DF Training

Engine Safety

Content

Aim of training

Understanding for the Engine Safety System gas functions

Signal flows between WiCE and ESS

Understanding for the Engine Safety Concept

- Gas interlocks
- Gas trips

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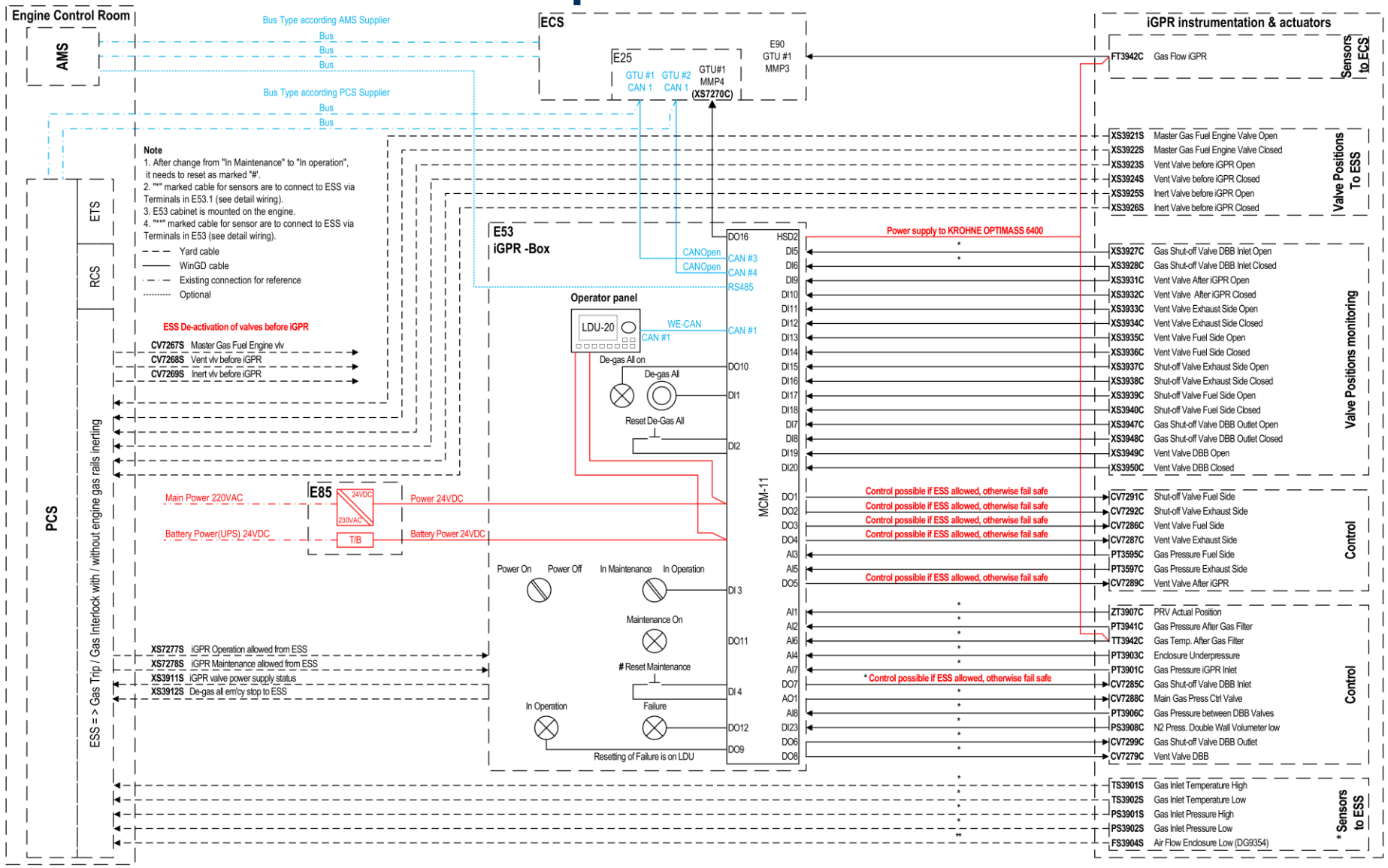
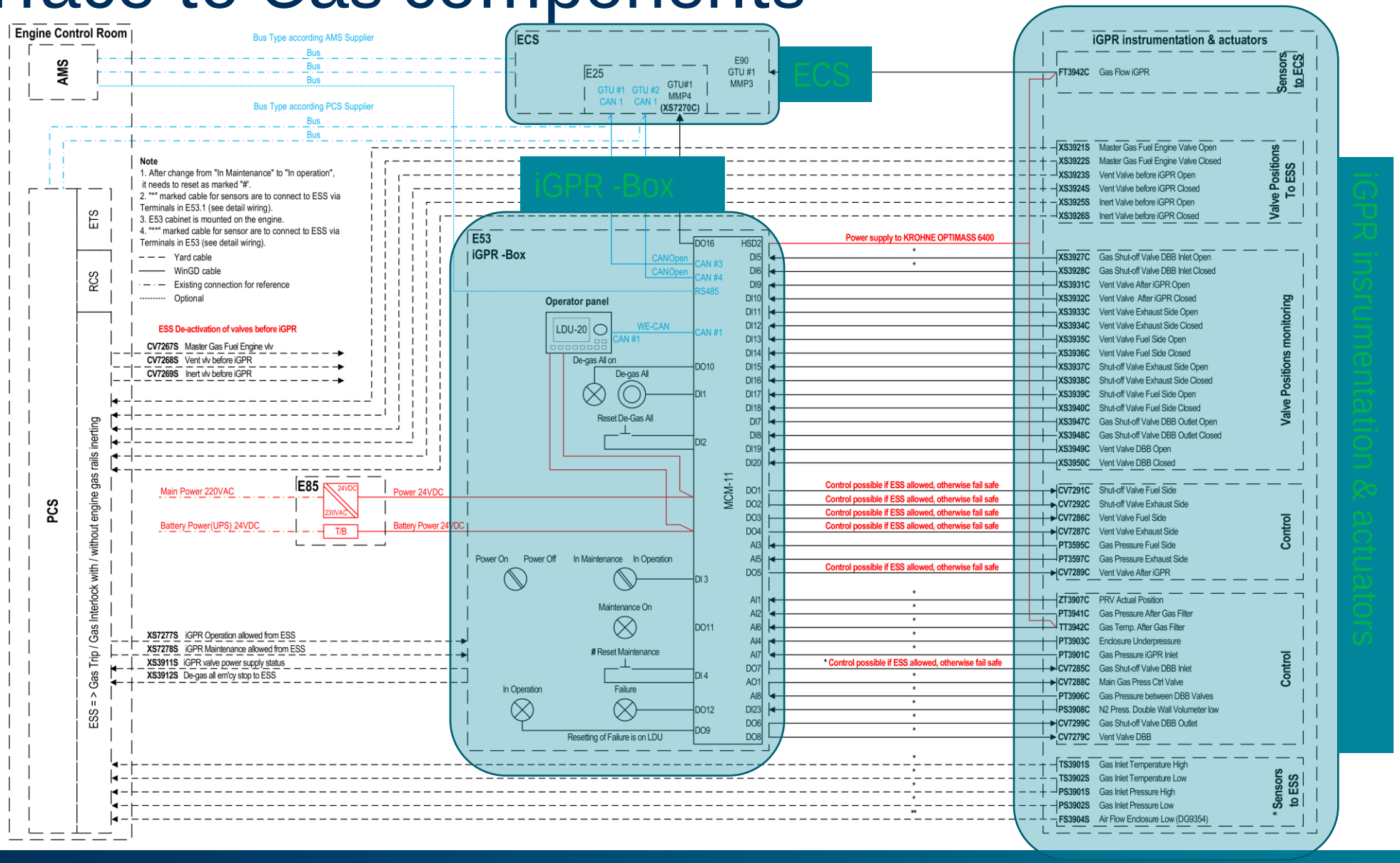
Interface to Gas components



