report on Nov-2020.

Differential of each cylinder shows less than 60deg (24-34deg) and normal

Differential of each cylinder shows 0.0-1.0mm and normal

This is still some different with commissioning test data. Please check each location of

N100107 (様式-8 0701) 改正-5

IHI POWER SYSTEM CO.,LTD.

LOG DATA SHEET 2

(10 / 23)

Engine Type 16V28HLX
Engine No. JICA 1: 57671
JICA 2: 57672

TC:TPL65-A10(CA15/TA14) Date ; 2020/10/23

			STD	Limit	Unit No.		Unit No.2		Unit No.1		Unit No.2		Unit No.	
Date			–	–							09.30.20			
Recorded Time		Hr.min	–	–							13:20-14:(			
Total running hour		Hrs	–	–							45-21			
Generator Output		kWe	4,000-4,500	5,500	4000		4000		4000		4000			
Load Ratio		%	80-90	110	80%		80%		80%					
Lubricating Oil														
Pressure (Main Bearing) 9		MPa	0.5-0.6	0.45	0.500		0.520		0.500		0.510			
Temperature(Cooler Inlet)		℃			70.0		64.0		68.0		70.0			
Temperature(Cooler Outlet)		℃			50.0		48.0		49.0		50.0			
Temperature(Eng. Inlet)		℃	50-60	65	57.0		55.0		57.0		54.0			
Temperature(Eng. Outlet) 10		℃			70.0		64.0		50.0		50.0			
Fuel Oil Pressure		MPa	0.3-0.6	0.25	0.250		0.400		faulty meter		faulty meter			
Fuel Oil Temperature		℃		HFO 150	86 (HFO)		49.0		52.0		49.0			
Turbo Charger					A	B	A	B	A	B	A			
Charge Air Pressure 11		MPa	(0.23)		0.130		0.130		0.150		0.140			
T/C Oil Pressure 12		MPa	0.18-0.25	0.13/0.11	0.090	0.170	0.140	0.13	0.10?	0.18	0.15	0.14		
Speed		min^{-1}		30,180	24	24	23	24	23000	24000	23000	24000		
Exhaust-gas Temperature	(T/C Inlet)	℃		650	512	522	526	529	500	519	524	518		
	(T/C Outlet)	℃			384	395	393	402	378	388	394	393		
Air Temperature	(Air Filter Inlet)	℃	20-40	40										
	(A/C Inlet) 13	℃												
	(A/C Outlet) 14	℃		60										
	(Engine inlet) 15	℃		60	0.0		0.0		62.0		63.0			
AC efficiency		%	60	70	N/A	N/A	N/A	N/A						
Back Pressure		mmAq		200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Intake air press diff 16		mmAq		50	N/A	N/A	N/A	N/A						
Main Bearing Temperature			Eng. Inlet plus											
Thrust		℃	20	Max.95	62		62		62		62			
No.1	No.6	℃	20	20	78	77	76	80	79	80	76	80		
No.2	No.7	℃	20	20	78	80	80	78	80	83	80	78		
No.3	No.8	℃	20	20	79	77	81	80	81	78	81	80		
No.4	No.9	℃	20	20	81	79	82	77	82	81	81	76		
No.5	No.10	℃	20	20	80		80		82		80			
Generator			@100%											
Voltage		V	6,600		6600		6600		6600		6600			
Current	(R)	A	547		360		380		380		360			
	(S)	A	547		380		380		390		360			
	(T)	A	547		380		380		400		380			
Excitation Voltage		V	(30~40.7)		30		30		30		30			
Excitation Current		A	(5.6)		4.5		4.5		4.5		4.5			
Stator Coil Temp.	(U)	℃		155	64		68		64		66			
	(V)	℃		155	64		68		63		66			
	(W)	℃		155	64		68		64		67			
Frame Temperature		℃			33		34		--		--			
Air Temperature	(Inlet)	℃			35		34		--		--			
	(Outlet)	℃			34		35		--		--			
Bearing Lube Oil. Pressure		MPa	0.5-0.6		0.5		0.5		--		--			
Bearing Lube Oil. Temp. (Inlet)		℃	50-60		56		56		--		--			
Bearing Temperature	Coupling side	℃		95	51		60		52					
	Opposite Coupling side 17	℃		95	94.0		59.0		54.0		58.0			
Barometric Pressure		hPa			34.3		32.8		N/A		N/A			
Humidity		%		88	34		33		N/A		N/A			
Room Temperature		℃	28	20-40	33.7		33.7		N/A		N/A			
Ambient temp.		℃	28	20-40	33.7		33.7		N/A		N/A			

Watching if 0.5MPa is steady or not. check pressure differential at filter in/out and adjust pressure by pressure regulating valve.

Watching if this temperature is steady or not

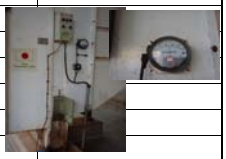
Note: Pressure getting lower than green mark level
And TC A DG1 0.09MPa is abnormally low! If it getting more lower, please stop engine and trouble shoot by stop

Getting slightly lower than last data 30-Sep-2020. Watching further development with exh. temp.

Note: Temperature getting slightly higher than 30-Sep-2020

Check and replace with new if damaged

Please check again if reading error or true?



＊ A/C ・・・ Air Cooler J.W ・・・ Engine Jacket Water L.O. ・・・ Lubricating Oil
＊ Fuel oil consumption above shows figure converted to calorific value of 42700kL/kg also reduced injection pump & injection nozzle drain volume.
＊ Exhaust gas temperature are measured by mercury thermometer.

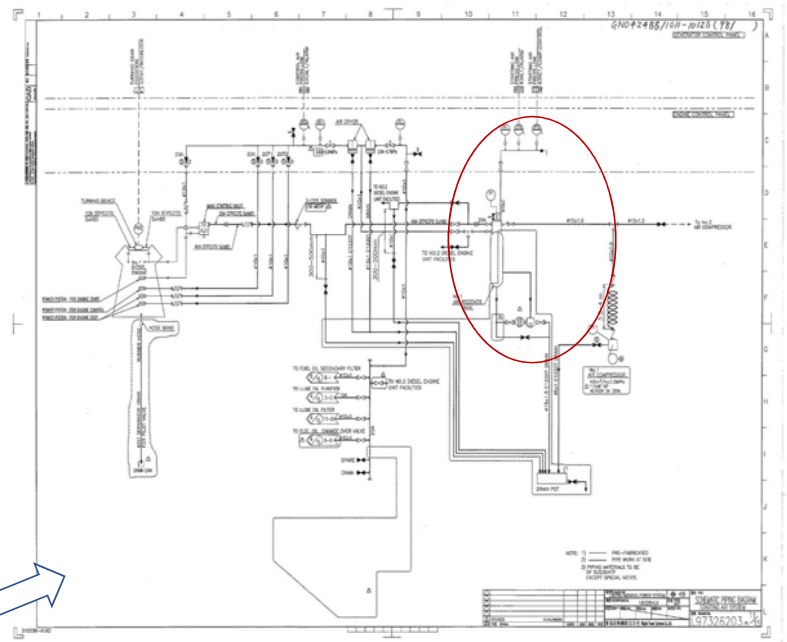
<Pick up comment portion> LEC monthly report on Oct-202 (1/3)

