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Service Letter

Date : May 25, 2020
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Subject: Introduction of Trouble Shooting Manual For HiMSEN DF engine

Product: HiMSEN DF Engine

Type : H22CDF , H27DF , H35DF

Dear Customers,

We are pleased to introduce Trouble Shooting Manual for HiMSEN DF engine.

The manual includes various trouble shooting cases based on the service experiences of Hyundai Global Service on HiMSEN DF engine since 2014.Therefore we believe the manual will help our valued customers to solve the trouble easily.
It may not 100 percent enough to solve your trouble since the manual is aiming to cover General trouble, so if you have any further technical questions please do not hesitate to contact us.

The manual can be downloaded through our website and it will be updated regularly to include the latest technical information and trouble shooting cases.

Faithfully yours,

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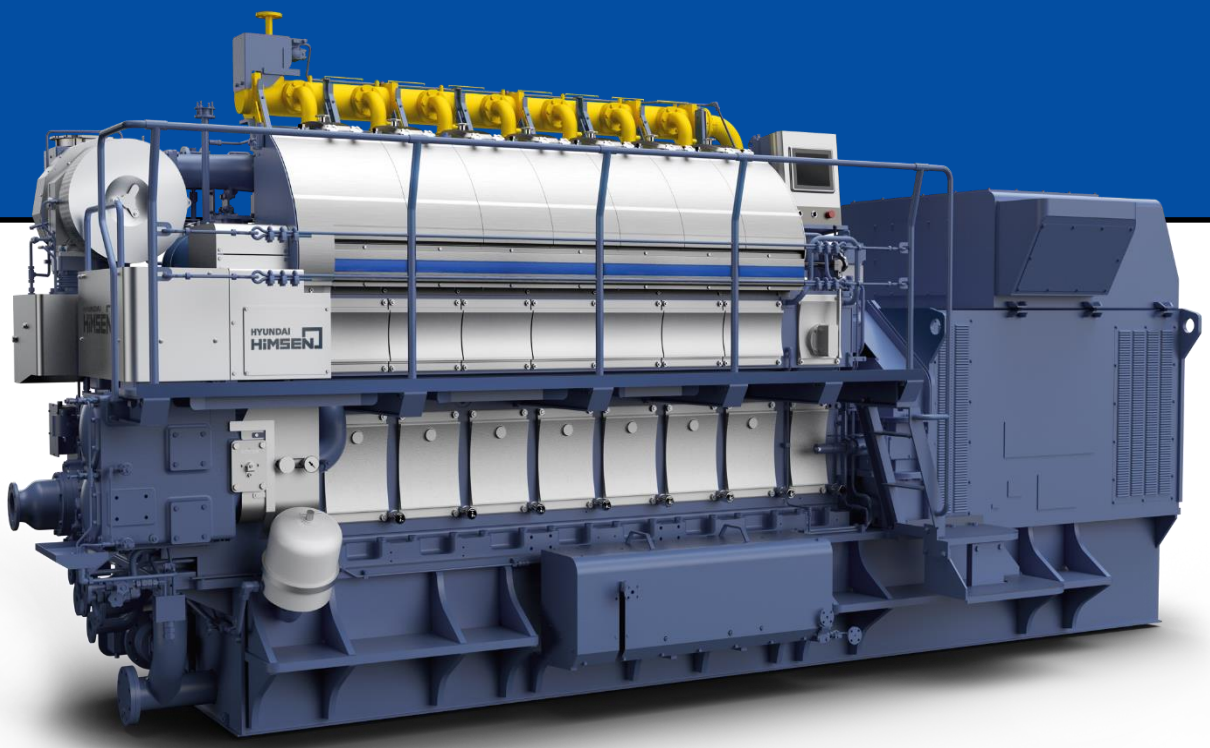
Trouble Shooting Manual For HiMSEN DF Engine



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Contents

Introduction

This document is intended to provide on site Trouble shooting for HiMSEN DF engine operators.

Since the contents in this document are reflecting the service experiences of Hyundai Global Service for HiMSEN DF engine for last couple of years, therefore we believe that our valued customers can take advantage of this document usefully along with Instruction manual for safe operation of HiMSEN DF engine.

It may not possible for the operators to solve all the troubles by reviewing this document. If so, please do not hesitate to contact us.

This document will be regularly updated to include the latest cases and new technical information.

Faithfully yours,

H. L. Oh, General Manager

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Technical Division

General Notice

All information provided in this document is for informational purposes only. Therefore, it is not a definitive binding document and may be changed without prior notice. In addition, there are no guarantees or guarantees for any particular content.

Depending on the requirements of the specific project in the future, related data and documents may be changed, and specifications should be determined after evaluation by specific project.

This should be determined according to each individual project, that is, the specifications required for the specific area and specific operating conditions.

Abbreviation

IVC: Intake Valve Closing

AFR: Air Fuel Ratio

C.W: Cooling Water

DOI: Duration of Injection

ECS: Engine Control System

PT: Pressure Transmitter

JW: Jacket Water

GRU: Gas Regulating Unit

ICM: Ignition Control Module

T/C: Turbocharger

Pmax : Cylinder Max Pressure

PF: Power Factor

TE: Temperature Element

LT: Low Temperature

HT: High Temperature

L.O: Lubrication Oil

GAV: Gas Admission Valve

TDC: Top Dead Center

IP converter: Current to Pressure converter

CMM: Cylinder Monitoring Module

PFO: Pilot Fuel Oil

Pcomp : Cylinder Compression Pressure

Trouble shooting

1. Slow turning
2. Start failure
3. Misfiring(during starting)
4. DVT
5. Micro pilot system
6. Cooling water
7. Load Operation(Diesel mode)
8. GRU
9. GAV(Gas Admission Valve)
10. Fuel change over
11. Waste gate
12. Abnormal combustion (Knocking & Misfiring & Exhaust deviation)
13. Cylinder pressure
14. Valve position failure
15. Knocking failure
16. Speed & positioner sensor failure
17. Charge air deviation
18. Gas Injection max duration
19. Any circuit breaker off
20. CAN communication failure
21. ICM minor alarm
22. Rupture disc

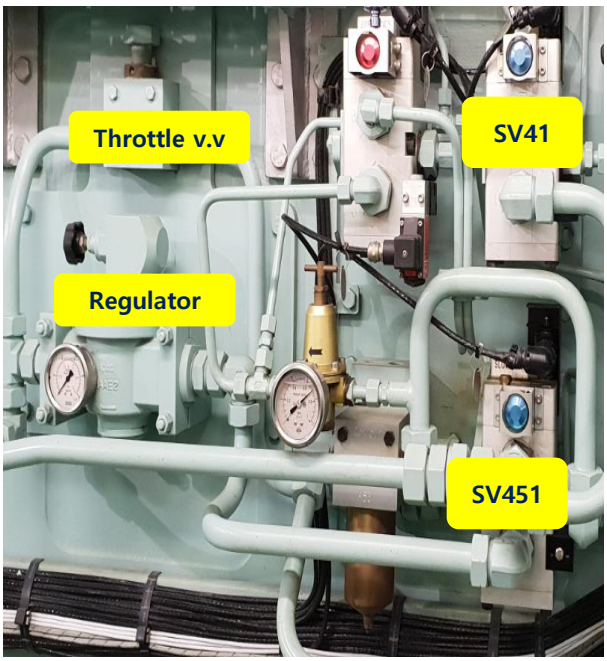
1. Slow turning

Description	Slow-turning
Problem indication	Slow-turning failed
Causes of problem	Troubleshooting/ Corrective Action

※ In case of slow turning failure, there are two cases that Mechanical and Electrical and it can be verified by activating SV41(Starting valve) , SV451(Slow turning valve) , SV452 (Slow Turning valve 2) manually.
※ Slow turning should be done when engine is in 'Ready to start' condition.

<Mechanical check point>

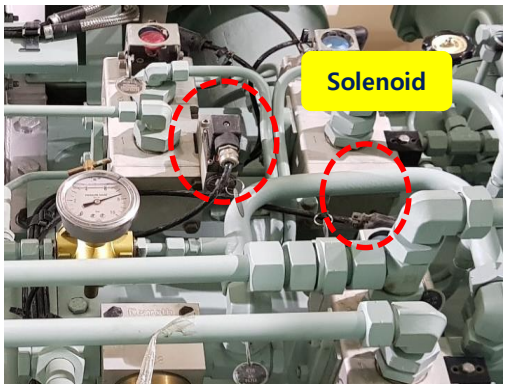
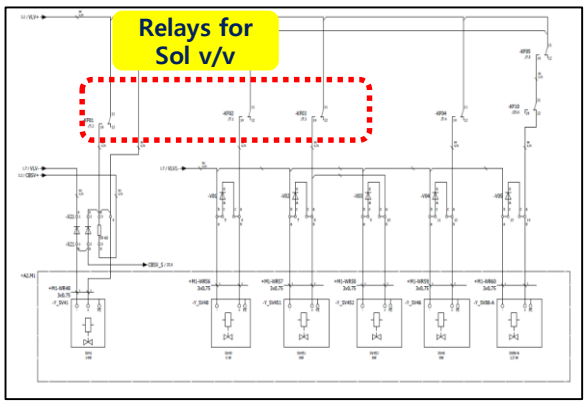
1. No rotation of flywheel during the Slow-turning



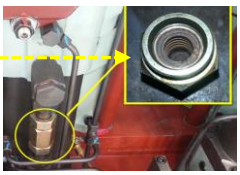
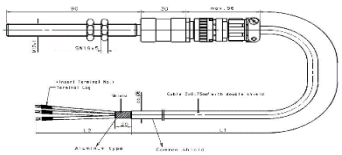
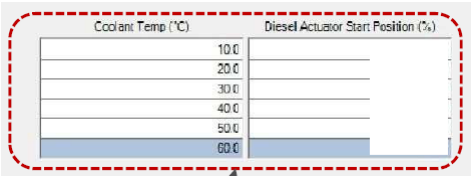
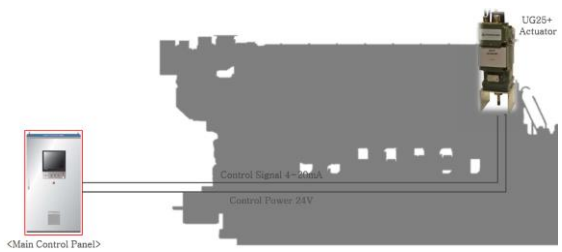
- ✓ Check starting air pressure is enough to start engine.
- ✓ Re-adjust pressure regulator setting.
- ✓ Re-adjust throttle valve setting.
- ✓ Turn 2 round with turning gear for confirm rotating part trouble.
- ✓ Check whether there is liquid inside of combustion chamber by carrying out slow turning after open indicator valve or removing cylinder pressure sensor. If there is liquid inside, please follow below procedure.

1) Condensate water : Re-try after remove condensate water
2) Cooling water : Check cylinder head gasket and O-ring condition.
3) If O-ring was damaged, could confirm by drain hole next to cylinder head.
4) Lube Oil : Check O-ring condition of intake valve of cylinder head.
5) Fuel Oil : Check fuel injection valve condition.
6) Check dis-engagement of turning gear

1. Slow turning

Description	Slow-turning
Problem indication	**Slow-turning failed**
Causes of problem	**Troubleshooting/ Corrective Action**
<Electrical check point> 1. If **"24V Earth fault " alarm** from SV41, SV451, SV452 when slow-turning is activated. 	✓ It may occur due to burnt internal coil or internal trouble of solenoid valve (valve stick, O-ring, etc). Thus, please follow below procedure. ➢ Change the solenoid valve complete ➢ Overhaul the valve and replace internal damaged component.
1. If **No "24V Earth fault " alarm** from SV41, SV451, SV452 when slow-turning is activated. 	✓ Check solenoid valve relay in control panel. ➢ If relay is normal (detected 24V in relay output), check damage of cable between relay and sol. valve. ➢ If relay function is abnormal, check relay input voltage (normal 24V). ➢ If not detected 24V, check damage of cable between relay and main controller. 1) Additionally check main controller channel output is 24V. 2) If detected 24V, it is caused by relay fault. So replace it.