Interface to Gas components



Engine Safety

Interaction between following Systems

- The Engine Safety System (ESS)
- The Alarm and Monitoring System (AMS)
- The Engine Control System (ECS)
- The Gas Valve Unit (GVU) or Integrated Gas Pressure Regulation (iGPR)
- The Gas Detection System (GDS)

Engine Safety

Execution of gas trip

- Gas supply
  - In the case of a gas trip triggered by ESS, GVU or iGPR, the gas supply will be automatically stopped by the activation of the DBB valves. In addition, the shut-off valves on the engine side will be closed and the vent valves opened by the ESS or the iGPR control unit.
  - The ECS closes the gas admission valves
- Pilot fuel supply
  - The ECS may reduces the pilot fuel amount injected, depending on the tuning
- Main fuel supply
  - The ECS activates the main injectors and main fuel pumps

Engine Safety

Execution of engine shutdown

- Gas supply
  - The ESS stops the fuel gas supply by closing the master gas valve.
  - The shut-off valves on the engine side will be closed and the vent valves opened by the ESS
  - The ECS closes the gas admission valves
- Pilot fuel supply
  - The pilot fuel pump is stopped by both ESS and ECS
- Mail fuel supply
  - The ESS depressurises the main fuel rail
  - The ECS stoppes the main fuel injection and sets the fuel pump supply to zero

Engine Safety

Execution of engine slowdown

- Maximum speed and load is reduced. It is executed by the ECS when demanded via the Remote Control System (RCS)

Sensors and Signals

Engine Safety System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Cylinder cooling water	Cyl. Cool. Water Press. Inlet Eng. Very Low	X		X	X
Main bearing oil	Main Brng. Oil Press. Supply Very Low	X		X	X
Thrust bearing oil	Thrust Brng. Oil Temp. Outl. Very High	X		X	X
Piston cooling oil	No Flow	X		X	X
Oil mist concentration	Oil Mist Conc. in Crankcase Very High	X	X		
Turbocharger oil	Turbochg. N Bearing Oil Press. Inl. Very Low	X		X	X
Air spring air	Exhaust valve Air Spring Air Press. Very Low	X		X	X
Engine overspeed	Engine Speed Very High	X		X	X

Sensors and Signals

Engine Safety System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Emergency engine stop buttons	Emergency engine stop requested	X		X	X
Emergency gas trip buttons	Emergency gas trip requested	X			X*
Gas Detection System	Gas trip due to Very High Concentration by gas detection system	X			X*
Fire detection system	Gas trip due to fire detection in engine room by fire detection system	X			X*
Fuel gas supply system	Gas trip due to valve position failures by fuel gas supply system	X			X*

* These gas trips trigger additionally request of inerting

Sensors and Signals

Engine Safety System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Fuel Gas Supply	Fuel Gas Pressure too high or too low	X			X
to iGPR	Fuel Gas Temperature too high or too low	X			X
	Air flow within enclosure too low	X			X*
iGPR system	Gas trip by iGPR system	X			X
GVU system	Gas trip by GVU system	X			X
Engine control system	Gas trip by ECS	X			X

* These gas trips trigger additionally request of inerting

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Sensors and Signals

Alarm and Monitoring System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Cylinder cooling water	Cyl. Cool. Water Press. Inlet Eng. Low	X	X		
	Cyl. Cool. Water Temp. Outl. Cyl. N High	X	X		
Main bearing oil	Main Brng. Oil Press. Supply Low	X	X		
	Main Brng. Oil Temp. Supply High	X	X		
	Main Brng. Oil Temp. Outl. Brng. N High	X	X		
Thrust bearing oil	Thrust Brng. Oil Temp. Outl. N High	X	X		
Crank bearing oil	Crank Brng. Oil Temp. Outl. High	X	X		
Crosshead bearing	Crosshead Brng. Oil Temp. Outl. N High	X	X		
Oil mist concentration	Oil Mist Conc. in Crankcase High	X			
	Oil Mist Conc. Fail in Crankcase Unit	X			
Piston cooling oil	Pist. Cool. Oil Temp. Outl. Cyl N High	X	X		
Turbocharger oil	Turbochg. Bearing Oil Press. Inl. Low TC n	X	X		
	Turbochg. Bearing Oil Temp. Outl. High TC n	X	X		
Air spring air	Air Spring Air Press. Low	X	X		
	Air Spring Air Press. High	X			
	Air Spring Oil Leakage Level High (exh v/v)	X			