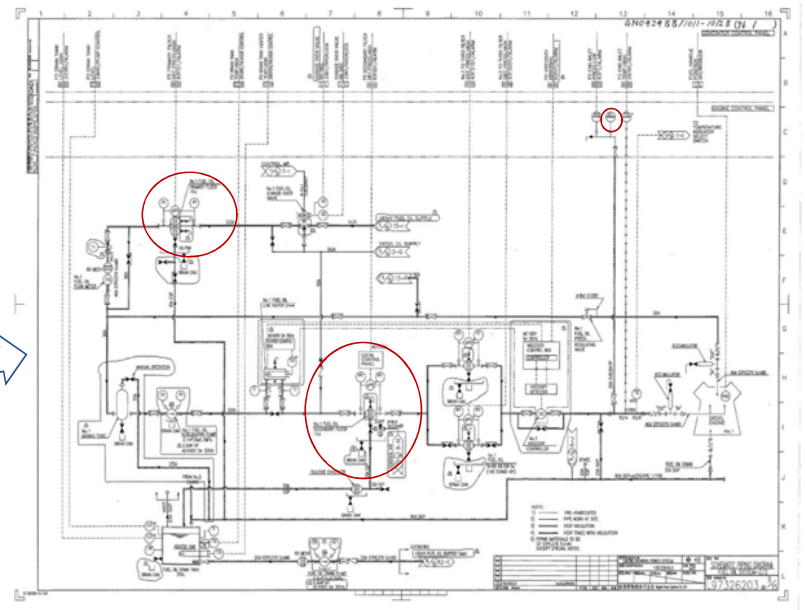
<Check sheet>

Daily check-5	Except for the Smokey condition on unit 1 when loaded @ 4500KW and oil Leaks from Turbocharger	Please inform details on leakage condition/ point with photo. Also how is Smokey such as duration, smell, mist and no problem for fire accident?
Weekly check-3	Continuous oil leaks from Turbocharger pipes flanges. Require special tools for proper tightening	Please inform us exact leak point. Also what kind of special tools are required in addition
	 	
Weekly check-4	Air leaks from High pressure valve	Please point actual valve with photo
		
Check before running-4	Indication of tachometer and pressure gauge ⇒ To be replace on both units. Currently taking readings from fuel primary filters.	Please purchase genuine parts

mark on log data sheet

1





9. Remote Technical Support Record

<Pick up comment portion> LEC monthly report on Oct-202 (2/3)

<Check sheet>

13 14 15 Check before running-5	Indications of each thermometer ⇒ Some are not indicating readings (Air Cooler, etc.)	Please describe location and Please purchase genuine parts
Check during running-7	Vibration and a bit of smoke mostly on unit 1 when ever loaded at 4500KW. Sometime on Unit 2 also. So we currently running and maintaining the load @ 4000KW (please see attached photos.	Please show mentioned portion by photos. Also measure vibration with meter which supplied and used on commissioning test. If poosible with short movie/ sound. Please check tightening of all installation bolts/ nuts accordingly. Follow up above comment of Daily check-5 accordingly.

<Data sheet>

1 Engine speed	760min-1 on frequency 50.0Hz	Watching if 760 is steady or not. If steady 760min-1, replace tachometer new.
2 Fuel consumption l/hr & kg/hr	NO data recording	Please measure actual fuel flow as comparison purpose

1. quantity of flow
2. temperature
3. density

a: Measure furl oil flow 10min x 6 = Fuel consumption liter/hr
b: Mesure fuel oil gravity by hydrometer and temperature.
c: Find fuel oil gravity on engine inlet temperature
⇒ a x c = Fuel oil concumption kg/hr

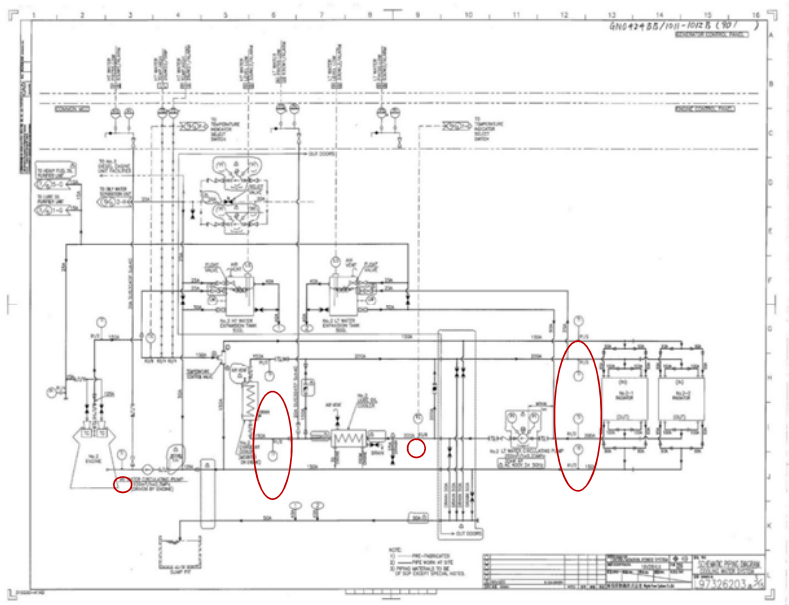
Calucuation for specific gravity
Example: b if 0.961 @ 15 deg.C
Fomula ↓
0.961-(0.00069 x (86-15)
' c → 0.912 @ 86deg.C eng inlet

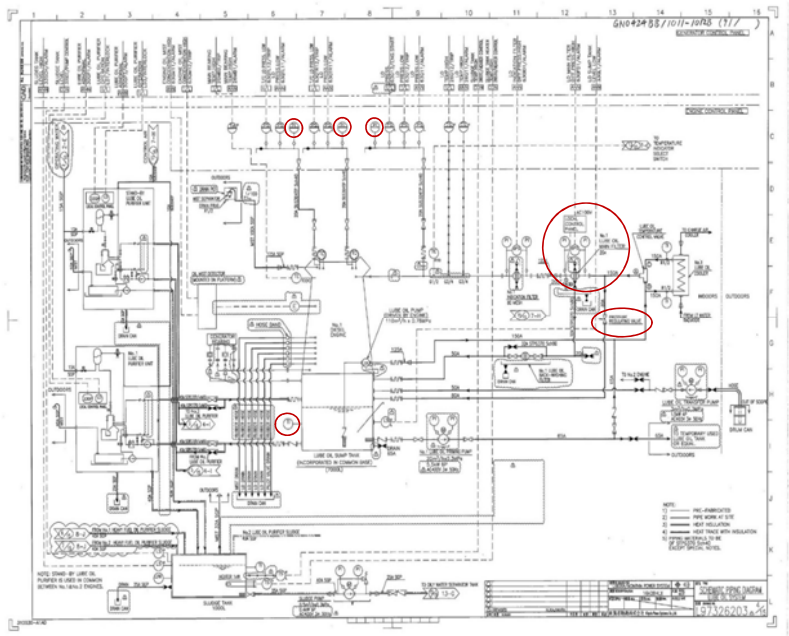
Convertion table between specific gravity - temperture correction coefficient from JIS K 2249 1995 table Ⅱ 2B

付録表G.2－JIS K 2249:1995付表Ⅱ表2Bから算出した密度補正係数

15°C の燃料密度	0～90°C 補正係数	15°Cの燃料密度	0～90°C補正係数
0.8000	-0.000754		
0.8100	-0.000744	0.9100	-0.000701
0.8200	-0.000735	0.9200	-0.000697
0.8300	-0.000726	0.9300	-0.000695
0.8400	-0.000718	0.9400	-0.000693
0.8500	-0.000715	0.9500	-0.000691
0.8600	-0.000712	0.9600	-0.000689
0.8700	-0.000710	0.9700	-0.000687
0.8800	-0.000708	0.9800	-0.000684
0.8900	-0.000705	0.9900	-0.000682
0.9000	-0.000702	1.0000	-0.000681

3 Max. Combustion Pressure	NO data recording	Getting data and inform us on next reporting as Nov-2020
Cooler Cooling Water		
4 Temp. AC inlet	So big different with commissioning data	This is still some different with commissioning test data. Please check each location of thermometer on piping diagram.
5 6 Temp. LO Cooler in/ out		
7 8 Temp. JW Cooler in/ out		