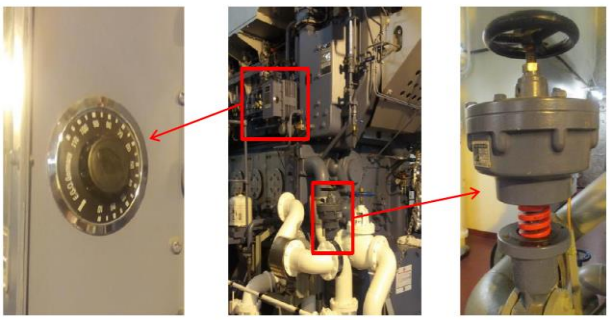
2. Start failure

Description	Starting failure
Problem indication	Engine start failure
Causes of problem	**Troubleshooting/ Corrective Action**
1. Air-running failure Starting Non return valve 	✓ If air running failed , please check starting air supply system whether main starting air valve or pilot air valve is stuck. **※Note : Poor cleanliness of air frequently causes rust and stuck of valves.**
2. Speed pick-up sensor failure 	✓ If air running is available but engine rpm is '0' on LOP(Local Operation Panel), should check speed pick-up sensor and sensor cable. **※Note chapter 16. about Speed & positioner sensor failure**
3. Wrong setting of fuel rack starting position 	✓ If setting is lower than minimum fuel rack to start, it could cause start failure. ※ On the contrary, if setting is too higher than requirement, it could cause black smoke and mechanical trouble.
4. Low fuel oil pressure	✓ Fuel oil pressure is lower than normal range of project guide, it could cause start failure by misfire.
5. No activation of UG25+ actuator 	✓ If command(4-20mA) is not delivered to actuator due to cable damage or other reason, actuator could not operate during air running. Check cable and controller output. ✓ Power 24V should be supplied to UG 25+ actuator. Check supply voltage. ✓ Change or swap the actuator

3. Misfiring(during starting)

Description	Misfiring during Starting
Problem indication	Misfiring detect from cylinder pressure Cyl. # xx
Cause and Photo	**Troubleshooting description**

1. Not pre-heated sufficiently

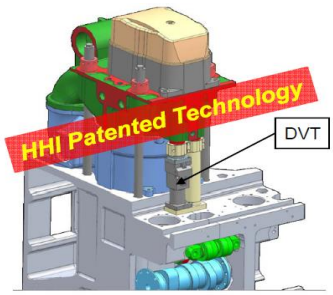


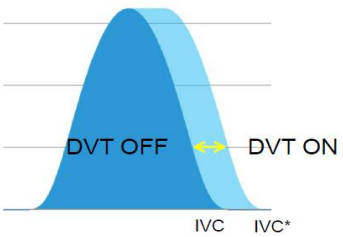
Check preheater setting and sealing condition of C.W V/V

- ✓ Maximum temperature of combustion air in compression stoke is not too higher than fuel oil self-ignition temperature because compression ratio is low compared with conventional diesel engine. To compensate this, engine should be pre-heated sufficiently before start. And it could prevent misfire, white smoke.

※ Generally DF engine has function of start block if H.T.C.W temperature is lower than 40℃.

2. DVT function failure



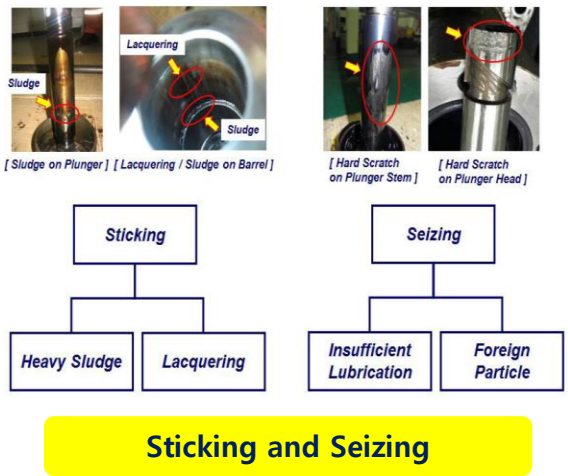


IVC* at low load operation

- ✓ If DVT function failed, it could cause misfire because combustion air quantity is not enough. DVT operation makes retard of IVC(Intake Valve Closing) timing and it will supply enough charge air to combustion chamber.
- ✓ New type of DVT will be operated when control air is not supplied. Confirm control air supply with DVT feedback pressure and controller parameter setting should be done.

※ Note : old type of DVT will be operated when control air is supplied. It could set with control parameter.

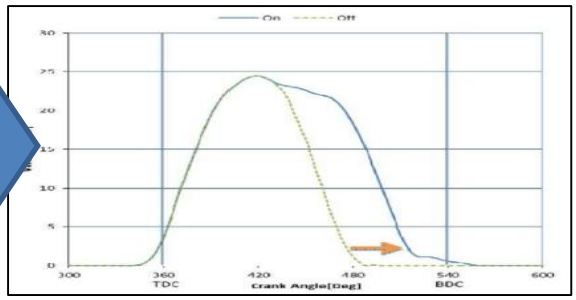
3. Misfiring(during starting)

Description	Misfiring during Starting
Problem indication	Misfiring detect from cylinder pressure Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
3. Fuel injection equipment trouble  **Sticking and Seizing**	✓ Following trouble may cause starting failure. ➢ Sticking or seizing of FIP ➢ Excessive wear or damage of plunger ➢ Poor atomization of Fuel injection valve

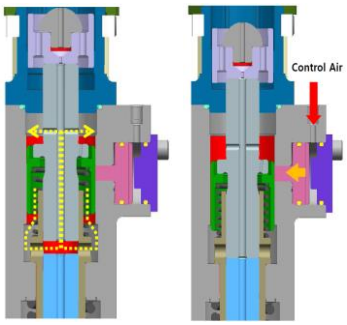
4. DVT

Description	DVT Failure
Problem indication	DVT positon fault at DVT on/off condition
Causes of problem	**Troubleshooting/ Corrective Action**

DVT improve combustion quality in low load and starting by retarding IVC(Intake Valve Closing) timing. If DVT is operated, Pcomp and Pmax will be increased because combustion air quantity is higher. Especially DVT operation in high load, it could cause serious damage in combustion chamber because of high Pmax.



1. DVT is not worked



DVT mechanism For Pusher type

- ✓ If DVT is not activated in starting and low load operation, it could cause white smoke and misfire, exhaust gas temperature deviation, etc.
- ➢ Check function of Sol. Valve (check blockage of sol. Valve vent hole)
- ➢ Check supply of control air.
- ➢ Check DVT was stick.

2. DVT operation in high load

- ✓ In this case, increased Pmax may cause combustion chamber damage. To prevent this damage, load limitation alarm will be activated and limit engine load.
- ➢ Check function of Sol. Valve (check blockage of sol. Valve vent hole)
- ➢ Check supply of control air.
- ➢ Check DVT was stick.
- ➢ Check engine load signal from PMS(Power management system) is correct or not.
- ➢ Check fuel rack base load estimation setting is correct in case of load signal fault.

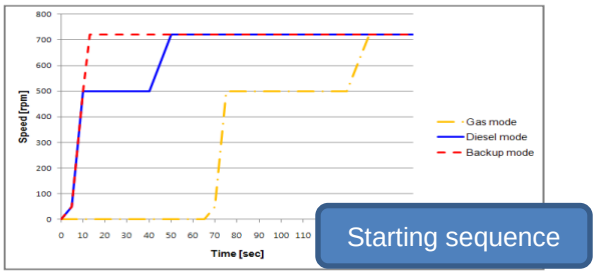
4. DVT

Description	DVT Failure
Problem indication	DVT positon fault at DVT on/off condition
Causes of problem	**Troubleshooting/ Corrective Action**
3. Feedback alarm is activated even though DVT is worked normally.	✓ Check correction of on/off setting and delay time of pressure which is read from feedback sensor. ✓ Check feedback cable damage. ✓ Check feedback switch condition.

5. Micro Pilot system

Description	Rail press. build up failure
Problem indication	PFO pressure HP pump outlet high & low PFO press. Fails to build up
Causes of problem	**Troubleshooting/ Corrective Action**

At engine starting, micro pilot system will be operated and increase pressure to 900 or 1,000 bar (set press.). After that, by operating only pilot injector, system will check normal operation of micro pilot system with monitoring engine rpm and each cylinder exhaust gas temperature.



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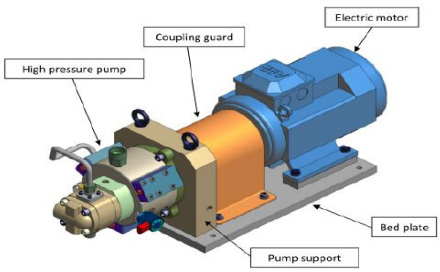
1. HP pump motor is not rotated



- ✓ Check alignment of pump and motor.
- ✓ Check supply voltage (3 phase, 440V).
- ✓ Check command signal from main controller to pilot pump starter.
- ✓ Check relay function for command signal.
- ✓ Check 24V command signal from controller.
- ✓ Change or swap the motor.

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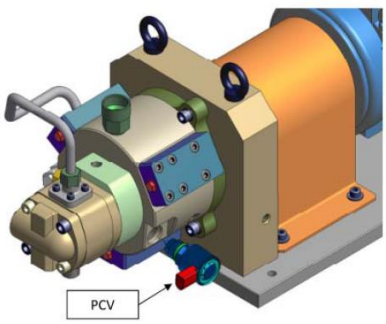
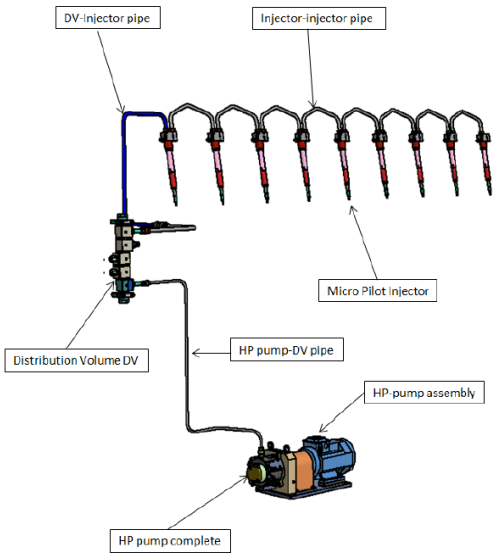
2. HP pump is rotated but pressure could not build up or control properly



- ✓ Check motor rotating direction. If rotate opposite direction, pump will be damaged.
- ✓ Check signal to pressure control valve and relief valve(if applied).
- ✓ Change or swap throttle valve and relief valve(if applied).
- ✓ Check if there are any fuel leakage points.
- ✓ Change or swap the HP pump.

5. Micro Pilot system

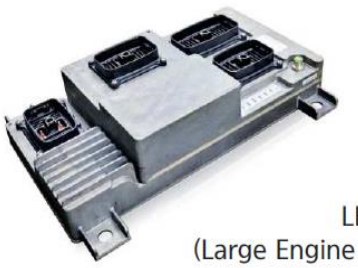
Description	PFO flow
Problem indication	PFO flow high
Causes of problem	**Troubleshooting/ Corrective Action**
HP throttle valve positon MAX is set to prevent excessive increase of opening value due to fuel leakage at HP pump or double wall pipe.	
1. Fuel oil leakage 	✓ Retighten and change the leaking parts if necessary. ✓ Check sealing O-ring and pipe fitting condition replace it necessary.
2. HP pump is rotated but pressure could not build up	✓ Check signal to throttle valve and relief valve(if applied). ✓ Change or swap throttle valve and relief valve(if applied). ✓ Check if there are any fuel leakage points ✓ Change or swap the HP pump.

5. Micro Pilot system

Description	Pilot injection test failure
Problem indication	Pilot injection test failed Pilot injection test failed cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**

MP test should be carried out before rpm reach to the rated rpm in order to check the condition of pilot injector and make the engine gas ready condition.

1. Misfiring of Single or Multiple cylinder during test period



LECM
(Large Engine Control Module)

MP system controller

- ➢ If single or multiple cylinders do not work properly, failure alarm occurs. All cylinder's IMEP or Exhaust gas temp are compared with average value and failure are decided according to the setting reference.

Check relevant cylinder MP injector alarm(open coil or over current condition)

- ✓ In case of open coil alarm, injector could not receive command due to cable damage.
- ✓ In case of over current, it needed replacement of MP injector or check cable condition because sol. Valve trouble or cable short could cause over current.

1) Check the condition of Pilot Injector.
2) Check the cabling condition.
3) Control module

- ➢ Swap Control module with other engine(same cylinder no.)'s one.

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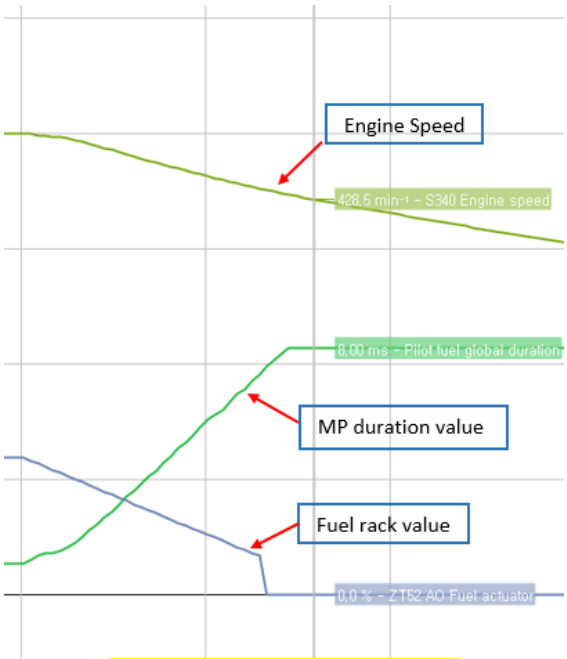
2. Pilot trip activated during MP test because engine rpm was dropped. (pressure is normal)

Fig.1 Measuring MP injection timing

Fig.2 MP injection timing calibration

- ✓ Check each MP injector normal operation by MP injector click test.(by S/E)
- ✓ Check MP injection degree (normal is just before TDC) by confirm TDC setting with Scopelite.(by S/E)
- ✓ Check cable connection between MP injector and controller.
- ✓ Swap the Controller with other cylinder(same cylinder no)'s one.