Sensors and Signals

Alarm and Monitoring System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Exhaust gas	Exh. Gas Temp. after Cyl. #N High	X			
	Exh. Gas Temp. after Cyl. #N Very High	X	X		
	ECS Exh. Gas Temp, after Cyl #N Too High	X			X
	Exh. Gas Temp. after Cyl's High Deviation	X			
	Exh. Gas Temp. after Cyl's Very High Deviation	X	X		
	ECS Exh. Gas Temp. after Cyl's #N Too High Deviation	X			X
	Exh. Gas Temp. before TC #N High	X	X		
	Exh. Gas Temp. after TC #N High	X	X		

Sensors and Signals

Alarm and Monitoring System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
Scavenge air	Scav. Air Temp. after Air Cooler #N Low	X			
	Scav. Air Temp. after Air Cooler #N High	X	X		
	Scav. Air Temp. Pist. Underside Cyl. #N High	X	X		
	Charge Air Condense Water Detection in Air Rec. High	X	X		
	Charge Air Condense Water Drain Detection before Water Sep. #N High	X	X		
Pilot fuel system	Pilot Fuel Filter Diff. Press. High	X			

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
UNIC-ECS modules	Module Fail Diesel CCM #N		X	X		X
	Module Fail Gas CCM #N	X				X
	Module Fail MCM	X				X
	Module Fail IOM	X				X
UNIC-ECS internal communication	System Bus #1 Fail or #2 Fail	X				

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Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Communication to ESS and RCS	Propulsion Bus #N Fail	X				
	No connection to propulsion control system	X				X
External gas trip	External Gas Trip	X				X
Engine speed	Engine Speed Deviation from Reference	X				
	Excessive Engine Speed (115% RPM)		X		X	X
External power signal	Engine Load Measurement Fail	X				
Load limit	Excessive Engine Load in Gas Mode	X				X
Control air	Control Air Pressure Low	X				X

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Auxiliary Systems	Auxiliary Servo Oil Pump Fail	X				
Servo oil pressure	Servo Oil Pressure Measuring Fail #1 or Fail #2	X				
	Servo Oil Pressure Measuring High Difference	X				
	Servo Oil Pressure High	X				
	Servo Oil Pressure Very Low		X	X		
Exhaust gas valve control	Exhaust Valve Position Measuring Fail Cyl #N	X				
	Exhaust Valve Timing Fail Cyl #N		X	X		X

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Scavenge air pressure	Scavenge Air Pressure Measuring Fail #1 or Fail #2	X				
	Scavenge Air Pressure Measuring High Difference	X				X
	Scavenge Air Pressure Very High		X	X		X
	Exhaust Waste Gate wrong position	X				X
	Auxiliary Blower #1 Fail or #2 Fail	X				
	T/C #N Speed High	X				
	T/C #N Speed Very High		X	X		X

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Cylinder lubrication control	Cylinder Lubrication Oil Pressure Measuring Fail Cyl #N		X	X		
	Cylinder Lubrication Oil Injection Pressure High Cyl #N		X	X		
	Cylinder Lubrication Oil Injection Pressure Low Cyl #N		X	X		
	Wrong Cylinder Oil in Use	X				
Cylinder balancing	Cylinder Pressure Measuring Fail Cyl #N (max load limitation)	X				
	Cylinder Peak Pressure Very High Cyl #N	X				X
Knock detection	Knock Sensor Fail Cyl #N	X				
	Both Knock Detection Systems Fail Cyl #N	X				X
	Heavy Knock Cyl #N	X				X

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Misfiring	Misfiring Cyl #N	X				X
	Misfiring Detection by Press. Sensor Fail Cyl #N	X				
	Misfiring Detection by TVM Fail	X				X*
Pilot fuel injection	Pilot Fuel Injector 1 Open/Short Circuit Cyl #N	X				*1
	Pilot Fuel Injector 2 Open/Short Circuit Cyl #N	X				*1
	Pilot Fuel Injector 1 and 2 Open/Short Circuit Cyl #N	X				X

*1 If one pilot fuel injector is out of order at high load, it shows only minor, or none effect. At low load possibly gas trip occurs by unstable combustion. In diesel mode a gas interlock is active.