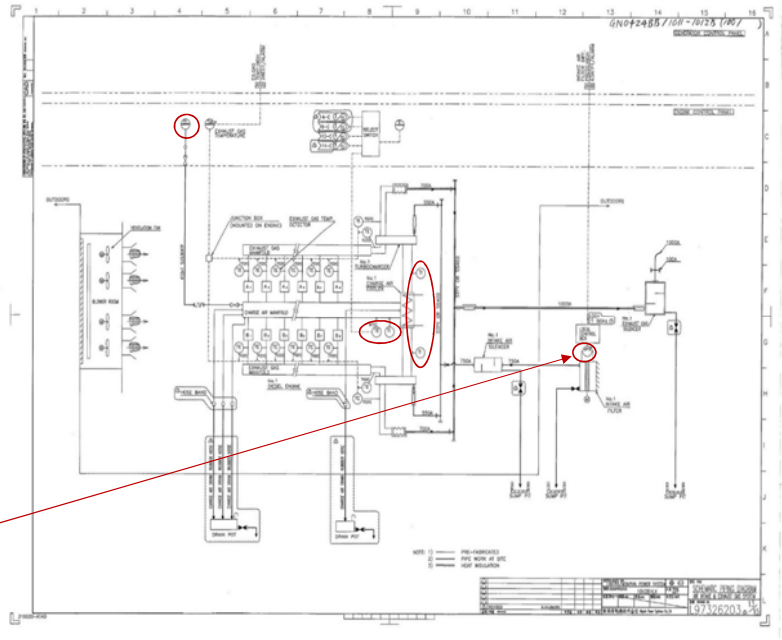




<Pick up comment portion> LEC monthly report on Oct-202 (3/3)

<Data sheet>

	Lubrication oil		
9	Pressure (main Bearing)	0.5MPa at DG1 is low level on green mark 0.5-0.6MPa	Watching if 0.5MPa is steady or not. If getting lower, check pressure diffferntiin at filter in/out and adjust pressure by pressure regulating valve.
10	Temperature (Engine outlet)	70deg.C at DG1 is so high	Watching if this temperature is steady or not. If it is true and steady/ increasing. Please stop engine and inspection Lube oil filter/ sludge checker also indies of crank case.
	Turbo Charger		
11	Charge air pressure	Getting lower than Sep-2020.	Watching further development with exh. Temp.
12	T/C Oil Pressure	Pressure getting lower than green mark level. A	If it getting more lower, please stop engine and trouble shoot by stop leakage first.
13 14	Air Temperature at A/C Inlet, A/C Outlet, Engine Inlet	NO data recording	Check and replace with new if damaged
		 Thermometer at A/C inlet Thermometer for engine inlet (A-bank or B-bank)	
16	Intake air press differencial	NO data recording	Check and replace with new if damaged
		  	
	Generator		
17	Bearing Temperature Opposite coupling side	Data shows DG1 94deg C but DG2 59deg C only	Please check again and confirm true or error. If true stop engine due to alarm level 95deg C.



Check list (Stand-by / Normal operation)

Note; Maintenance intervals and inspection items are subject to change with engine running hours, maximum engine load, kind of fuel oil / lubrication oil to be used, frequency of engine starts / stops, kind of load such as low load and varying load, and quality of maintenance.

Legend: **LO:** Lubrication Oil, **FO**: Fuel Oil, **JW**: Jacket Water, **RA**:Rocker Arm **MCP**: Motor Control Panel **EIP**:Engine Instrument Panel **ECP**:Engine Control Panel, **FIP**:Fuel Injection Pump

A: Good
B: Partially good
C: Bad

Date : 11/03/2020
By : Jordan V. Jannell & Aron Juloto

Interval	No.	Items for maintenance and inspection work	Result	Remarks	Checking point	
Daily check	1	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other	A		・In automatic position? ・Opening/ closing in normal position?	
	2	Pressure of starting air receiver	A		・Within normal range of approx. 2.2 to 3.0MPa?	
	3	Leakage on compressor air system (starting air receiver, EIP/ECP pressure regulator	A		・NO leakage?	Solved leakage? How did it?
	4	Volume/ level of cooling water (primally, secondary) in cooling towers, each expansion tanks, radiators and others	A		・Level=volume is normal? To be filled in proper level?	
	5	Surrounding conditions of engine/ chimney/ control panel/ power distribution panel / battery panel/ MCP room and others	A	Except for the somkey condition on unit 1 when loaded @ 4500KW and oil Leaks from Turbocharger	・NO oily, dirty and dusty? ・NO spilled liquid? ・NO abnormal smell?	Please inform details on leakage condition/ point with photo. Also how is smokey such as duration, smell, mist and no problem for fire accident?
	6	Condition pf auto lube oil priming (if provided)	A		・Timer operation properly work? ・Confirm pressure establishment at EIP/ECP	
	7	Insulation (worming) system working (automatic) (if provided)	A		Confirm jacket water temperature kept 15-30deg.C	
Weekly check	1	Water leakage from the cooling water system	A		Water leakage from pipes, each connecting portion and or equipment(tanks, coolers, pumps) itself, etc.?	
	2	Tank and sump level — Water expansion tank	A		・Level is normal? To be filled in proper level? ・NO dirty? ・NO mix with water and or fuel oil? ・NO abnormal smell? (Lube oil with fuel oil?) ・NO abnormal vapor or mist?	
		Tank and sump level — LO: Sump tank, oil pan	A			
		Tank and sump level — LO: Hydraulic governor/ actuator	A			
		Tank and sump level — LO: Turbocharger	A			
		Tank and sump level — LO: Air compressor	A			
		Tank and sump level — LO: Fuel injection pump (integrated type)	A			
		Tank and sump level — LO: Generator bearing	A			
		Tank and sump level — LO: Rocker arm lube oil tank (RA lubrication independent type)	A			
		Tank and sump level — FO: FO service tank, Buffer tank and Storage tank	A			
	3	Oil leakage from lube oil and fuel oil system	B	Continous oil leaks from Turbocharger pipes flanges. Require special tools for proper tightening	Oil leakage from pipes, each connecting portion and or equipment(tanks, coolers, pumps) itself, etc.?	Please inform us what kind of special tools are required in addition
	4	Air leakage from starting air system	B	Air leaks from High pressure valve	Air leakage from pipes, each connecting portion and or equipment (tanks, LECP/ECP) itself, etc.?	Please point actual valve with photo
	5	Drain discharge from starting air receiver and drain separator at EIP/ ECP	B	A	After discharge drain, compressed air must be charged to normal range.	
	6	Drain discharge from miscellaneous equipment such as air filter fuel filter, and FO service tank, Buffer tank and Storage tank	A		After drain discharge, air vent must be carried out.	
	7	Manual cleaning for FO and LO filter (auto clean type) if provided	A		Turn handle more than 2 revolution.	
	8	Movement of fuel injection pump rack	A		Moving smoothly?	
Weekly	9	Tension of driving V-belt (cooling tower, radiator, air compressor, ventilation etc.)if provided	A		NO loose? Adjust tensions if loose. **Note: Motor CB should be off during checking!**	

samle photo

Somewhere on this

Check list (Stand-by / Normal operation)

check	10	Battery charger	A		Proper specific gravity, level of electrolyte and voltage?	
Monthly check	1	Confirm good starting and running (No load for 5 to 10 minutes)	A		No abnormal heat and/or sound? All indication at EIP/ ECP shows normal?	
	2	Looseness on connecting portions of driven equipment such as generator, air compressor, pump, etc..	A		Not looseness?	
	3	Lube oil volume/ level/ flow on generator bearing	A		Check oil level by sight glass and flow sight. To be filled in proper level? To be adjusted needle screw or orifice.	
	4	Oil leakage from generator bearings	A		NO oil leakage?	
	5	Slip-ring and commutator condition of	A		NO surface rough, dusty, dirtiness and rusty?	
	6	Tightening of bolts, nuts and foundation bolts / nuts for engines and auxiliary equipment	A		NO loose?	
	7	Lubrication on starting air distributor, starting motor, fuel/governor linkage/lay shaft & FIP rack	A		Check volume and put clean grease and or oil.	
	8	Cleaning of fuel oil filter	A		Handling for manual blow off	
	9	Air vent of lube oil filter , lube oil cooler, lube oil heater (if provided)	A		Air vent/ breeding during lube oil priming.	
	10	Cleaning of TC air filter (primary screen or fiber filter)	A		Depend on condition but every 3month regularly.	
	11	Dirtiness of terminals of battery	A		Being clean?	
Check before running	1	Conduct Daily, Weekly, Every 2weeks and Monthly action	A		NO abnormality?	
	2	Lubrication to each valve gear (rocker arm) lubrication oil device	A		To lubricate with clean oil.	
	3	Moving check and lubrication of fuel/governor linkage/ lay shaft & FIP rack	A		To confirm whether fuel/governor linkage/ lay shaft & FIP rack moves smoothly by operating a fuel handle.	
	4	Indication of tachometer and pressure gauge	C	To be replace on both units. Currently taking readings from fuel	NO abnormal?	Please inform purchasing status
	5	Indications of each thermometer	B	Some are not indicating readings (Air Cooler, etc)	NO abnormal?	Please inform purchasing status
	6	Priming with lubricating oil	A		Pressure is established when lubrication oil priming pump runs with a pressure gauge at instrument panel ?	
	7	Turning of flywheel	A		1.Open indicator cock. 2. Fuel handle on "STOP" position 3. To be done during lubrication oil priming pump operation.	
	8	Air run	A		**・Turning gear/ apparatus must be disengaged !!** ・Confirm any abnormal discharge/ exhaust (water, fuel oil etc.). Close indicator cock after finished air run.	
	9	Volume/ level of each water, fuel and lube oil	A		・Level=volume is normal? To be filled in proper level?	
Check before running	10	・Position of each switches on operation panel (s) ・Position of engine fuel handle and each cocks / valves / other handles	A		・In automatic position? ・Opening/ closing in normal operation position?	
	11	Drain discharge from starting air receiver and drain separator at EIP/ ECP	A		・Within range of 2.2 to 3.0MPa? ・Drain discharge from starting air receiver and drain separator. ・After discharge drain, compressed air must be charged to normal range.	