5. Micro Pilot system

Description	Pilot injection test failure
Problem indication	Pilot injection test failed Pilot injection test failed cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
2. Pilot trip activated during MP test because engine rpm was dropped. (pressure is normal)  **Engine RPM Dropping during MP Test Period**	✓ Check each MP injector normal operation by MP injector click test.(by S/E) ✓ Check MP injection degree (normal is just before TDC) by confirm TDC setting with Scopelite.(by S/E) ✓ Check cable connection between MP injector and controller. ✓ Swap the Controller with other cylinder(same cylinder no)'s one.

6. Cooling water

Description	L. T. C. W / H. T. C. W 3-Way Valve failure
Problem indication	Charge air temp high LT temp air cooler inlet high
Causes of problem	Troubleshooting/ Corrective Action

※ DF engine controls L.T.C.W temperature more precisely compared with diesel engine. This control target is charge air temperature. If this control is abnormal, fuel gas combustion may be unstable

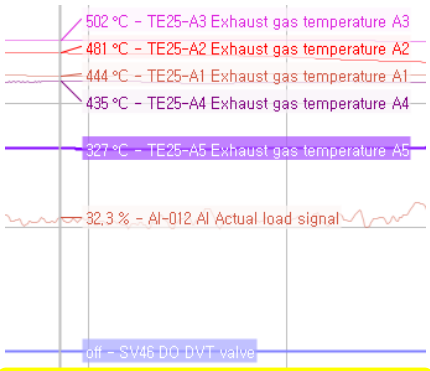
1. Control valve function is abnormal 	✓ Check mechanical manual handle position of control valve. ✓ Check valve position by controlling parameter value. Give command 0~100% and check valve rotating movement. ✓ If valve is not rotated, check command output (4-20mA) and cable condition, connection. ✓ If valve is not rotated, check cable connection between controller and actuator.
2. Control valve is rotated well but could not control temperature	✓ Adjust PID gain . (It should be discussed with HGS) ✓ Adjust valve open/close limit. (It should be discussed with HGS) ✓ Check water temperature of valve inlet.
3. Valve position feedback failure/deviation occurred even though temperature control is normal.	✓ Check cable damage and cable connection. ✓ Check feedback (4-20mA) output from control valve. (As valve position, feedback output(4-20mA) will be detected)

7. Load operation(Diesel mode)

Description	Trouble on load operation (Diesel mode)
Problem indication	
Causes of problem	Troubleshooting/ Corrective Action

※ DF engine diesel mode is similar with diesel engine. But difference is operation of Micro Pilot system and LT 3-way valve.

1. Exhaust gas deviation (Diesel mode)



Exhaust Gas Temp Deviation

- ✓ Check fuel rack value of each cylinder. If there is deviation, adjust to same value.
- ✓ Check P-comp of each cylinder with combustion pressure trend.
- ✓ If some cylinder DVT operation is abnormal, P-max and exhaust gas temperature deviation may occur due to P-comp deviation. In this case, relevant cylinder DVT overhaul work should be done.
- ✓ Check tappet clearance of intake/exhaust valve.

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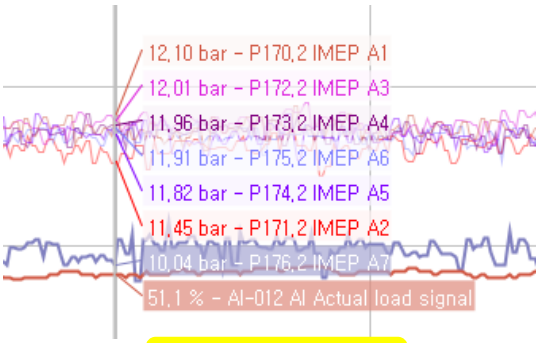
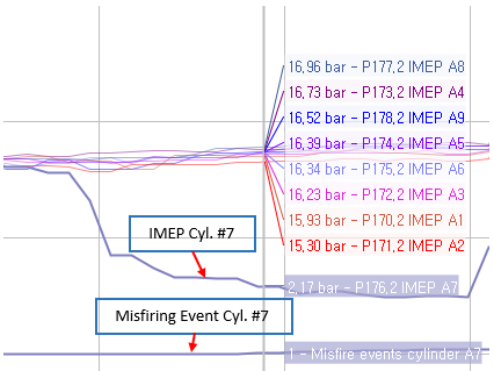
2. Pmax deviation on load operation (Diesel mode)

- ✓ Check Shim thickness of fuel injection pump. By adjusting shim thickness, Pmax could be adjusted due to changed injection timing.
- ✓ Check each cylinder DVT function. Abnormal of DVT operation, Pcomp of each cylinder will be different and it may cause Pmax deviation. In this case, relevant cylinder DVT should be overhauled.

※Note chapter 4. about DVT

- ✓ Compare each cylinder fuel rack value. If deviation is high, adjust it.

7. Load operation(Diesel mode)

Description	Trouble on load operation (Diesel mode)
Problem indication	
Causes of problem	**Troubleshooting/ Corrective Action**
3. IMEP deviation on load operation (Diesel mode)  **IMEP Deviation**	✓ If cylinder pressure sensor fail, it could cause display abnormal IMEP value. In this case, replace relevant cylinder pressure sensor. ✓ Long term operated engine could cause blow-by because wearing of piston ring. It will cause IMEP deviation. This case, after review of engine running hour and combustion pressure trend, piston ring and liner should be overhauled and replaced if needed.
4. Misfire on load operation (Diesel mode)  **Misfiring on Load Operation**	✓ If fuel injection pump is stick, it might cause misfire due to fuel injection trouble. This case, injection pump should be replaced. ✓ If fuel oil pressure is low, fuel supply will be not enough. Check external system and increase fuel oil pressure to normal range.
5. Main bearing high temperature on load operation (Diesel mode)	✓ Check engine load if overload, decrease load. ✓ Check LO pipe to main bearing in engine stop. If pipe was blocked with anything, it could cause bearing damage.

7. Load operation(Diesel mode)

Description	Trouble on load operation (Diesel mode)
Problem indication	
Causes of problem	**Troubleshooting/ Corrective Action**
6. High oil mist level in load operation (Diesel mode)	✓ Open crankcase door and check oil mist generated part in engine stop condition. ✓ If liner scuffing occurred, there are various root-causes like main bearing metal contact due to foreign substance in oil film, etc.
7. Abnormal sound from rotating part on load operation (Diesel mode)	✓ Stop engine and check cylinder head and bolt tightness of each rotating part.
8. Pilot trip on load operation (Diesel mode)	✓ If pilot fuel oil leak from double-hulled pipe, replace it. ✓ If pressure sensor is out of work, replace it. ✓ Throttle valve opening value is higher than normal operation. 1) Fuel supply quantity is increased because injection quantity is over the needed or leakage from double-hulled pipe 2) Even though fuel leakage and injection quantity are normal, if throttle valve opening value is high, pump performance could be judged as trouble. Replace pump. ✓ Fluctuation of pilot fuel rail pressure 1) Adjust PID value.(by S/E) 2) If total injection quantity is too low, it could cause trouble on pressure control. In this case, increase injection quantity.

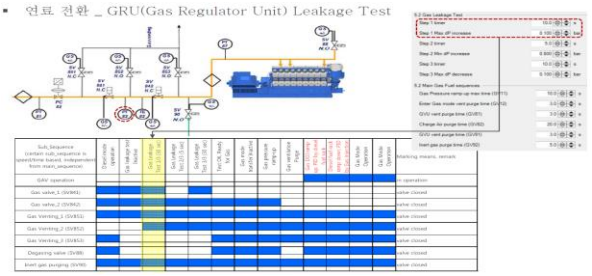
8. GRU

Description	GRU leakage test
Problem indication	Gas leak check failed in step 1 or 2 or 3 Gas leakage test failed
Causes of problem	Troubleshooting/ Corrective Action

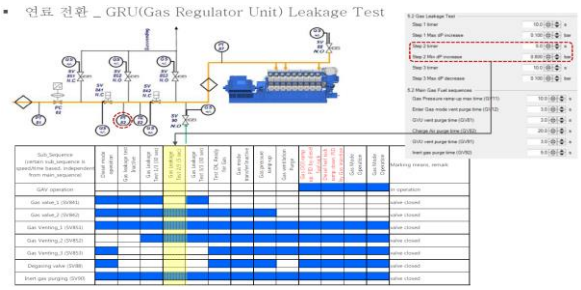
※ GRU leakage test will be done before every transfer from diesel mode to gas mode for check leakage test of each part. In the meantime, if GRU shut-off valve and venting valve is abnormal, Gas trip will be activated.

<Gas leakage test step 1>
At closed condition of shut-off valve #1, #2, gas will be supplied until before shut-off valve#1. If there is leakage on shut-off valve#1, pressure will be increased between shut-off valves #1, #2 and leakage step 1 fail will be activated.

✓ For resolve, shut-off valve #1 will be replaced.



<Gas leakage test step 2>
Shut-off valve #1 will be open and pressure will be increased between shut-off #1, #2. But if pressure could not reach to set value, leakage test step 2 failure will be activated.



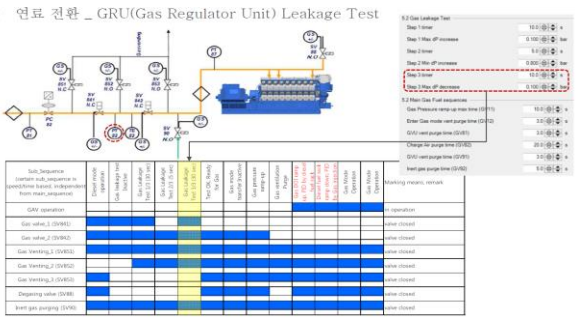
1. Mechanical offset of GRU is not 1 bar

✓ Set to 1 bar by adjusting screw.
✓ If pressure could not be adjusted with screw, check instrument air pressure to regulator. (normal 7 bar)
✓ Replace regulator if the others are normal.

2. Abnormal opening of shutoff valve #1

✓ Check 24V of valve control signal
✓ Check cable damage and connection.

8. GRU

Description	GRU leakage test
Problem indication	Gas leak check failed in step 1 or 2 or 3 Gas leakage test failed
Causes of problem	**Troubleshooting/ Corrective Action**
3. Abnormal closing of venting valve #2	✓ Check 24V of valve control signal. ✓ Check cable damage and connection. ✓ Check valve leakage.
<Gas leakage test step 3> At closed condition of shut-off valve #1, #2 and venting valve #2, system will monitor whether mechanical offset pressure keep 1 bar between blocked area. If there is pressure drop, could estimate leakage of venting valve #2 or shut-off valve #2.	
1. Abnormal closing of shut-off valve #2	✓ Check 24V of valve control signal. ✓ Check cable damage and connection. ✓ Check valve leakage.
2. Abnormal closing of Venting valve #2	✓ Check 24V of valve control signal. ✓ Check cable damage and connection. ✓ Check valve leakage.

8. GRU

Description	GRU gas supply failure
Problem indication	Gas pressure deviation from reference
Causes of problem	**Troubleshooting/ Corrective Action**
※ Supplied gas pressure of GRU is charge air pressure + offset pressure. Generally offset pressure is 1 bar and it could be changed according to the field condition by commissioning engineer. If gas pressure could not follow set pressure, gas trip will be activated.	
1. Abnormal instrument air pressure to IP converter (normal 7 bar)	✓ Check external system.
2. Sensor failure	✓ Check cable damage and connection. ✓ Change the sensor with new one.
3. Abnormal control signal (4-20mA) to IP converter	✓ Check cable damage and connection. ✓ Check controller output.
4. IP converter failure	✓ Calibrate IP converter. ✓ If function fail after calibration, replace it.
5. Regulator failure or leak	✓ If gas pressure deviation alarm happen only during change over from gas to diesel, leakage inside the valve is suspected. ✓ Change internal repair parts or complete after discussing with maker.

9. GAV(Gas Admission Valve)

Description	GAV gas supply failure
Problem indication	Gas admission valve Cyl. # xx fault
Causes of problem	**Troubleshooting/ Corrective Action**

※ Fuel gas supply from GAV to each cylinder by opening GAV during intake valve open condition. If there is trouble on GAV, fuel gas supply will be affected and relevant cylinder combustion condition will be abnormal like misfire or knock.