X* The misfiring detection by TVM is based on the speed and crank angle measurement system. Only if the speed and crank angle cannot be determined, TVM cannot function.

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Pilot fuel oil pressure control	Pilot Fuel Pump Control Signal Failure	X				X
	Pilot Fuel Inlet Pressure Measurement Fail	X				*
	Pilot Fuel Inlet Pressure Low	X				*
	Pilot Fuel Inlet Temperature Measurement Fail	X				X
	Pilot Fuel Inlet Temperature High	X				X
	Pilot Fuel Rail Pressure Very Low	X				X
	Pilot Fuel Rail Pressure High	X				
	Pilot Fuel Rail Pressure Measuring High Difference	X				X
	Pilot Fuel Rail Pressure Measurement Fail #1 or #2	X				

* Gas interlock in diesel mode

Sensors and Signals

Engine Control System

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Gas admission valve	GAV 1 Cyl #N Stays Open		X	X		X**
	GAV 2 Cyl #N Stays Open		X	X		X**
	GAV Feedback Position Measuring Fail	X				
	GAV 1 Cyl #N Stays Closed	X				
	GAV 2 Cyl #N Stays Closed	X				
Piston Underside	Gas Detection Pre-Warning	X				
	Gas Detection	X				X
	Gas Detection Sensor Failure	X				

** Gas trip, gas interlock and all fuel cut-out on failed cylinder unit

Sensors and Signals

Engine Control System and external Systems

Engine system function	Failure	Actions				
		ALM Minor	ALM Major	SLD	SHD	GT
Gas sealing	Gas Admission Valves Sealing Lub. Oil Press. Low	X				X
Gas pressure control by GVU*	Gas Fuel Pressure Low or High	X				X
(if installed)	Gas Fuel Pressure Setpoint Deviation High	X				X
	Gas Fuel Rails Pressure Measurement High Difference	X				X
	Gas Pressure Fuel or Exhaust Side Measurement Fail	X				
SCR System	SCR Reactor not by-passed	X				X**
(if installed)	SCR Communication fail	X				X

* See the documentation of the GVU (Gas Valve Unit) supplier for other alarms and gas trips

** Unless a redundant monitoring of SCR exhaust valves via ESS is available

Sensors and Signals

Integrated Gas Pressure Regulation System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
iGPR	Gas Inlet Temperature Too Low or High	X			X
	Gas Inlet Pressure Too Low or High	X			X
Integrated Gas Pressure Regulation	iGPR Gas Pressure between shut-off valves Low or High	X			X
(if installed)	Gas Fuel Pressure Low or High	X			X
	Gas Fuel Pressure Setpoint Deviation High	X			X

Sensors and Signals

Integrated Gas Pressure Regulation System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
iGPR Integrated Gas Pressure Regulation (if installed)	Gas Fuel Rails Pressure Measurement High Difference	X			X
	Pressure Regulating Valve Actual Position Wrong	X			X
	Any shut off valve wrong position	X			X
	Any vent valve wrong position	X			X
	Annular space Underpressure Too Low	X			X
	Any criteria of fuel transfer to fuel gas not fulfilled, e.g. pressure stabilization	X			X

Sensors and Signals

Integrated Gas Pressure Regulation System

Engine system	Failure	Actions			
		ALM	SLD	SHD	GT
iGPR Integrated Gas Pressure Regulation (if installed)	LDU iGPR Fail	X			X
	MCM iGPR Fail	X			X
	AC Power Supply Fail	X			X
	DC power supply Fail (UPS as backup)	X			
	Bus Communication #1 OR #2 between ECS/ESS and iGPR Fail	X			