sample photo

Check list (Stand-by / Normal operation)

running						
	12	Confirmation of safety	A		・Fuel handle on "RUN/START" position. **・Nobody close to rotation portion!** **・Double check for turning gear/ apparatus must be disengaged !!**	
Check during running	1	In the case of automatic start ･･･ Starting engine with test button. Remote start on GCP and Manual start at engine side	A		"Start" and No-load running to be done for 5 to 10 minutes.	
	2	Condition of surroundings	A		NO leakage of water / oil / fuel/ air and exhaust gas?	
	3	Condition of various piping systems	A		NO leakage of water / oil / fuel/ air and exhaust gas from connecting portion?	
	4	Indication of pressure gauge and temperature	A		NO abnormal? Within normal range?	
	5	Indication of tachometer	A		NO abnormal such as hunting?	
	6	Exhaust gas color. Oil mist color and volume	A		NO abnormality compared to usual and previous running?	
	7	Vibration and noise	B	Vibration and a bit of smoke mostly on unit 1 when ever loaded at 4500KW. Sometime on Unit 2 also. So we currently running and maintening the load @ 4000KW (please see attached photos.	NO abnormality compared to usual and previous running?	Please show mentioned portion by photos. If poosible with short movie/ sound. Please check tightening of all installation bolts/ nuts accordingly. Follow up above comment of Daily check-5 accordingly.
	8	Indicator cock	A		NO leakage?	
	9	Temperature of each bearings (main bearings and generator bearings)	A		NO abnormal?	
	10	If running continuously, take all log data every 1-2hours	A	Log data are taken on every hour	All parameter is normal?	
Check after running	1	Stop status with remote stop button on EIP/ECP/GCP/ fuel handle/ lever operation	A		Reliable stopping?	
	2	Pressure in starting air receiver	A		NO leakage?	
	3	Check of battery	A		Proper specific gravity, level of electrolyte and voltage?	
	4	Operation of battery charger	A		Battery to be equal charge followed by own operation	
	5	Drain discharge from starting air receiver	A		Check drain condition.	
	6	Drain discharge from drain separator at EIP/ ECP	A		Check drain condition.	

Remarks; ・Inspection other than the above, interval shall be confirmed followed by instruction manual of each equipment.
・For the safety reasons and avoid from un-expected starting, following should be kept on stand by position.
*Main outlet valve of starting air receiver must be normally closed.
*Engine fuel handle(stop handle) shall be in stop position.

LOG DATA SHEET 1 (11/03)

Engine Type 16V28HLX
Engine No. JICA 1: 57671
JICA 2: 57672

TC:TPL65-A10(CA15/TA14) Date ; 2020/11/3

			STD	Limit	Unit No.1	Unit No.2	Unit No.1	Unit No.2	Unit No.1	Unit No.2	Unit No.
Date			–	–	11.03.20	11.03.20	10.28.20	10.23.20	09.30.20	09.30.20	
Recorded Time		Hr.min	–	–	11:12-11:56	10:10-11:56	13:00-14:20	13:00-16:00	10:04-12:00	12:30-13:15	
Total running hour		Hrs	–	–	4,192	4,526	4,189	4,522	4,185	4,519	
Generator Output		kWe	4,000-4,500	5,500	4000	4000	4000	4000	4000	4000	
Load Ratio		%	80-90	110	80%	80%	80%	80%	80%	80%	
Frequency		Hz	50	51	50.0	50.0	50.0	50.0	50.0	50.0	
Engine Speed		min^{-1}	750	775	760	760	760	760	760	755	
Power Factor		—	80		0.90	0.90	0.90	0.90	0.90	0.90	
Generator eff.		%	96.5								
Fuel Oil Consumption		l/h	–	–	#REF!	#REF!	#REF!	#REF!			
Fuel Oil Consumption		kg/h	–	–	#REF!	#		#REF!			
Spec. Fuel Oil Consumption at 100% load		g/kW.h			#REF!	#		#REF!	–	–	
〃 converted ISO conditions (Gen terminal end)		g/kW.h	@100% 210.0						–	–	
Governor Load Indicator		–	8.0	10.0	8.0	7.8	8.2	7.8	10.0	10.0	
Fuel Handle Pointer		–	7.5	8.0	6.0	6.0	6.5	6.0	6.0	6.0	
Max. Combustion Pressure			@100%		A B	A B	A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	MPa	20.0		15.2 15.2	15.0 15.0					
No. 2 Cyl.	No. 2 Cyl.	MPa	20.0		15.0 15.0	15.3 15.0					
No. 3 Cyl.	No. 3 Cyl.	MPa	20.0		15.0 15.0	15.0 15.0					
No. 4 Cyl.	No. 4 Cyl.	MPa	20.0		15.2 15.2	15.0 15.0					
No. 5 Cyl.	No. 5 Cyl.	MPa	20.0		15.2 15.0	15.4 15.0					
No. 6 Cyl.	No. 6 Cyl.	MPa	20.0		15.0 15.0	15.3 15.2					
No. 7 Cyl.	No. 7 Cyl.	MPa	20.0		15.0 15.0	15.5 15.0					
No. 8 Cyl.	No. 8 Cyl.	MPa	20.0		15.0 15.0	15.6 15.0					
			Dev. Max. 0.7MPa		0.2 0.2	0.6 0.2					
Average		MPa			15.1 15.1	15.3 15.0					
Exhaust Gas Temperature					A B	A B	A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	℃		480	386 403	367 399	378 401	368 403	382 398	388 397	
No. 2 Cyl.	No. 2 Cyl.	℃		480	296 399	387 393	402 412	391 398	392 400	386 389	
No. 3 Cyl.	No. 3 Cyl.	℃		480	388 402	394 404	386 414	397 391	381 402	395 390	
No. 4 Cyl.	No. 4 Cyl.	℃		480	386 400	409 391	386 398	398 394	385 394	416 388	
No. 5 Cyl.	No. 5 Cyl.	℃		480	383 389	399 388	382 401	400 389	390 383	396 386	
No. 6 Cyl.	No. 6 Cyl.	℃		480	396 386	381 368	392 387	381 371	386 383	383 367	
No. 7 Cyl.	No. 7 Cyl.	℃		480	387 389	383 384	381 384	387 388	378 373	384 388	
No. 8 Cyl.	No. 8 Cyl.	℃		480	383 379	377 378	380 380	394 378	370 378	400 373	
			Diff. Max. 60deg		13 24	42 36	24 34	32 32	22 29	32 30	
Average		℃			376 352	387 349	386 357	390 349	383 389	394 385	
Fuel Injection Pump Rack			@100%		A B	A B	A B	A B	A B	A B	A B
No. 1 Cyl.	No. 1 Cyl.	mm	31.0		25.0 24.0	25.0 24.0	27.0 27.0	26.0 27.0	29.0 29.0	26.0 27.0	
No. 2 Cyl.	No. 2 Cyl.	mm	31.0		25.0 24.0	25.0 24.0	27.0 27.0	26.0 27.0	28.0 28.0	27.0 27.0	
No. 3 Cyl.	No. 3 Cyl.	mm	31.0		25.0 25.0	25.0 24.0	26.0 27.0	26.0 27.0	28.0 29.0	26.0 27.0	
No. 4 Cyl.	No. 4 Cyl.	mm	31.0		25.0 24.0	25.0 24.0	26.0 27.0	26.0 27.0	27.0 28.0	26.0 27.0	
No. 5 Cyl.	No. 5 Cyl.	mm	31.0		26.0 25.0	25.0 24.0	26.0 27.0	26.0 27.0	27.0 28.0	26.0 27.0	
No. 6 Cyl.	No. 6 Cyl.	mm	31.0		25.0 24.0	25.0 25.0	27.0 27.0	26.0 27.0	27.0 29.0	25.0 27.0	
No. 7 Cyl.	No. 7 Cyl.	mm	31.0		26.0 25.0	25.0 26.0	26.0 26.0	26.0 26.0	27.0 28.0	25.0 26.0	
No. 8 Cyl.	No. 8 Cyl.	mm	31.0		25.0 25.0	25.0 26.0	27.0 26.0	26.0 27.0	26.0 28.0	26.0 26.0	
			Diff. Max. 3mm		1.0 1.0	0.0 2.0	1.0 1.0	0.0 1.0	3.0 1.0	2.0 1.0	
Average		mm			25.3 24.5	25.0 24.6	26.5 26.8	26.0 26.9	27.4 28.4	25.9 26.8	
Jacket Water											
Pressure (Eng. Inlet)		MPa	0.2-0.3	0.1	0.230	0.240	0.230	0.240	0.250	0.250	
Temperature (Eng. Inlet)		℃			40.0	40.0	40.0	38.0			
Temperature (Eng. Outlet)		℃	80-90	95	80.0	79.0	80.0	80.0	79.0	79.0	
Cooler Cooling Water			0.15-0.25				0.17				
Press. (Eng. Inlet)		MPa		0.05	0.150	0.170	0.170	0.180	0.180	0.180	Dec-12-2017
Temp. (Charge A/C Inlet)		℃		49	36.0	35.0	36.0	33.0	32.0	33.0	42.0
Temp. (L.O. Cooler Inlet)		℃			70.0	70.0	70.0	64.0	68.0	70.0	47.0
Temp. (L.O. Cooler Outlet)		℃			49.0	50.0	50.0	48.0	49.0	50.0	37.0
Temp. (J.W. Cooler Inlet)		℃			42.0	40.0	40.0	37.0	40.0	39.0	
Temp. (J.W. Cooler Outlet)		℃			80.0	80.0	80.0	75.0	50.0	50.0	