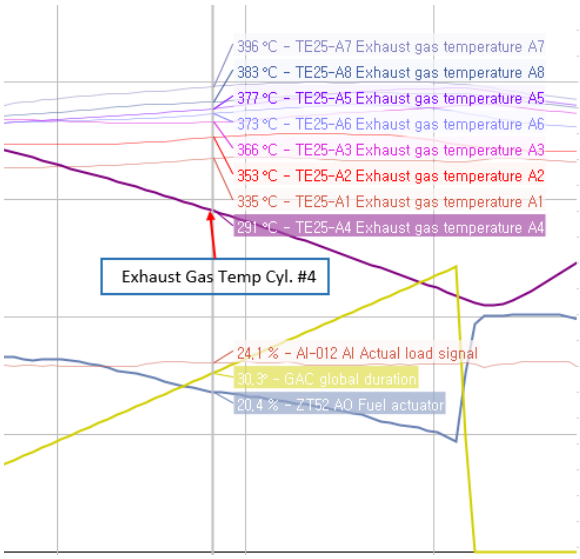
1. If GAV could not be closed completely because of strange substance, fuel gas will be supplied continuously to cylinder and Pmax, exhaust gas temperature will be increased.	✓ This case, remove strange substance by overhauling GAV.
2. If 'open coil' alarm is activated, GAV could not be open normally due to broken cable. (Open coil alarm can be checked after connect to the Controller by S/E)	✓ Check cable condition and connection.
3. If 'over current' alarm is activated, could estimate cable short or sol. Valve trouble in GAV. (Over current alarm can be checked after connect to the Controller by S/E)	✓ Check cable condition and connection. ✓ In case of sol. Valve trouble, replace GAV.

10. Fuel change over

Description	Diesel to gas failure
Problem indication	EGT deviation high Cyl. # xx
Causes of problem	Troubleshooting/ Corrective Action

※ DF engine has 2 kind of fuel mode (diesel mode, gas mode). Fuel gas increasing ratio is slow when changeover from diesel to gas mode so it need enough time. And changeover diesel to gas is most unstable in DF engine operation.

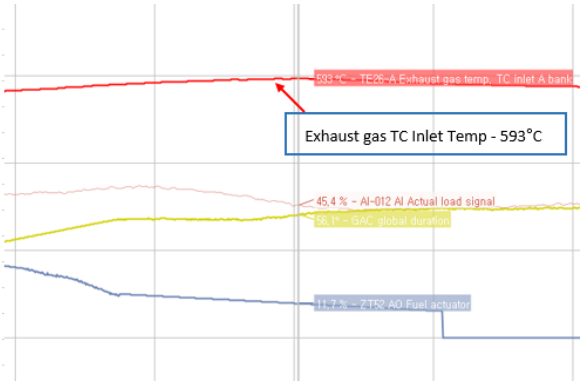
1. Gas trip due to exhaust gas temperature deviation.



Gas Trip due to Exhaust Gas Temp Deviation

- ✓ Check ‘active’ of exhaust gas temperature balancing function in cylinder balancing function during changeover.(It should be discussed with HGS)
- ✓ Carry out MP test after stop and re-start engine. If some cylinder exhaust temperature is too lower than others during MP test period, MP nozzle hole should be checked.
- ✓ If some cylinder exhaust gas temperature is too higher than average, GAV should be checked. If fuel gas supply continuously because of GAV abnormal closing, Pmax and exhaust gas temperature will be increased and it may cause ‘gas trip’.

10. Fuel change over

Description	Diesel to gas failure
Problem indication	EGT deviation high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
2. Sudden increase of exhaust gas temperature  **Exhaust Gas TC Inlet Temp High During Change-Over**	➢ MP injection timing change speed is not optimized. (It should be discussed with HGS) ✓ Generally, MP injection timing in diesel mode is BTDC 0 degree, timing in gas mode is around BTDC 25 degree. Timing change is done in constant speed but if speed is too low, exhaust gas temperature will be highly increased. But if change speed is too high, it could cause engine damage. ➢ Charge air pressure change speed is not optimized. (It should be discussed with HGS) ✓ Generally, Charge air pressure in diesel mode is more higher than gas mode. Charge air pressure change is done in constant speed but if speed is too fast, exhaust gas temperature will be highly increased. But if change speed is too low, it could cause unstable combustion(misfiring) .

10. Fuel change over

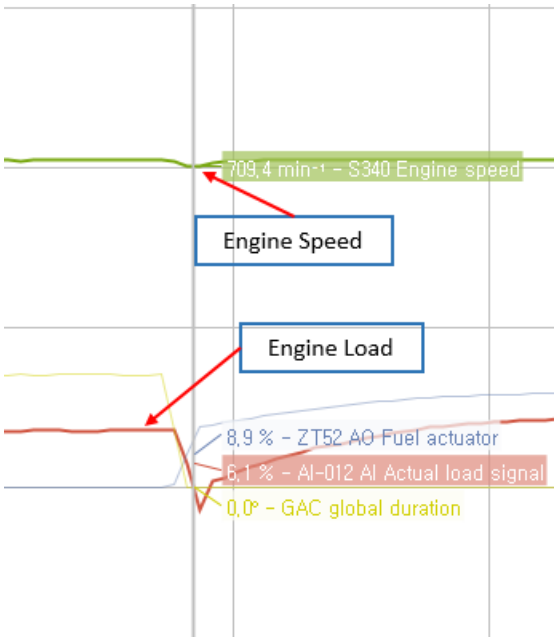
Description	Diesel to gas failure
Problem indication	Valve position failure Gas pressure deviation from reference
Causes of problem	**Troubleshooting/ Corrective Action**
1. Gas trip due to gas valve open / close failure	➢ After gas leakage test, control system received feedback signal of valve position from GRU. ✓ Check cable and relay condition. ✓ Check limit switch of GRU.
2. High fluctuation of engine load during changeover	➢ Check changeover parameter. (It should be discussed with HGS) ✓ Diesel PID → Gas PID changing time set to slightly before diesel fuel cutoff. (But if PID changing time is too late, actuator may be hunted.) ✓ If load is changed when diesel fuel cutoff, reduce cutoff value. (But could not reduce until fuel oil injection is unstable) ✓ Adjust PID value applied to fuel changeover ➢ Purge time optimizing before fuel gas supply (It should be discussed with HGS) ✓ There is air in gas pipe in diesel mode operation. So if purging period is too short, fuel gas combustion will be effect by air and nitrogen gas. **※Note: Chapter 8. GRU.** ➢ Fuel gas material property ✓ If methane number or calorific value is not satisfied as project guide, combustion quality will be bad. **※Note : Minimum Methane number - 80**

10. Fuel change over

Description	Gas to diesel failure
Problem indication	
Causes of problem	Troubleshooting/ Corrective Action

※ Fuel changeover from gas to diesel mode is done in a moment. Fuel rack position is set in each load. When receive fuel mode changeover signal, fuel rack will be move to set value in present load in a moment.

1. Rpm or load fluctuation when changeover from gas to diesel.



RPM/Load decrease during Change-Over

✓ Optimize fuel rack position set value.
※ Note : To be discussed with HGS prior to set value.

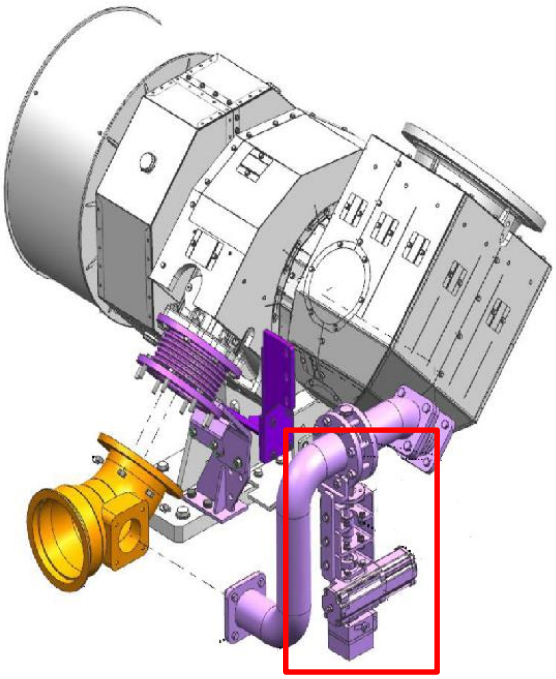
✓ Reduce gas supply stop delay setting value if speed increasing is high. After delay time of changeover command, gas supply will be stop. If delay time is too long, fuel oil and fuel gas will be injected at the same time and it could cause over-speed.
(It should be discussed with HGS)

11. Waste gate

Description	Waste-gate control failure
Problem indication	C.A press dev high(PT24 & REF)
Causes of problem	Troubleshooting/ Corrective Action

※ In diesel mode, if charge air quantity is higher, it will be helpful for efficiency. But in gas mode, proper air quantity is important and if over the range, it could cause abnormal combustion like misfire or knock. To control charge air quantity, waste-gate valve is installed on DF engine.

1. Unable to control charge air pressure as set value.



Wastegate Valve

- ➢ Check control air pressure(7 bar) to waste-gate valve.
- ➢ Check 24V control signal (4-20mA) is in normal.
- ✓ Check function(0-100% open command) in engine stop. Carry out zero position calibration.
- ➢ Check setting mode in parameter.
- ✓ If set to manual mode, valve will not follow the command and keep to set position.
- ➢ Check valve shaft breakage.
- ➢ Check valve housing bolts breakage
- ➢ Check exhaust gas leakage from valve connection part.
- ➢ Check engine load signal from PMS(Power management system) is correct or not. Wrong load signal can cause big deviation of charge air pressure.

12. Abnormal combustion(Knocking & Misfiring & Exhaust deviation)

Description	Knocking
Problem indication	Knock high timing regard Cyl. # xx Cylinder press high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
※ DF engine in gas mode is pre-mixture combustion, so it could cause often knock and pre-ignition, etc. So DF engine is tuned for reducing this case and optimizing efficiency, emission.	
1. L.O flow in combustion chamber	✓ If L.O from intake valve flow in combustion chamber, it could cause knock because of self-ignition of L.O. This case, O-ring of intake valve should be checked.
2. Charge air temperature	✓ If charge air temperature is too high, it could cause knock because of self-ignition of fuel gas. This case, check the cooling water control valve condition.
3. Charge air pressure	✓ If AFR is too rich, it could cause knock. This case, check the actual charge air pressure. **※Note: Chapter 12. Waste gate**
4. Gas property(Methane number) **2) Methane number (MN)** The methane number is the index which indicates the resistance of abnormal explosi on, anti-knock rating of a fuel gas. Hydroge n(H_2), which is highly liable to knocking, ha s the MN '0', while pure methane has the MN '100'. If the components and contents-r atio of a fuel gas are known, the MN could be calculated.	✓ If methane number of fuel gas is lower than standard value, it could cause knock. This case, detail discussion should be carried out with HGS

12. Abnormal combustion(Knocking & Misfiring & Exhaust deviation)

Description	Knocking
Problem indication	Knock high timing regard Cyl. # xx Cylinder press high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**

5. L.O Specification

White deposit due to using high BN lube oil

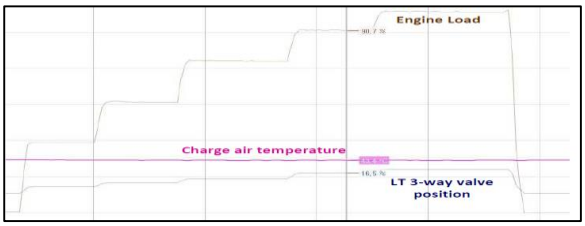
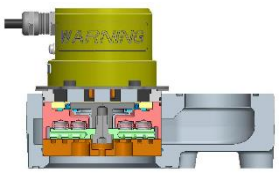
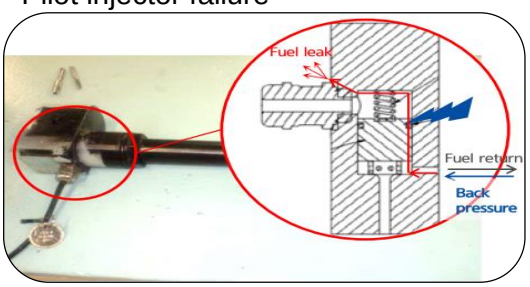
✓ If LO It has been occasionally reported that DF engines using lubricating oil with too high BN and running mainly on natural gas and/or low sulfur distillate fuel had excessive (white) deposit formation on combustion chamber component surfaces and turbocharger. This is because the higher the lubricating oil BN is, the more it also contains ash constituents (mainly calcium). These ash constituents stick to component surfaces under several conditions (their composition, temperature, etc.). These phenomena may cause higher turbocharger speed, exhaust gas temperature in diesel mode and knocking in gas mode

.

