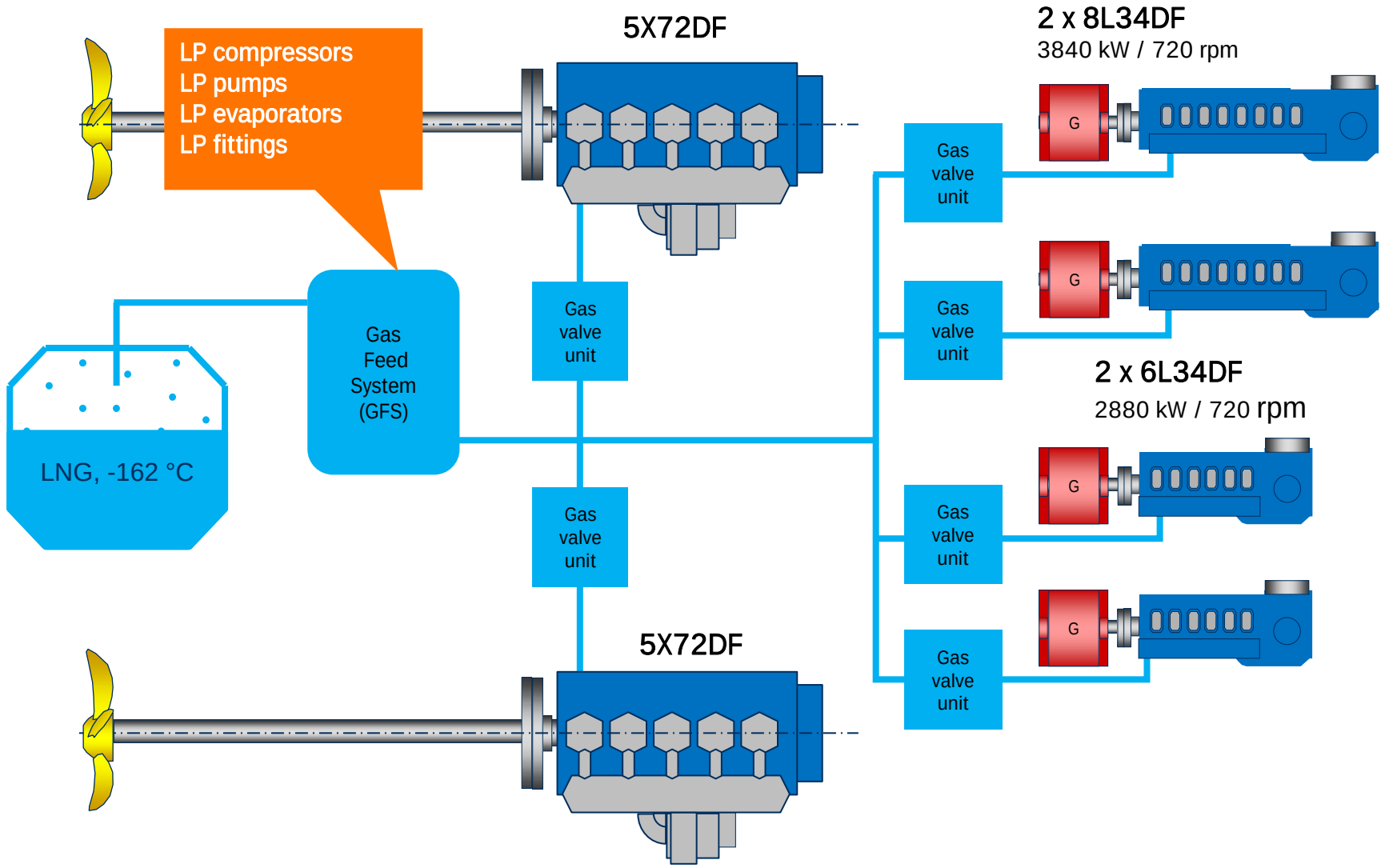
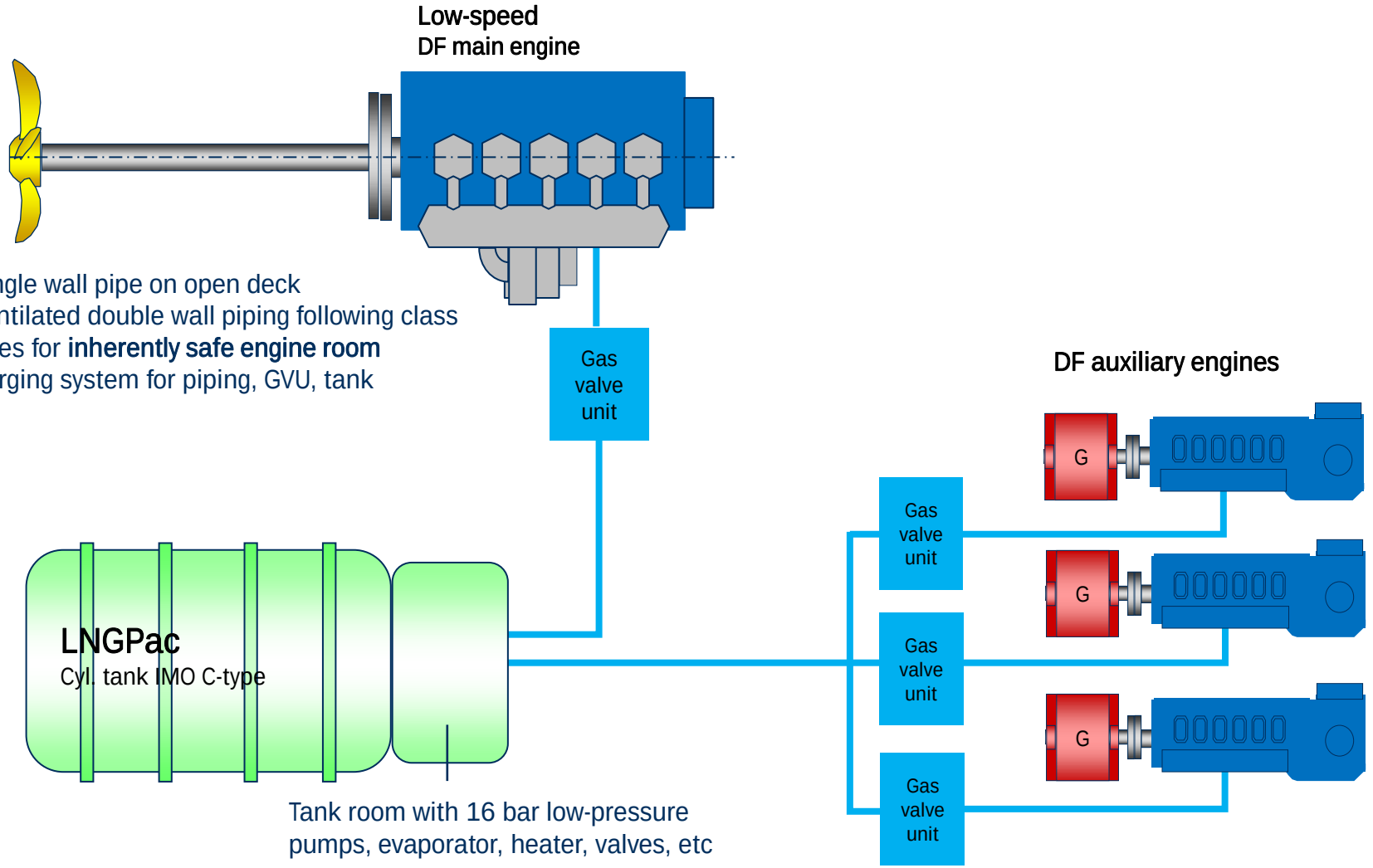
UNIC DF Training