1 Steady: Check tachometer and or renew?

2 Check and instruct on site on investigation prior to 4,000hrs maintenance

3 Normal

4 Normal (please fill up on site)

5 Is it true? or 396 is correct?

6 Normal (please fill up on

7 Normal (please fill up on site)

8 Check and instruct on site as OJT

N100107 (様式-8 0701) 改正-5

IHI POWER SYSTEM CO.,LTD.

LOG DATA SHEET 2

(11/03)

Engine Type 16V28HLX
Engine No. JICA 1: 57671
JICA 2: 57672

TC:TPL65-A10(CA15/TA14) Date ; 2020/11/3

			STD	Limit	Unit No.1	Unit No.2	Unit No.	Unit No.2	Unit No.1	Unit No.2	Unit No.
Date			–	–	11.03.20	11.03.20	10.28.20	10.23.20	09.30.20	09.30.20	
Recorded Time		Hr.min	–	–	11:12-11:56	10:10-11:56	13:00-14:20	13:00-16:00	10:04-12:00	12:30-13:15	
Total running hour		Hrs	–	–	4,192	4,526	4,189	4,522	4,185	4,519	
Generator Output		kWe	4,000-4,500	5,500	4,000	4,000	4,000	4,000	4,000	4,000	
Load Ratio		%	80-90	110	80%	80%	80%	80%	80%	80%	
Lubricating Oil											
Pressure (Main Bearing)		MPa	0.5-0.6	0.45	0.500	0.500	0.500	0.520	0.500	0.510	
Temperature(Cooler Inlet)		℃			70.0	70.0	70.0	64.0	68.0	70.0	
Temperature(Cooler Outlet)		℃			50.0	50.0	50.0	48.0	49.0	50.0	
Temperature(Eng. Inlet)		℃	50-60	65	54.0	55.0	57.0	55.0	57.0	54.0	
Temperature(Eng. Outlet)		℃			70.0	70.0	70.0	64.0	50.0	50.0	
Fuel Oil Pressure		MPa	0.3-0.6	0.25	0.260	0.280	0.250	0.400	faulty meter	faulty meter	
Fuel Oil Temperature		℃		HFO 150	87 (HFO)	51.0	86 (HFO)	49.0	52.0	49.0	
Turbo Charger					A B		A B	A B	A B	A	
Charge Air Pressure		MPa	(0.25)		0.140	0.140	0.130	0.130	0.150	0.140	
T/C Oil Pressure		MPa	0.18-0.25	0.13/0.11	0.080 0.160	0.140 0.130	0.090 0.170	0.140 0.13	0.10? 0.18	0.15 0.14	
Speed		min^{-1}		30,180	24 25	24 25	24 24	23 24	23000 24000	23000 24000	
Exhaust-gas Temperature	(T/C Inlet)	℃		650	532 519	530 535	512 522	526 529	500 519	524 518	
	(T/C Outlet)	℃			401 389	395 404	384 395	393 402	378 388	394 393	
Air Temperature	(Air Filter Inlet)	℃	20-40	40							
	(A/C Inlet)	℃									
	(A/C Outlet)	℃		60							
	(Engine inlet)	℃		60	0.0		.0	0.0	62.0	63.0	
AC efficiency		%	60	70	N/A N/A	N/A	N/A	N/A N/A			
Back Pressure		mmAq		200	N/A N/A	N/A	N/A	N/A N/A	N/A N/A	N/A N/A	
Intake air press diff		mmAq		50	N/A N/A	N/A	N/A	N/A N/A			
Main Bearing Temperature			Eng. Inlet plus								
Thrust		℃	20	Max.95	58	60	62	62	62	62	
No.1	No.6	℃	20	20	75 76	75 79	78 77	76 80	79 80	76 80	
No.2	No.7	℃	20	20	76 79	79 77	78 80	80 78	80 83	80 78	
No.3	No.8	℃	20	20	77 74	80 79	79 77	81 80	81 78	81 80	
No.4	No.9	℃	20	20	79 78	80 75	81 79	82 77	82 81	81 76	
No.5	No.10	℃	20	20	77	79	80	80	82	80	
Generator			@100%								
Voltage		V	6,600		6600	6600	6600	6600	6600	6600	
Current	(R)	A	547		380	380	360	380	380	360	
	(S)	A	547		390	390	380	380	390	360	
	(T)	A	547		390	390	380	380	400	380	
Excitation Voltage		V	(30~40.7)		32	33	30	30	30	30	
Excitation Current		A	(5.6)		5	5	4.5	4.5	4.5	4.5	
Stator Coil Temp.	(U)	℃		155	71	70	64	68	64	66	
	(V)	℃		155	70	70	64	68	63	66	
	(W)	℃		155	72	71	64	68	64	67	
Frame Temperature		℃			36	35	33	34	--	--	
Air Temperature	(Inlet)	℃			37	36	35	34	--	--	
	(Outlet)	℃			37	35	34	35	--	--	
Bearing Lube Oil. Pressure		MPa	0.5-0.6		0.50	0.52	0.5	0		--	
Bearing Lube Oil. Temp. (Inlet)		℃	50-60		57	56	56	5		--	
Bearing Temperature	Coupling side	℃		95	52	61	51		52	60	
	Opposite Coupling side	℃		95	52.0	59.0	94.0	59.0	54.0	58.0	
Barometric Pressure		hPa			36.1	36.1	34.3	32.8	N/A	N/A	
Humidity		%		88	46	46	34	33	N/A	N/A	
Room Temperature		℃	28	20-40	36.5	36.5	33.7	33.7	N/A	N/A	
Ambient temp.		℃	28	20-40	36.5	36.5	33.7	33.7	N/A	N/A	

9 Steady

10 Steady

12 Steady

13 Still getting down and all lower than normal value! Advice not run and trouble shoot for leakage

11 Is it on the way to change over

Note: Pressure getting lower than green mark level And TC A DG1 0.09MPa is abnormally low! If it getting more lower, please stop engine and trouble shoot by

14 Getting higher even room temp

15 Check and instruct on site as OJT

16 Steady

17 Getting higher even room temp

18 Normal

19 ?