※Lube oil selection table for DF engine

Engines operation	Fuel S content (% mm)	Recommended BN	Allowed Max. operating hours
Continuous Natural Gas (Gas mode operation ≥ 95%)	-	BN 3-7 (Sulphated Ash : Max. 0.6 % m/m)	N/A
Alternate Natural Gas and Distillate Fuel [1]	<0.20		Distillate Fuel : 15% of total monthly accumulated operating hours [4]
	0.20-0.50		Distillate Fuel : 10% of total monthly accumulated operating hours [4]
Continuous Distillate Fuel or Alternate Distillate Fuel and Natural Gas	<0.40	BN 10-15	Natural Gas : 15% of total monthly accumulated operating hours
	0.40-1.50	BN 15-20	Natural Gas : 10% of total monthly accumulated operating hours
Continuous Residual Fuel [2] or Alternate Residual Fuel, Distillate Fuel, Natural Gas	<1.00 [3]	BN 20	Residual Fuel : 15% of total monthly accumulated operating hours [5]
	1.00-2.50 [3]		Residual Fuel : 5% of total monthly accumulated operating hours [5]
	≤3.50 [3]	BN 30-50	Natural Gas : 10% of total monthly accumulated operating hours

12. Abnormal combustion (Knocking & Misfiring & Exhaust deviation)

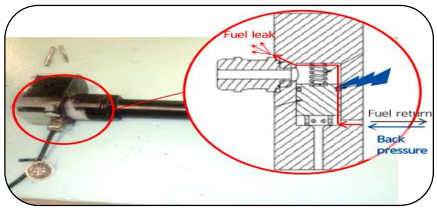
Description	Misfiring
Problem indication	Misfiring detect from cylinder press Cyl. # xx Pilot FO injector Cyl. # xx fault Gas admission valve Cyl. # xx fault
Causes of problem	**Troubleshooting/ Corrective Action**
1. Charge air temperature 	✓ If charge air temperature is too low, it could cause misfiring. This case, check the cooling water control valve condition. **※Note: Chapter 6. Cooling water**
2. Charge air pressure	✓ If air/fuel ratio is too lean, it could cause misfiring. This case, check the actual charge air pressure. **※Note: Chapter 11. Waste gate**
3. GAV failure  	✓ If there is trouble on GAV, fuel gas supply will be affected and relevant cylinder combustion condition will be abnormal like misfire or knock. **※Note: Chapter 9. GAV**
4. Pilot injector failure 	✓ Check cable damage and connection. ✓ Carry out nozzle spray test for check atomizer condition ✓ Check the terminal block condition and change the terminal if necessary ✓ Change the Pilot Injector with spare if necessary

12. Abnormal combustion (Knocking & Misfiring & Exhaust deviation)

Description	Exhaust deviation
Problem indication	EGT deviation high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**

※ Exhaust gas temperature deviation is higher than before. In gas mode, exhaust gas temperature deviation could be acceptable because of cylinder head mechanical characteristic. So if Pmax is similar, it could be acceptable until alarm activation level

1. Pilot Injector



✓ If pilot fuel oil is lower than other cylinders, it could cause temperature deviation. This case, by increasing specific cylinder injection quantity, could decrease temperature deviation. But after replacement of pilot fuel injector, setting should be back to original value.

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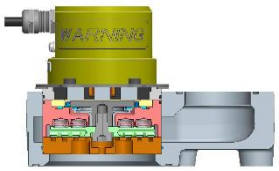
2. GAV



✓ If specific cylinder exhaust gas temperature is high, should check GAV and GAV filter condition also. If flowrate deviation is higher than other cylinders, it could not be covered by cylinder balancing function.

※ Note: Chapter 9. GAV

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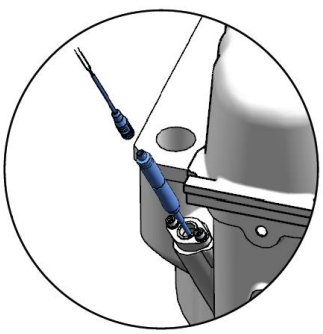
3. Cylinder pressure sensor



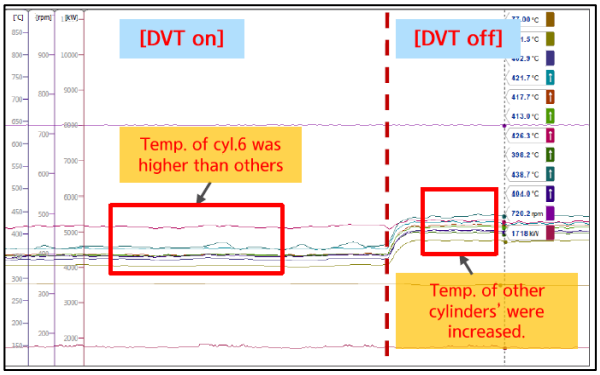
✓ Cylinder balancing is performed based on the each cylinder pressure sensor. Thus wrong cylinder pressure sensor value can cause mis-balancing.

※ Note: Chapter 13. Cylinder pressure

12. Abnormal combustion (Knocking & Misfiring & Exhaust deviation)

Description	Exhaust deviation
Problem indication	EGT deviation high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**

4. DVT malfunction



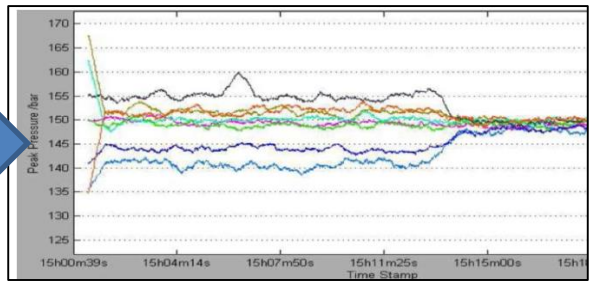
#6 Cylinder is showing different pattern of exhaust temperature during DVT activation due to defective DVT

- ➢ All cylinder's exhaust gas temp have to be increased after DVT off condition. If specific cylinder have no temperature difference before & after DVT operation, it means it is DVT function fault.
- ✓ Check the condition of DVT's spool or pusher body & tip.
- ✓ Change the damaged parts with new one
- ✓ Check if there is any blockage point of control air.
- ✓ Change complete DVT.

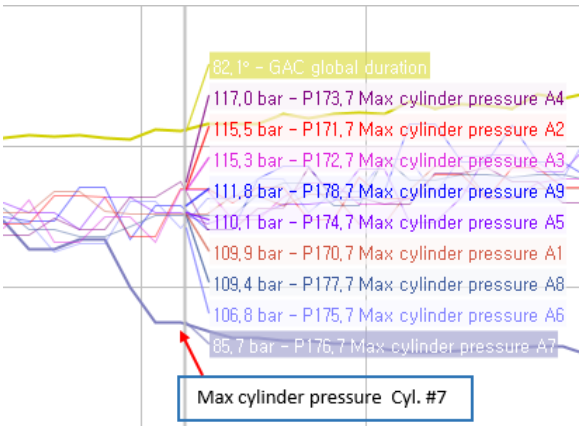
13. Cylinder pressure

Description	Cylinder balancing failure
Problem indication	Cylinder press. high Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**

※ Cylinder balancing function will be activated in gas mode. Cylinder balancing will be done with Pmax control by controlling gas supply quantity.



1. Max pressure deviation

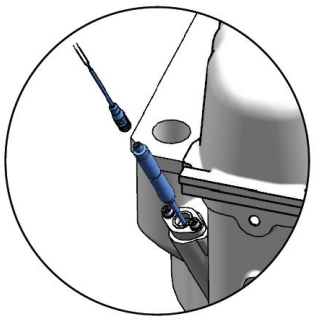


➢ Cylinder pressure sensor is out of work

✓ To confirm cylinder pressure sensor function, check cylinder pressure trace. If pressure trace is not smooth, replace cylinder pressure sensor.

✓ Changeover to diesel mode and check P-max deviation. If deviation is existed only in gas mode, could confirm as combustion quality trouble.

13. Cylinder pressure

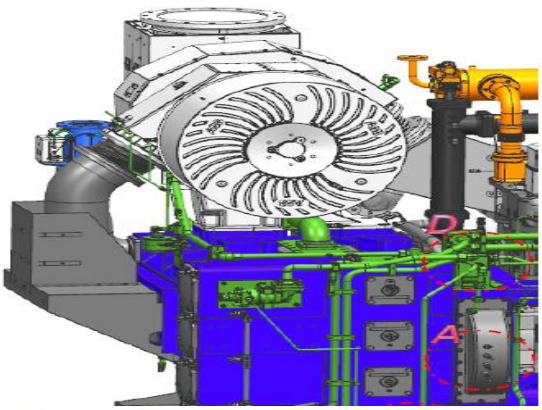
Description	Cylinder pressure sensor failure
Problem indication	Cylinder pressure sensor failure Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
1. Sensor failure  	✓ Swap the sensor with other cylinder's one.
2. Cable connection	✓ Check cable damage and connection. ✓ Change the cable with spare if necessary. ✓ Check the terminal block condition and change the terminal if necessary. ✓ Retighten the connector to CMM.(cylinder monitoring module)
3. CMM(Cylinder monitoring module) failure  CMM(E2Precon)	✓ Swap the control module with other engine's one or spare one. **※Note: CMM is compatible with all engine and no setting are required.**

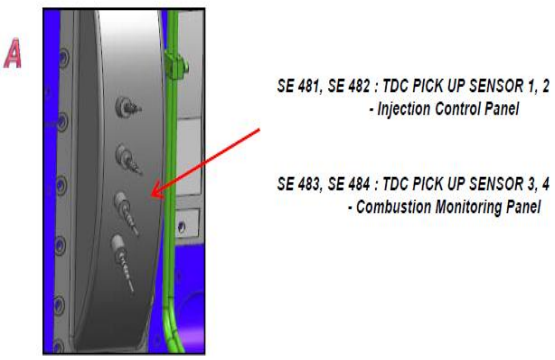
13. Cylinder pressure

Description	All Cylinder pressure sensor failure
Problem indication	Cylinder pressure sensor failure Cyl. # xx E2precon 1 pickup signals
Causes of problem	Troubleshooting/ Corrective Action

※ The value related to the cylinder pressure sensor such as P-max, IMEP and SOC(start of combustion) are calculated by taking two values of each cylinder's pressure sensor and positioner(cam timing) sensor.

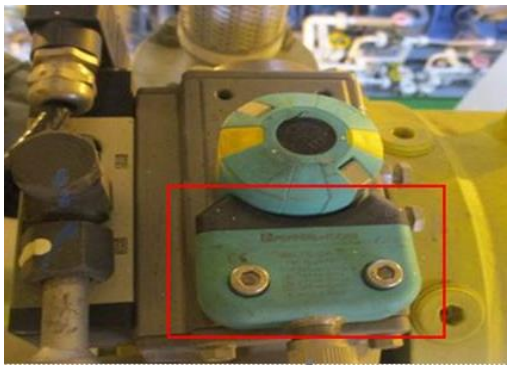
1. Positioner(Cam timing) sensor failure(SE48x)



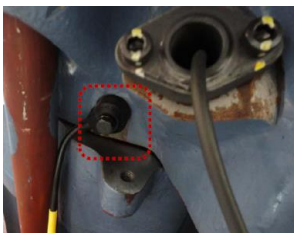
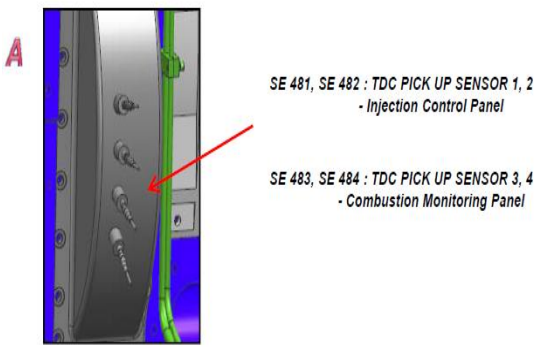


- ✓ Retighten the connector to CMM.(cylinder monitoring module)
- ✓ Check cable damage and connection.
- ✓ Cleaning the sensor surface
- ✓ Change the sensor with new one.

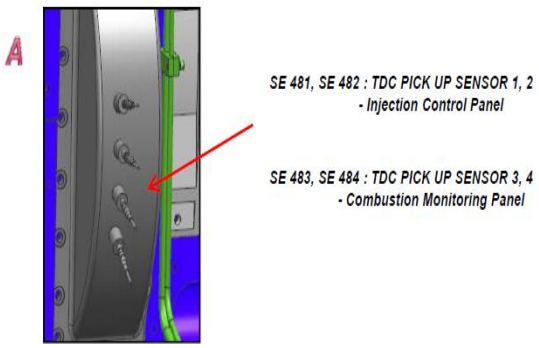
14. Valve position

Description	Valve position failure
Problem indication	DVT position fault at DVT on/off condition xxx valve position failure
Causes of problem	**Troubleshooting/ Corrective Action**
1. Operation failure	✓ Check 24V of valve control signal. ✓ Check cable damage and connection. ✓ Check valve leakage. ✓ Change the valve new one
2. Feed back sensor(limit switch) failure  Feedback Sensor	➢ If command signal is not matched with feedback signal, failure alarm occurs. Major valves(GRU and degassing valve) can be operated in LOP's test mode at engine stop condition. ✓ Check cable damage and connection. ✓ Change feed back sensor(limit switch) new one.