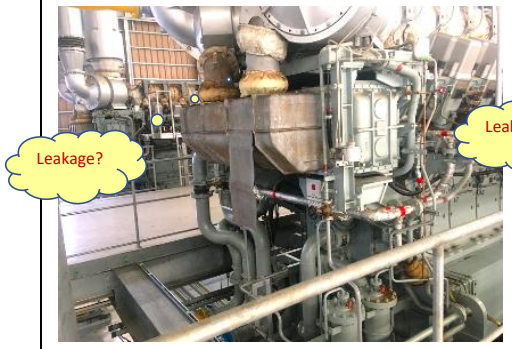
was reading error

＊ A/C ･･･ Air Cooler J.W ･･･ Engine Jacket Water L.O. ･･･ Lubricating Oil
＊ Fuel oil consumption above shows figure converted to calorific value of 42700kL/kg also reduced injection pump & injection nozzle drain volume.
＊ Exhaust gas temperature are measured by mercury thermometer.

9. Remote Technical Support Record

<Pick up comment portion> LEC monthly report on 3-Nov-2020 Rev.0.0 (1/3)

<Check sheet>	Status	Following up
Daily check-3	Leakage on compressor air system (starting air receiver, EIP/ECP pressure regulator	-NO leakage ? - ⇒Please reconfirm that solved leakage? How did it?
Daily check-5	Except for the Smokey condition on **unit 1** when loaded @ 4500KW and oil Leaks from Turbocharger	⇒Please inform details on leakage condition/ point with photo. What is smoke? Exhaust gas ? Wet lagging by TCLO leakage ? Also how is Smokey such as duration, smell, mist and **NO PROBLEM FOR FIRE ACCIDENT?**
Weekly check-3	Continuous oil leaks from Turbocharger pipes flanges. Require special tools for proper tightening	⇒Please inform us exact leak point. Also what kind of special tools are required in addition.



Please point TC Lube oil leakage on pin point

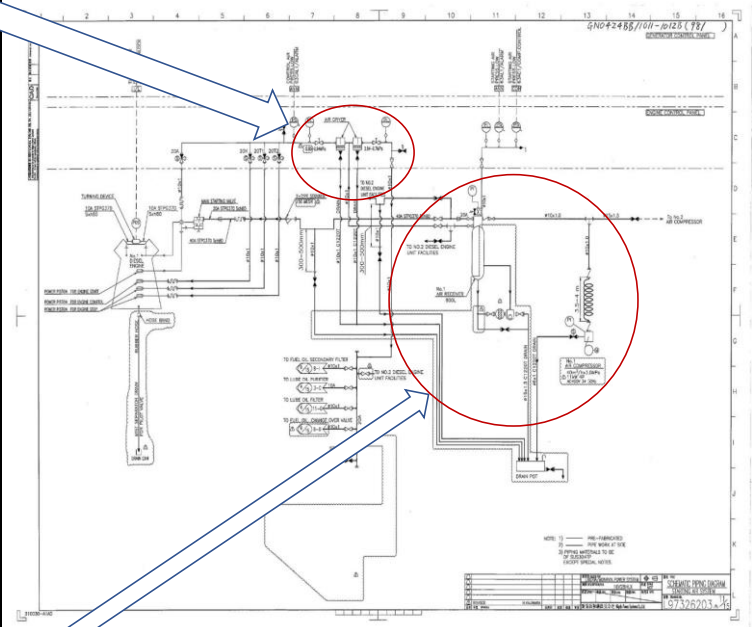
Weekly check-4	Air leaks from High pressure valve	Please point actual valve with photo

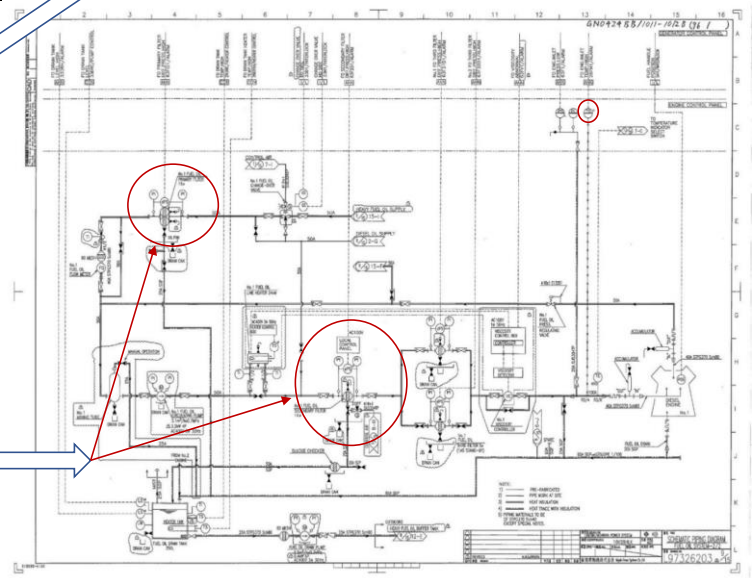
25% 1,250kW load condiiton 90% 4,500kw load condition on 12-2017

How is condiiton on 90% (4,500kWe) load on Nov-2020

Where is leakage point/ place

Check before running-4	Indication of tachometer and pressure gauge on LECP⇒ To be replace on both units. Currently taking readings from fuel primary filters.	Please inform purchasing status
Check before running-5	Indications of each thermometer ⇒ Some are not indicating readings (Air Cooler, etc.)	Please inform purchasing status

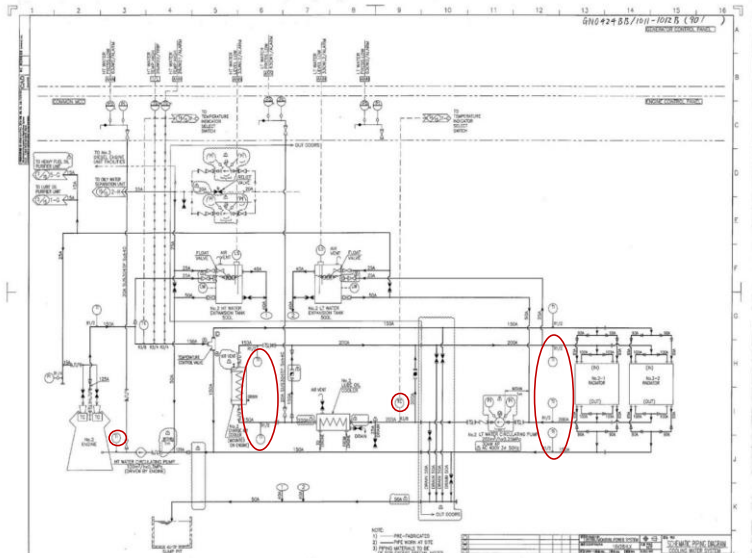


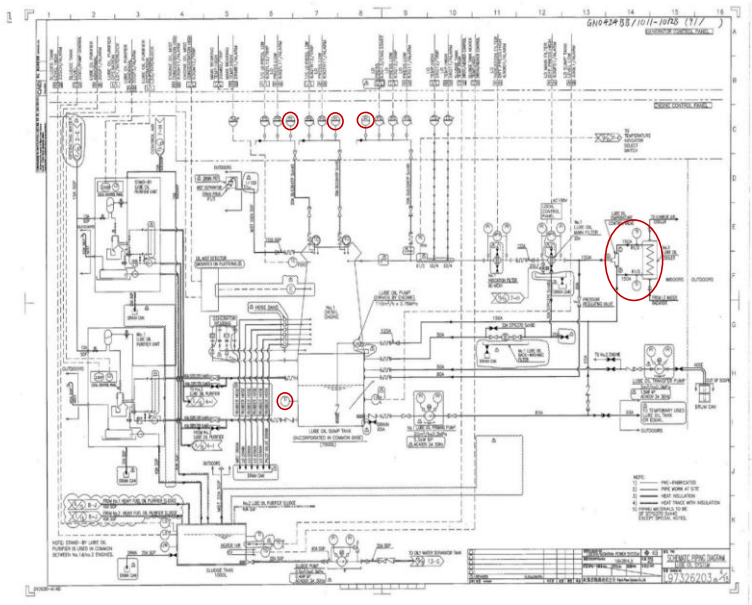


9. Remote Technical Support Record

<Pick up comment portion> LEC monthly report on 3-Nov-2020 Rev.0.0 (2/3)

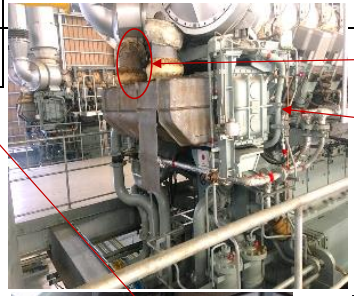
← mark on log data sheet	<Check sheet>	Status	Following up
	Check during running-7	Vibration and a bit of smoke mostly on unit 1 when ever loaded at 4500KW. Sometime on Unit 2 also. So we currently running and maintaining the load @ 4000KW (please see attached photos.	Please show mentioned portion by photos. Also measure vibration with meter which supplied and used on commissioning test. If possible with short movie/ sound. Please check tightening of all installation bolts/ nuts and any bnormlity accordingly. Follow up above comment of Daily check-5 accordingly.
		Sample: Vibration Isolator Spring unit +Damper 	Sample: Spring unit 
No.	<Data sheet>		
1	Engine speed	760min-1 steady on frequency 50.0Hz	Please check tachometer and or replace new.
2	Fuel consumption l/hr & kg/hr	NO data recording	Will check and instruct on site at investigation prior to 4,000hrs maintenance
3	Max. Combustion Pressure	Data is normal both leading and deviation too	Normal
4			
5	Exhaust gas temp. at cyl. Outlet	Data is normal except DG1 A-2 cylinder recorded 296deg. C and deviation is normal.	Please confirm data on DG1 A-2 cylinder. 296deg C is true or may it be 396deg C.
6			
7	Fuel Injection Pump Rack	Data is normal both leading and deviation too	Normal
8	Jacket water and Cooler Cooling Water	So big different with commissioning data	Will check and instruct on site on investigation prior to 4,000hrs maintenance
	Lubrication oil		
9	Pressure (main Bearing)	Steady 5.00MPa	Please watching further development if.
10	Temperature (Engine outlet)	Steady 70deg.C	Please watching further development if.
11	Fuel oil temp.	51 deg C on DG2: Is it on the way to change over fuel? Or out of order	Please re-check data.
	Turbo Charger		
12	Charge air pressure	Back 0.140MPa as same as level on Sept-2020 normal	Please watching further development with exh. Temp.
13	T/C Oil Pressure	Still getting down and all lower than normal value!	Advice not run and trouble shoot for leakage first!
14	Exhaust gas temp. at TC inlet	Getting higher even room temp +2deg	Please watching further development.





<Pick up comment portion> LEC monthly report on 3-Nov-2020 Rev.0.0 (3/3)

	<Data sheet>	Status	Following up
15	Air Temperature at A/C Inlet, A/C Outlet, Engine Inlet	Many missing	Will check and instruct on site at investigation prior to 4,000hrs maintenance
	Intake air press differential		
	Generator		
16	Main bearing temperature	Steady	Normal
17	Stator coil temperature	Getting higher even room temp +2deg	Please watching further development
18	Bearing Temperature	Normal	Normal
19	Barometric Pressure	36.1 sis wrong?	Please clarify

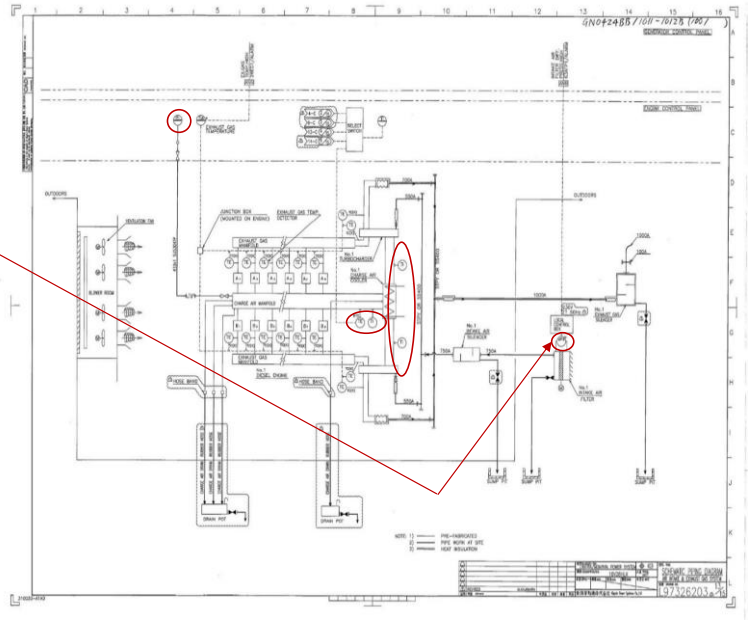


Thermometer at A/C inlet

Thermometer for engine inlet

(A-bank or B-bank)

Air intake filter



10. Project Monitoring Sheet

TO CR of JICA LIBERIA FIELD OFFICE

Project Monitoring Sheet

Project Title : The Project of Capacity Development for Diesel Generator Maintenance (Detailed Planning Phase)

Version of the Sheet: Ver.1（Term: April, 2020 - March, 2023）

Name: Kyoji FUJII

Title: Chief Advisor

Submission Date: March 30th, 2023

I. Summary

1 Progress

1-1 Progress of Inputs

100% complete

1-2 Progress of Activities

100% complete

1-3 Achievement of Output

The Classroom training was held in July 2022 (Before 8kOH (Overhaul)) and March 2023 (After 8kOH). About 25 staffs (engineers, technicians and operators) participated in each classroom training and obtained the knowledge of O&M works (Output 1), troubleshooting (Output 2), and preventive maintenance and methodologies for sustainable power supply (Output 3) of diesel generators.

In the 8,000 hours OH, practical training was conducted by OJT and the trainees acquired the know-how and skills more deeply.

1-4 Achievement of the Project Purpose

Routine operation and maintenance plans have not been completed, but by improving the routine operation checklist and teaching the basics of O&M work by using the draft plan and manual prepared by the JICA experts, LEC gradually understands the basic ideas of planning and necessity of LEC's own manual. In the implementation stage, the LEC's own manual will be discussed.

1-5 Changes of Risks and Actions for Mitigation

After starting the project, suddenly COVID-19 began to spread, and the situation hasn't allowed JICA experts to visit site and proceed with this project. LEC requested JICA

Experts to support them by checking the operation record so JICA and LEC agreed to start the remote technical support from September 2020 to November 2020. In the end of April 2021, JICA Expert received a report from LEC that Unit 2 had trouble and difficult to identify the cause. In May 2021, JICA experts visited the plant for the inspection and preparation of OH. During the stay, COVID-19 spread rapidly and the situation didn't allow them to continue the work.
While waiting for the OH, there was the critical necessity to operate the engines during the dry season from 2021 to 2022, LEC continued to operate though the manufacturer and JICA experts issued some letters not to recommend the operation without conducting OH. As a result, firstly 4kOH was planned but LEC and JICA experts agreed to skip it and conducted 8KOH with additional work items due to maintenance overdue.
During 8kOH in August to November 2022, additional work due to maintenance overdue has been taken place and the additional procurement of spare parts was necessary. To keep the OH on schedule, LEC proceeded to the procurement of necessary spare parts quickly by cooperating with the manufacturer's agent.