15. Knocking failure

Description	Knocking sensing failure
Problem indication	Knock control: speed signal error Knock module failure Knock sensor failure
Causes of problem	**Troubleshooting/ Corrective Action**
1. Knock sensor failure  	✓ Check if installation torque value of Knock sensor is correct(20Nm). ✓ Check cable damage and connection. ✓ Fix the connector parts with a cable tie. ✓ Change the sensor new one.
2. Knock control : Speed signal error 	✓ Missing Cam timing pickup sensor(positioner sensor) cause that alarm. **※Note: Chapter 16. Speed & positioner sensor failure**
3. Knock module failure	✓ Swap Knock control module with other engine(same cylinder no.)'s one.

16. Speed & positioner sensor failure

Description	Speed & positioner sensor failure
Problem indication	SE47x speed sensor failure SE48x Speed & position sensor to ICM & CMM failure
Causes of problem	**Troubleshooting/ Corrective Action**
1. Position(Cam timing) sensor failure 	✓ Retighten the connector to CMM(cylinder monitoring module) and ICM(Injection control module) ✓ Check cable damage and connection. ✓ Cleaning the sensor surface and adjust the air gap ✓ Change the sensor with new one
2. Speed sensor failure	✓ Check cable damage and connection. ✓ Cleaning the sensor surface and adjust the air gap ✓ Change the sensor with new one

17. Charge air pressure

Description	Charge air deviation
Problem indication	C.A press deviation high(PT24 & REF) Charge air press. sensor failure
Causes of problem	Troubleshooting/ Corrective Action

※ In diesel mode, if charge air pressure is higher, it will be helpful for efficiency. But in gas mode, proper air quantity is important.
Higher charge air pressure could cause abnormal combustion like misfire and lower charge air pressure could cause abnormal combustion like knocking.

1. Sensor failure	✓ Change the sensor with new one
2. Waste gate control failure	**※Note: chapter 11. Waste gate**
3. Charge air leakage	✓ Check if there are any leakage at charge air & exhaust gas line.
4. Room ventilation and suction temp	✓ In case of indoor intake air system, a sufficient volume of air should be supplied to the turbocharger. Therefore an air duct should be installed to face the air intake silencer for each turbocharger.
5. Turbo charger	✓ Check if there are any damage of turbocharger component and deposit. ✓ Check if there are any rust at TC intake casing.
6. Abnormal load signal from PMS	✓ Check engine load signal from PMS(Power management system) is correct or not. Wrong load signal can cause big deviation of charge air pressure

18. Gas injection max duration

Description	Gas injection max duration
Problem indication	Gas injection max duration
Causes of problem	**Troubleshooting/ Corrective Action**

※ Gas injection duration limit is set to prevent sudden increase of gas to the cylinder because it can cause knocking. If gas injection duration reach to the limit value for a preset time, Gas trip was triggered.

1. Changes in Gas composition	✓ Gas duration limit was set during commissioning period based on gas used at that time. When the gas component changes, the duration for each load can be changed. In this case, new setting have to be applied. (It should be discussed with HGS)
2. Mixture of Nitrogen to Gas	➢ Mixture of Nitrogen to the Gas can reduce LCV of Gas. ✓ Check if there any leakage point(Inert gas valve and other pipe)
3. Sudden increase of Load	✓ Check if load has increased within the allowable range.

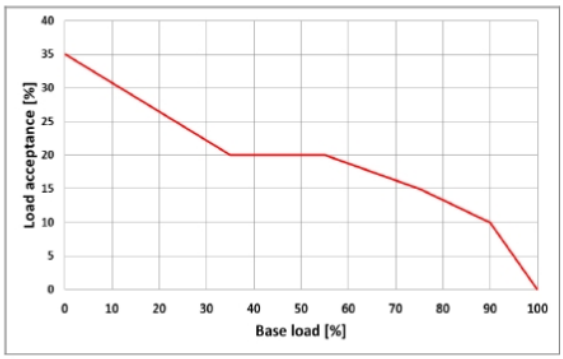
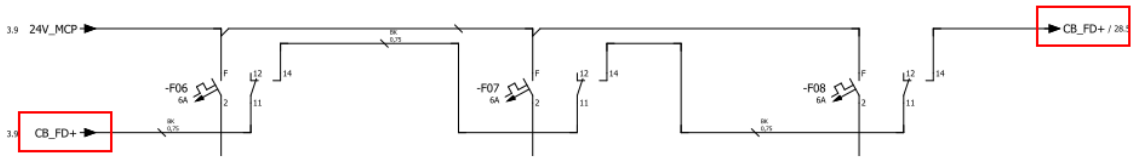


Fig. 4-1-8 Step load acceptance at gas mode

19. Any circuit breaker off

Description	Any circuit breaker off
Problem indication	Any circuit breaker off MCP Any circuit breaker off ACP
Causes of problem	**Troubleshooting/ Corrective Action**
1. Actual circuit breaker off	✓ Check actual position of circuit breaker of inside of the panel(MCP & ACP)
2. Feedback switch malfunction	✓ Check the condition of feedback switch by checking resistance of all feedback switch
3. Cabling failure	➢ All Circuit breaker from F01 to F xx have to be connected inside of the panel. ✓ Check the wiring by referring to the panel drawing



ex) Feedback Line Connection

20. CAN communication failure

Description	CAN communication
Problem indication	CAN J1939 failure bus 1 & 2 Can A & B time –out ICM CMM CANbus failure
Causes of problem	**Troubleshooting/ Corrective Action**
1. Cabling failure	✓ Check cable damage and cable connection by referring to the panel drawing ✓ Check the condition of CAN connector
2. CAN master module fault(if applied)  	✓ Check the condition of CAN master module First of all, check the LED condition ✓ Turn off the power and remove the module from the back-board and re-assemble the module  **Normal LED condition**
3. Control Module problem	✓ Change and swap the Control module(CMM & Injection controller)
4. Sensor fault and cable earth	✓ Check the earth check of each sensor connected to the module For example, cylinder pressure sensor's earth problem can cause the malfunction of CMM module.

21. ICM Minor alarm

Description	ICM(LECM, ECM3, IP2) Minor alarm
Problem indication	ICM minor alarm ECM minor alarm IP2 minor alarm
Causes of problem	Troubleshooting/ Corrective Action
※ Detail reason of minor alarm can be checked after connect to the Controller by S/E. The minor alarm has no significant effect on engine operation, but the following items need to be inspected by the ship's crew.	
1. Voltage High and low	✓ Check the voltage input value ✓ Check the condition of cable and connector
2. Module internal fault	✓ Swap Control module with other engine(same cylinder no.)'s one and new one
3. Over-current of MPI & GAV	✓ Check cable condition of MPI & GAV
4. Can fault	**※Note: Chapter 20. CAN communication failure**
5. Over speed	✓ Check if real rpm of engine is high If not, **Note: Chapter 16. Speed & positioner sensor failure**

22. Rupture disc

Description	Rupture disc
Problem indication	Rupture disc destroyed # x
Causes of problem	Troubleshooting/ Corrective Action

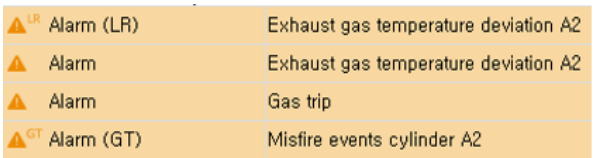
※ During the gas mode operation, if misfiring happen by any reason, it might cause rupture disc damage because un-burned fuel gas pass the T/C and explode in exhaust gas system. Rupture disc will be opened by explosion pressure to prevent damage in exhaust gas system (ex. Economizer and SCR etc.)
Opened rupture disc could not be used anymore due to exhaust gas leakage. So it should be changed.
"Rupture disc destroyed" signal trigger the shutdown or gas trip. It is different by project design.

1. Rupture disc destroyed by unburned fuel in exhaust gas pipe.	✓ First of all, find the root cause of the misfiring. **※Note: Chapter 12. Abnormal combustion(Misfiring)** ✓ And then change the rupture disc with new one.
2. Damaged/dis-connected rupture disc cable	✓ Cable damage of rupture disc could cause same alarm. Therefore check cable connection. ※Caution Do not install insulation for a certain period based on the sensor name plate to prevent damage of the sensor cable caused by heat. Please avoid over-tensioning the sensor cable connecting the Rupture Disc to the JB. (For detail information, note the manual of rupture disc)

Field Experience

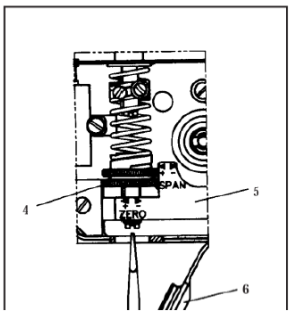
1. Misfiring
2. Knocking
3. Exhaust gas deviation
4. Speed & positioner sensor
5. Knock sensor failure
6. Valve failure
7. Fuel change over
8. Can communication
9. Rupture disc
10. Earth fault
11. Connection error to E2service
12. Load/Speed deviation
13. Charge air deviation
14. DVT

1.Misfiring

Description	Malfunction of SOGAV
Problem indication	Misfiring detect from cylinder press Cyl. # xx
Causes of problem	**Troubleshooting/ Corrective Action**
1. Malfunction of the Gas admission valve  Gas Admission Valve	✓ Check if MP test is carried out without any problem ✓ If MP test is carried out successfully with out any problem and just one cylinder have the problem, Change the Gas admission valve. **※Note: Chapter 9. GAV and 12. Abnormal combustion(misfiring)**  Alarm Event in E2service

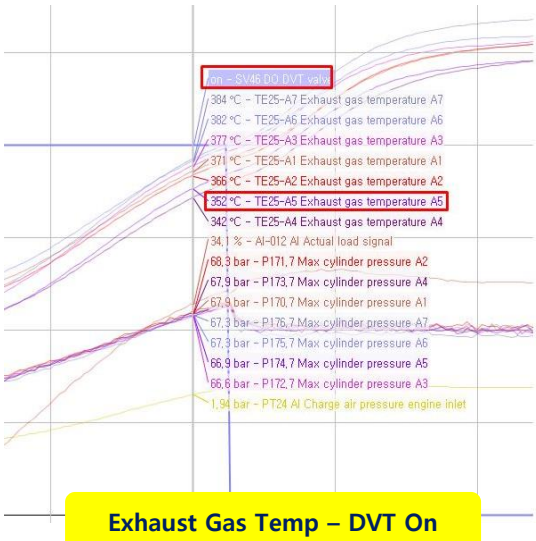
Alarm (LR)	Exhaust gas temperature deviation A2
Alarm	Exhaust gas temperature deviation A2
Alarm	Gas trip
Alarm (GT)	Misfire events cylinder A2

2. Knocking

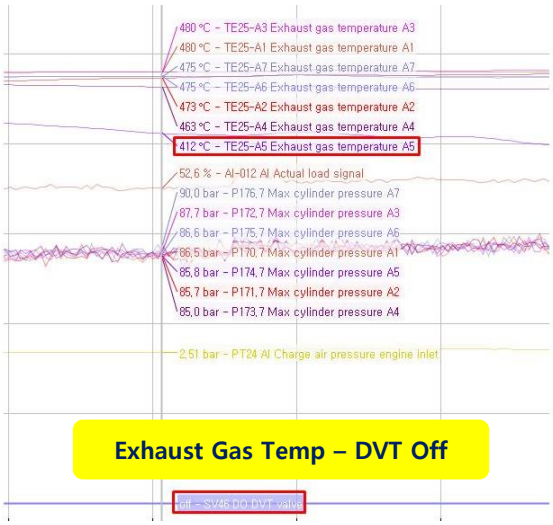
Description	Knocking & High exhaust temp
Problem indication	C.A press dev high(PT24 & REF) Exhaust temp high
Causes of problem	**Troubleshooting/ Corrective Action**
1. Waste gate wrong zero setting  Wastegate Valve	✓ Check if MP test is carried out without any problem ✓ If MP test is carried out successfully with out any problem and just one cylinder have the problem, change the Gas admission valve. **※Note: Chapter 11. Waste gate** **7. Calibration** P4/P5/EP5 is when shipped from PMV pre-calibrated for 90 ±0,5 deg rotation, (can also be 30, 45 or 60 deg, see installed cam). For most applications the valve closed position is more critical than valve open position, most attention should be paid at valve closed position. Always start calibration procedure by applying 0 % input signal, then adjusting zero. P4/P5/EP5 is calibrated by turning thumb wheels 1 & 4. Arrows on arm 5 indicate turning direction of thumb wheels. < "+" = Increase zero/span > "–" = Decrease zero/span  Calibration Manual

3. Exhaust gas deviation

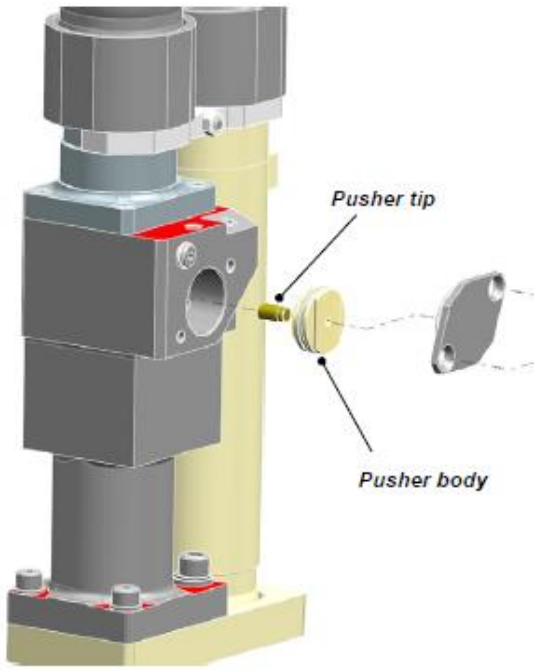
Description	DVT malfunction
Problem indication	**Exhaust gas temp deviation**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Malfunction of DVT	✓ Check if exhaust gas temp is normal in DVT on condition ✓ If exhaust gas temp is lower during only DVT off condition, it means DVT malfunction ✓ Change the DVT pusher body & Tip **※Note: Chapter 12. Abnormal combustion(Exhaust deviation)**



Exhaust Gas Temp – DVT On

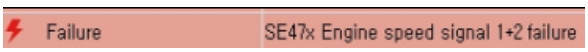


Exhaust Gas Temp – DVT Off



Pusher Tip & Body

4. Speed & positioner sensor

Description	Speed sensor fail
Problem indication	**Engine speed signal failure**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Speed sensor air-gap over limit 2. Speed sensor cable dis-connection 3. Speed sensor fuse failure  Fuse  Alarm Event in E2service	✓ Adjust speed sensor air-gap to 1.5-2mm. ✓ Check cable connection. ✓ Check fuse condition.(if fuse break, lamp will light) ※ **Note: Chapter 16. Speed & positioner sensor failure**

4. Speed & positioner sensor

Description	Cable connection of Cam TDC sensor
Problem indication	**Cylinder pressure sensor failure(All)**
Causes of problem	**Troubleshooting/ Corrective Action**

1. Due to missing of the cam pickup sensor which is connected to the CMM(E2precon), cylinder pressure failure of all cylinder are happened.
2. The reason of the pickup sensor missing was cable disconnection.
   After re-tightening the cable connector, that alarm was reset.

CMM(E2Precon)

1. Check the condition of cam pickup sensor or change the cam pickup sensor
2. Check the cabling condition and re-tighten the connector which is connected to the CMM.
3. Change the CMM module with new one.

※Note: Chapter 13. Cylinder pressure

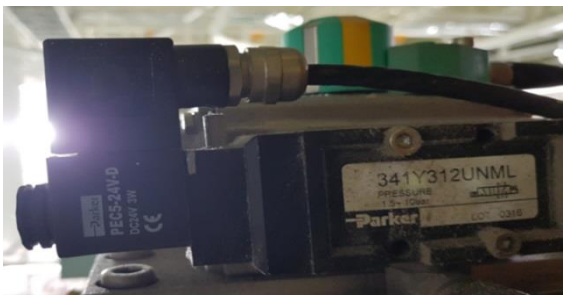
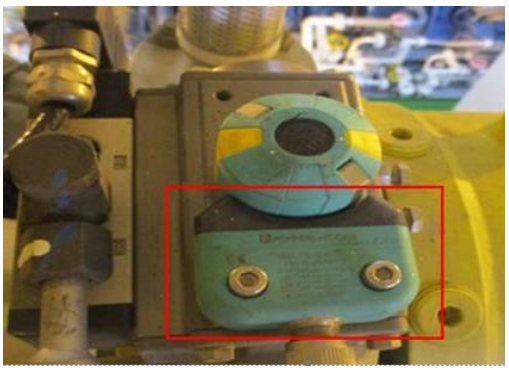
⚠	Alarm	Cylinder pressure sensor failure A7
⚠	Alarm	Cylinder pressure sensor failure A6
⚠	Alarm	Cylinder pressure sensor failure A5
⚠	Alarm	Cylinder pressure sensor failure A4
⚠	Alarm	Cylinder pressure sensor failure A3
⚠	Alarm	Cylinder pressure sensor failure A2
⚠	Alarm	Cylinder pressure sensor failure A1
⚠	Alarm	E2PRECON 1 pickup signals

Alarm Event in E2service

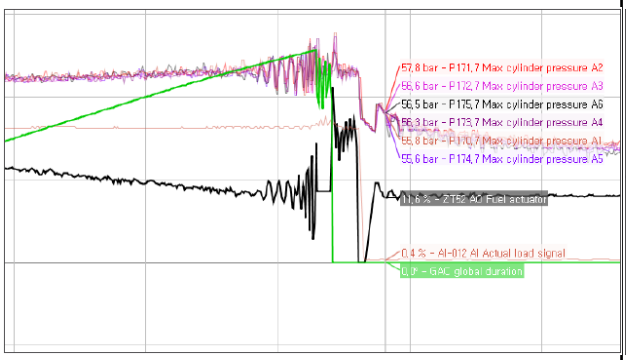
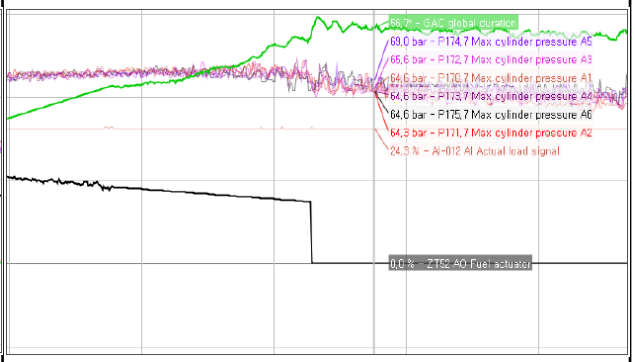
5. Knock sensor failure

Description	Cable Connection & Installation of Knock sensor
Problem indication	**Knock sensor failure**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Incorrect installation torque	✓ Check the torque valve of knock sensor NOTICE *Reassemble for cylinder pressure sensor knocking sensor and then tightened correctly with tightening torque.* *Knocking sensor : 20 Nm, Cylinder sensor : 15 Nm* **Torque Value of Knock Sensor**
2. Poor condition of connector of Knock sensor	✓ Check the cable & connector condition of knock sensor **※Note: Chapter 12. Knocking failure** ⚠ Alarm — Knock sensor failure A1 **Alarm Event In E2Service**

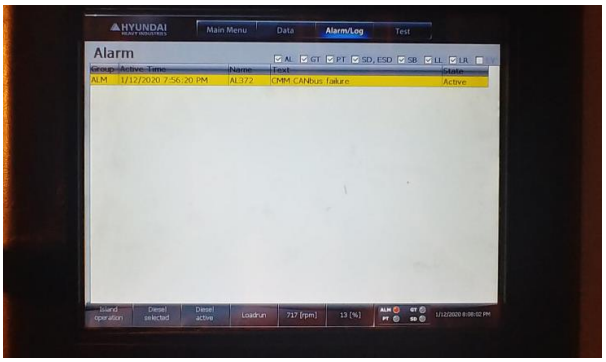
6. Valve failure

Description	Degasing valve position failure
Problem indication	**Degasing valve**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Degasing valve solenoid valve malfunction 2. Degasing valve feedback sensor malfunction  Alarm Gas trip Alarm (GT) LS88-Ax Degasing valve A command-feedback deviation **Alarm Event In E2Service**  **Solenoid Valve**	➢ Check operation of degasing valve in test mode. ✓ If valve operation is good, please check position sensor connection or replace it. ✓ If valve is not operated, please check instrument air line, electric connection of solenoid valve, stuck of solenoid. **※Note: Chapter 14. Valve position failure**  **Feedback Sensor**

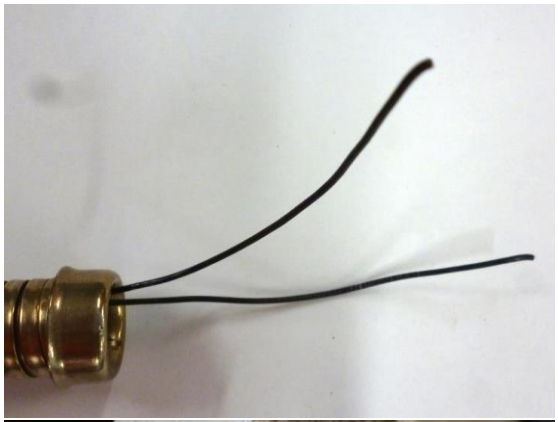
7. Fuel change over

Description	Changeover Diesel to Gas mode fail
Problem indication	**Control system**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Diesel PID control to Gas PID control switchover time was too late.	✓ Change earlier PID switchover time. (Fuel rack 12.9% → 13.5%) **※Note: Chapter 10. Fuel change over(Diesel to gas)**
 **Before Tuning**	 **After Tuning**

8. CAN communication

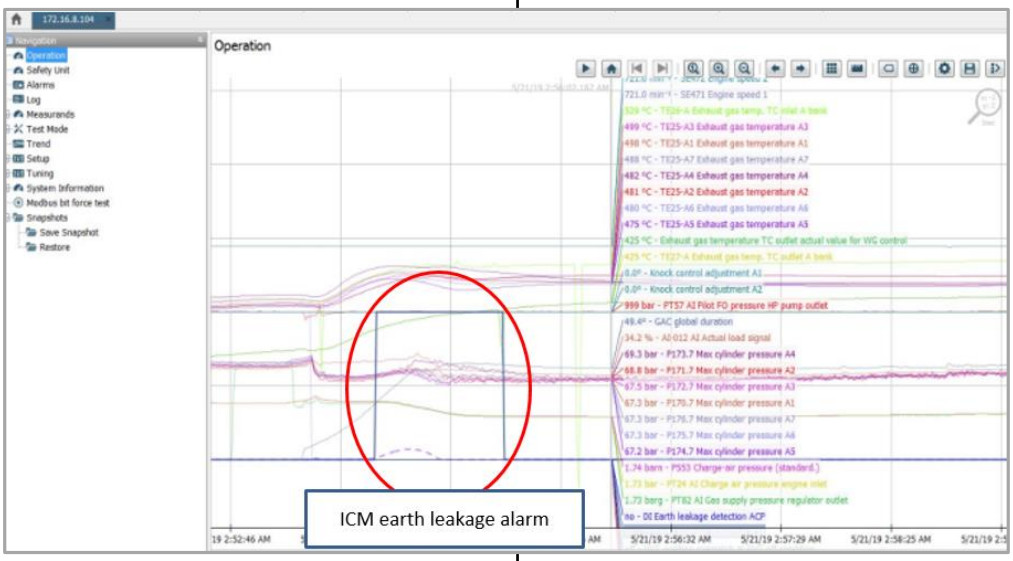
Description	Communication failure
Problem indication	**CMM CANbus failure**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Pressure sensor malfunction	✓ Check the relevant sensor's condition ✓ Check the cables connected with CMM ✓ Check the voltage connected with CMM **※Note: Chapter 20. CAN communication failure**
 CMM Alarm Status(Yellow LED)	 LOP Alarm Indication(CMM CANbus failure)