1-6 Progress of Actions undertaken by JICA
100% complete

1-7 Progress of Actions undertaken by Gov. of Liberia
100% complete

1-8 Progress of Environmental and Social Considerations (if applicable)
Not applicable

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction, disability, disease infection, social system, human wellbeing, human right, and gender equality (if applicable)
Not applicable

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)
Through this project, unexpected new relationships between LEC (Counterpart) and EGTC (Sierra Leone Power Utility Company) began to build. This led to the creation of new opportunities for personnel exchanges, as well as the lending and borrowing of tools and spare parts.

2 Delay of Work Schedule and/or Problems (if any)

Same as 1-5

2-1 Detail

2-2 Cause

2-3 Action to be taken

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of●●,etc.)

3 Modification of the Project Implementation Plan

3-1 PO

N/A

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D, Project Description, and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, input , and change of Environmental category) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D,Project Description, and PDM, the team may propose the draft.)

4 Current Activities of Gov. of Liberia to Secure Project Sustainability after its Completion

In JCC held in March 2023, LEC's CEO stated that the achievement of this project will be one of the important basics of the company. Additionally, he stated that LEC will incorporate the cost of spare parts for overhaul into its budget and tariff.

II. Project Monitoring Sheet I & II *as Attached*

10. Project Monitoring Sheet

Project Monitoring Sheet I （Revision of Project Design Matrix）

Project Title: Project of Capacity Development for Diesel Generator Maintenance (Detailed Planning Phase)

Version.2

Dated 31st March, 2023

Implementing Agency: Liberia Electricity Corporation

Target Group: N/A

Period of Project: 38 months

Project Site: Bushrod Island Power Plant in Monrovia

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	**Achievement**	**Remarks**
Overall Goal Engineers and technical staff (electricians, operators, mechanics), who are engaged in O&M of HFO power plants in LEC, acquire the knowledge and experiences to undertake proper O&M works.	i) In the diesel power plants owned by LECs, LEC personnel develop plans for routine operation and maintenance, and proper O&M works are carried out based on these plans. ii) The number of unplanned shutdowns and hours of diesel generators owned by LEC will be improved by xx% by 2025.	Application form of the project		i) O&M plans are roughly developed. ii)The genarators owned by LEC have not been operated since last year due to maintenance overdue.	
Project Purpose Engineers and technical staff (electricians, operators, mechanics), who are engaged in the Project at JICA plant in Bushrod Island Power Plant, acquire the knowledge and experiences to undertake proper O&M works.	i) At Bushrod Island Power Plant, LEC personnel develop plans for routine operation and maintenance, and proper O&M works are carried out based on these plans, for the diesel generators manufactured by IHI Power System. ii) The number of unplanned shutdowns and hours of diesel generators manufactured by IHI Power System will be improved by xx% by 2022.	Application form of the project		i) Routine operation and maintenance plans have not been completed, but by improving the routine operation checklist and teaching the basics of O&M work by using the draft plan and manual prepared by the JICA experts, LEC gradually understood the basic ideas of planning and necessity of LEC's own manual. ii) After 8KOH, No unplanned shutdown has not been occurred (The engine is standby)	
Outputs	i) Details will be discussed and agreed upon	Application form of the project	There are no frequent changes	The Classroom training	

Output 1: Engineers and Technical staff improve skills for regular O&M works of diesel generator. Output 2: Engineers and technical staff acquire know-how and practical skills of trouble shooting of diesel generator. Output 3: Engineers and technical staff acquire knowledge and skills for preventive maintenance and methodologies for sustainable power supply.	by the relevant entities at the detailed planning.		of the counterpart personnel.	was held in July 2022 (Before 8kOH) and March 2023 (After 8kOH). About 25 staffs (engineers, technicians and operators) participated in each classroom training and acquired the knowledge of O&M works (Output 1), troubleshooting (Output 2), and preventive maintenance and methodologies for sustainable power supply (Output 3) of diesel generator. In the 8,000 hours overhaul, practical training was conducted by OJT and they acquired the know-how and skills more deeply.	

10. Project Monitoring Sheet

Activities	Inputs		Important Assumption
	The Japanese Side	The Liberia Side	
<Output 1> 1-1 Classroom training on diesel engine and generating system. 1-2 Practical training on operation and maintenance. <Output 2> 2-1 Classroom training on theory of trouble shooting. 2-2 Practical training on trouble shooting. <Output 3> 3-1 Practical training on preventive maintenance. 3-2 Training on maintenance planning. (including the procurement of spare parts)	A. The following experts will dispatched: ・Chief Advisor / Technical Planning and Management ・Mechanical Engineer ・Electrical Engineer ・Mechanical Engineer for Auxiliary Equipment ・Mechanical Engineer for Overhauling ・Operational Coordination / Technical Planning and Management Assistant B. Training ・In-country training	Members of Management Group (MG) will be working with JICA experts for undertaking the relevant activities summarized in PDM. The members of MG are the primary target for technical transfer from JICA experts. A. The following counterpart personnel will be provided: ・Project Director ・Project Manager ・Members of Technical Management Team ・Members of Management Group ・Administrative Personnel B. Joint Coordinating Committee (JCC) C. Office Space and others LEC will provide necessary office facilities including electricity, air-conditioning, water and communication facilities during the duration of the project. Allocation of the budget necessary for the Project.	Pre-Conditions ・A sufficient number of engineers and technicians are provided. ・Spare parts will be purchased by LEC with sufficient lead time. <Issues and countermesures>

10. Project Monitoring Sheet

Project Monitoring Sheet II (Revision of Plan of Operation)

Version 1
Dated 30th, March, 2023

Project Title: Project of Capacity Development for Diesel Generator Maintenance

Inputs	Year	2020				2021				2022				2023				Remarks	Monitoring: Issue	Monitoring: Solution
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
Expert																		Due to COVID-19, the schedule was changed from plan.	None	
Chief Advisor / Technical Planning and Management	Plan																			
	Actual																			
Mechanical Engineer	Plan																			
	Actual																			
Electrical Engineer	Plan																			
	Actual																			
Mechanical Engineer for Auxiliary Equipment	Plan																			
	Actual																			
Operational Coordination / Technical Planning and Management Assistant	Plan																			
	Actual																			
Mechanical Engineer for Overhauling	Plan																			
	Actual																			

Activities	Year	2020				2021				2022				2023				Responsible Organization		Achievements	Issue & Countermeasures
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	Japan	GOL		
Output 1: Engineers and Technical staff improve skills for regular O&M works of diesel generator.																					
1-1. Classroom training on diesel engine and generating system.	Plan																			About 25 staffs (engineers, technicians and operators) participated in each classroom	
	Actual																				
1-2. Practical training on operation and maintenance.	Plan																			Practical training through 8000 hours OH has done.	
	Actual																				
Output 2: Engineers and technical staff acquire know-how and practical skills of trouble shooting of																					
2-1. Classroom training on theory of trouble shooting.	Plan																			About 25 staffs (engineers, technicians and operators) participated in each classroom	
	Actual																				
2-2. Practical training on trouble shooting.	Plan																			Practical training through 8000 hours OH has done.	
	Actual																				
Output 3: Engineers and technical staff acquire knowledge and skills for preventive maintenance for sustainable power supply.																					
3-1. Practical training on preventive maintenance.	Plan																			Practical training through 8000 hours OH has done.	
	Actual																				
3-2. Training on maintenance planning. (including the procurement of spare parts)	Plan																			About 25 staffs (engineers, technicians and operators) participated in each classroom	
	Actual																				

Monitoring Plan	Year	2020				2021				2022				2023				Remarks	Monitoring: Issue	Monitoring: Solution
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
Monitoring																				
Joint Coordinating Committee	Plan																		None	
	Actual																			
Implementation phase for detailed planning	Plan																		None	
	Actual																			
Implementation phase for core activities	Plan																	**TBD**	None	
	Actual																			

Note: The actual schedule shows “Implementation phase for detailed planning” only, originally planned to be implemented within 2020.