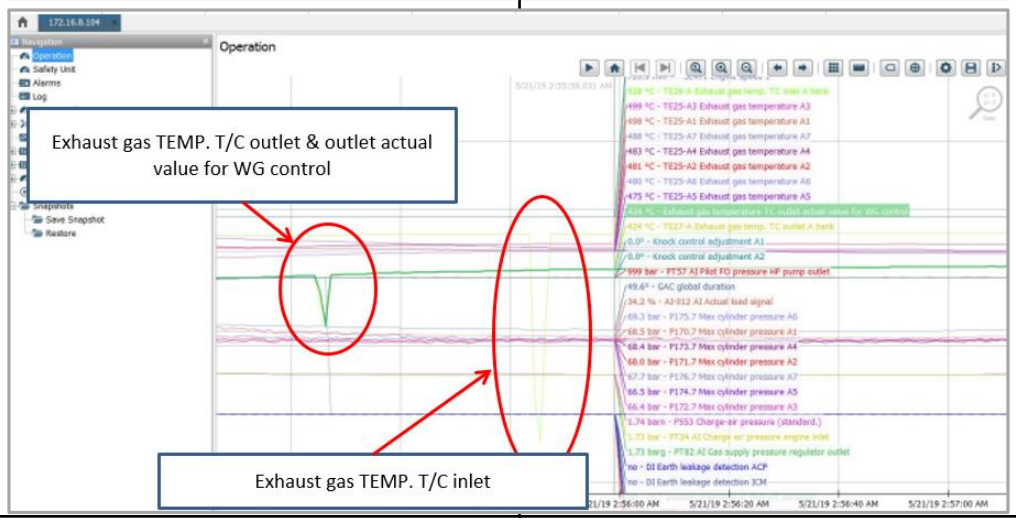
9. Rupture disc

Description	Rupture Disc Cable Damage
Problem indication	**Rupture Disc Destroyed # x**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Damaged/dis-connected rupture disc cable   Damaged Cable of Rupture Disc	✓ Cable damage of rupture disc could cause same alarm. Therefore check cable connection. **※Note: Chapter 22. Rupture disc**

10. Earth fault

Description	Exh. Gas Temp T/C inlet & outlet hunting with ICM earth leakage alarm
Problem indication	**ICM Earth leakage / Detrimental Error (sometimes)**
Causes of problem	**Troubleshooting/ Corrective Action**
1. Low insulation of cables, GAVs, MP injectors which are connected to LECM. 2. Cable connection failure of MP injector or SOGAV.	1) Check cable connection and insulation resistance of each parts. **※Note: Chapter 5. Micro pilot system and 9. about GAV**

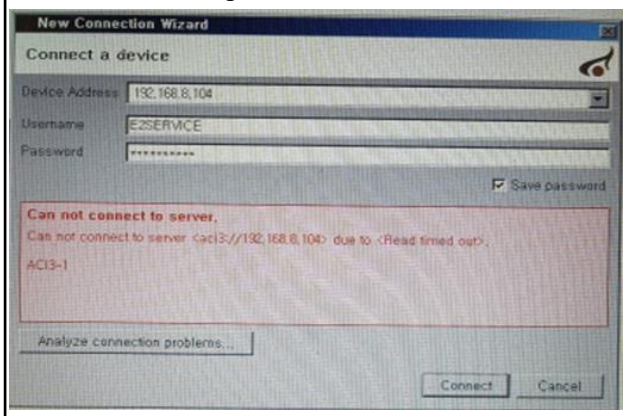




11. Connection error to E2Service

Description	Connection error to E2Service
Problem indication	-
Causes of problem	**Troubleshooting/ Corrective Action**

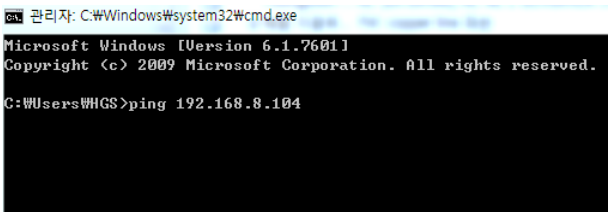
1. Cable connection
2. Software bug



Connection Failure of E2Service

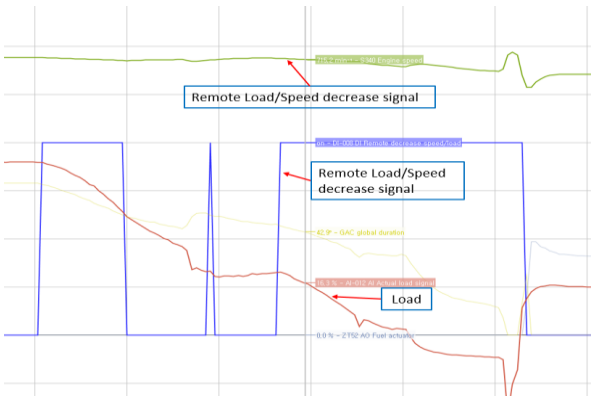
- ✓ Check the cabling condition
- ✓ If cabling is normal condition, carry out the Ping test. If there is no failure, it means cabling condition is good.
- ✓ If cable connection is good, update the software of Main CPU with same version which was already installed.

Go to Ping Test Page



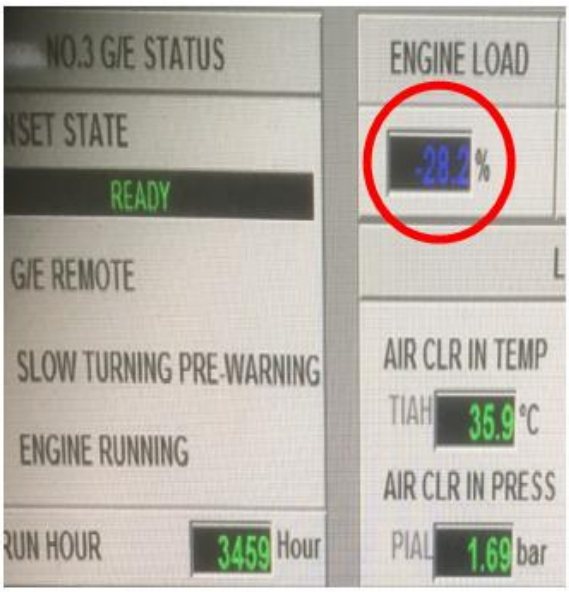
Ping Test

12. Load/Speed deviation

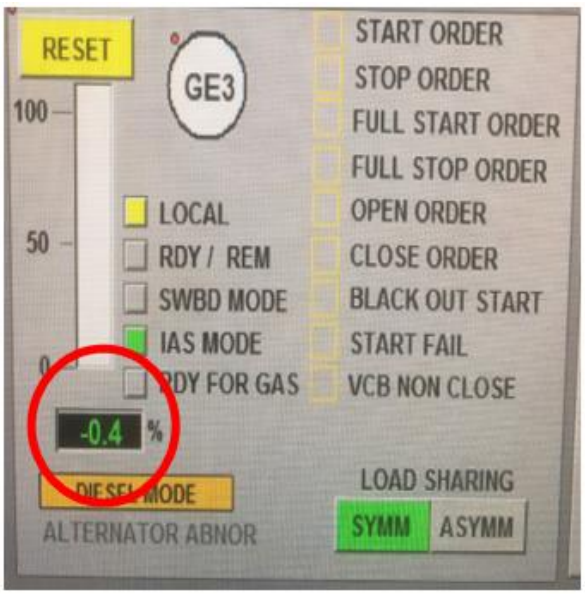
Description	Load /Speed decrease
Problem indication	**Load decrease without alarm** **Engine speed low**
Causes of problem	**Troubleshooting/ Corrective Action**
1. External Load / Speed decrease signal  **Load/Speed decrease signal in E2Sevice**	✓ Check the function of fuel actuator ✓ If there is no problem about actuator, kindly check the external Load/Speed decrease signal because Load/Speed decrease signal caused by a relay malfunction cause a sudden load/speed change.

13. Charge air deviation

Description	Charge air deviation
Problem indication	C.A press deviation high(PT24 & REF)
Causes of problem	**Troubleshooting/ Corrective Action**
1. Abnormal load signal	✓ Check the function of fuel actuator ✓ If there is no problem about actuator, kindly check the external Load/Speed decrease signal because Load/Speed decrease signal caused by a relay malfunction cause a sudden load/speed change. **※Note: Chapter 17. Charge air deviation**



Load signal of Engine



Load signal of MSB

Appendix

Gas Trip and Pilot Trip

This chapter is created to help H35DF operators what kind of alarms about Gas Trip and Pilot Trip there are since operators are not familiar with these alarms and DF engine.

1) Gas Trip

✓ If this alarm occurs, it is impossible to operate in Gas mode and it automatically switches to Diesel operation mode during Gas operation mode.

2) Pilot Trip

✓ If this alarm occurs, it is impossible to operate in Diesel & Gas mode and it automatically switches to Back-up operation mode during Diesel and Gas operation mode.

For detail alarm lists and trouble shooting guide, kindly refer to the next page.

Appendix

1. Gas Trip

1) Engine speed low in gas mode

2) Speed & position sensor to ICM failure
※**Note:** chapter 11. Waste gate

3) Pilot injection test failure Cyl. # xx
※**Note:** Chapter 5. Micro pilot system

4) Instrument air press. Low at gas mode
- Check instrument regulating valve
- Check Instrument air pressure sensor

5) EGT deviation high Cyl. #xx
6) EGT high Cyl. #1
※**Note:** Chapter 12 Abnormal combustion(Exhaust deviation)

7) Charge air press. sensor failure
8) Charge air press. High
9) C.A PRESS DEV HIGH & LOW (PT24 & REF)
※**Note**: Chapter 17. Charge air deviation

10) Charge air temp. sensor failure
- Check sensor and cable condition

11) Charge air temp. high at gas mode
※**Note:** Chapter 6. Cooling water

12) Crankcase press. High
- Check sensor and cable condition
- Check if there is any blow by
- Check the pipe line condition after oil mist piping to check if there is any clogging line

13) Knock & Cylinder sensor failure Cyl. # xx
- Check sensor and cable condition

Appendix
1. Gas Trip

14) Knock high timing retard Cyl. # xx
※**Note:** Chapter 12. Abnormal combustion(Knocking)

15) Cylinder press. high Cyl. # xx
※**Note:** Chapter 13. Cylinder pressure

16) Misfire detect from cylinder press. Cyl. # xx
※**Note:** Chapter 12. Abnormal combustion(misfiring)

17) Gas admission valve Cyl. # xx fault
※**Note**: Chapter 9. GAV

18) Gas supply press. filter outlet low
19) Gas supply press. filter outlet high
20) Gas temp. low & high
- Check sensor and cable condition
- Check Yard gas supply system

21) Gas regulator outlet press. sensor failure
- Check sensor and cable condition

22) Gas press. ramp up failure
23) Gas Reg. Out Press Dev. High & Low (PT82 & Ref)
24) PT83 GRU control air press. sensor failure
25) PT83 GRU control air press. Low
26) PT87 Gas press engine inlet sensor fail
27) Gas Inlet Press. Dev. High & Low (PT87 & Ref.)
28) PT87 Gas Press. Dev. High & Low (PT87 & C.A. Press)
29) Gas leakage test failed
30) SV88 too long open from high P diff.
※**Note:** Chapter 8. GRU

31) LS90 Inert gas valve position failure
32) LS841 Gas shutoff & venting valve #xx position failure
33) LS88 Gas degasing valve position failure
※**Note:** Chapter 14. Valve position failure

Appendix
1. Gas Trip

34) Yard main gas valve closed in gas operation
- Check Yard main gas valve & cabling condition

35) SV87 Gas injection max duration
※**Note:** Chapter 18. Gas Injection max duration

36) Gas mode blocked due to former Backup
- Engine should be stopped to reset Pilot trip.

37) Load signal failure
- Check engine load signal from PMS(Power management system) is correct or not. Wrong load signal can cause big deviation of charge air pressure and other ignition timing

38) Exceed Max. Available load at Gas mode
39) Load high at gas mode
40) Load low at gas mode
- Check actual load value of engine. Unlike diesel engines, the gas mode has a limited operational load.

41) Main I/O module fail
42) I/O Ext. module fail
43) No Knock Control (Module fail)
44) Knock & Cylinder HW failure
- Check cabling & connection between the module or LAN cable
- Turn off the power and remove the module from the back-board and re-assemble the module.

45) Gas Trip request from IAS(or external system)
- Check actual signal of Gas Trip from IAS

Appendix

2. Pilot Trip

1) Speed & position sensor to ICM failure

※**Note**: Chapter 16. Speed & positioner sensor failure

2) PFO press engine inlet low & high

- Check sensor and cable condition
- Check yard PFO supply system

3) PFO flow high

※**Note:** Chapter 5. Micro pilot system(PFO flow)

4) PFO PRESS. DEV. H. (PT57 & REF.)

5) PFO press. HP pump outlet sensor failure

6) PFO press. HP pump outlet high

7) PFO press. HP pump outlet low

8) PFO press. fails to build up

9) PFO Pressure engine outlet high

10) PFO pressure pump not running

※**Note:** Chapter 5 Micro pilot system(Rail press. build up failure)

11) LO PFO pump inlet press. Low

- Check sensor and cable condition
- Check L.O pump condition and if there is any blockage point

12) Pilot FO injector Cyl. # xx fault

※**Note:** Chapter 12. about Abnormal combustion(Misfiring)

13) ECS powered by battery only

14) CAN A&B time-out ICM

※**Note:** chapter 20. about Can failure

15) Main I/O module fail

- Check cabling & connection between the module or LAN cable
- Turn off the power and remove the module from the back-board and re-assemble the module.

Trouble Shooting Manual
For HiMSEN DF Engine

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