Gas Related Components

Dual-Fuel Engine Machinery

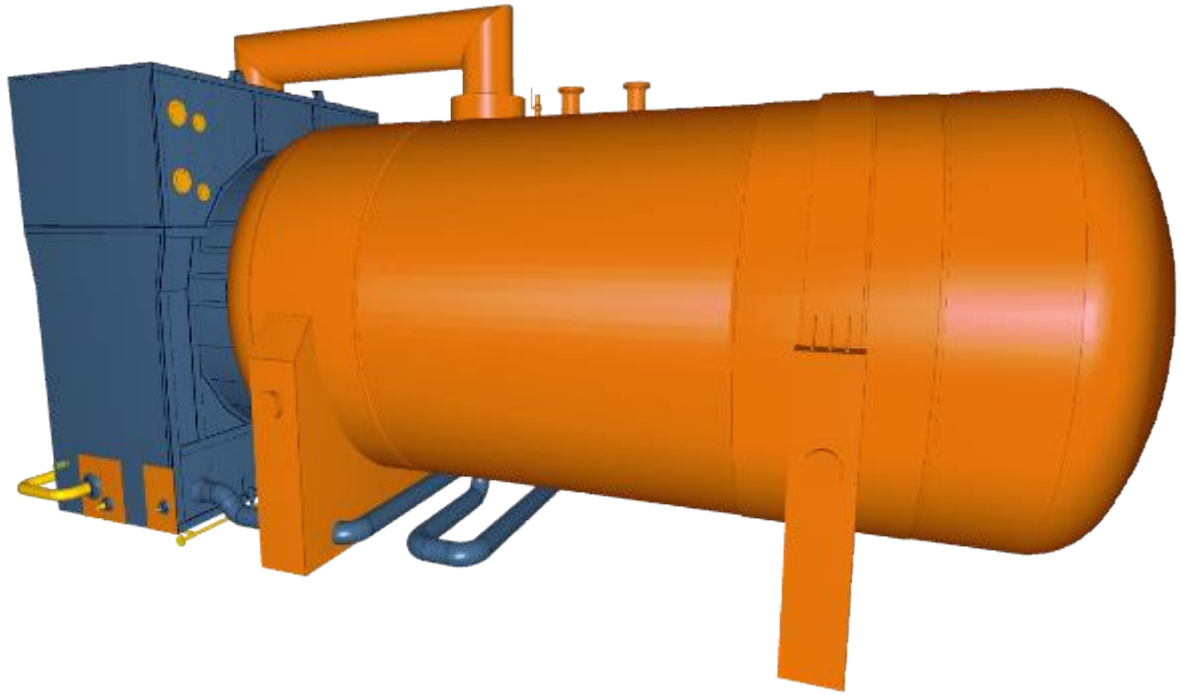


Dual-Fuel Engine Machinery



LNG PACK

- Cylindrical pressure vessel with vacuum insulation.
- Approved for passenger vessels.
- One or several LNG-storage tanks can be installed.
- IMO type C independent tank with single or double shell design:
  - Single shell PUR(polyurethane) insulated tank
  - Double shell perlite/vacuum insulated tank



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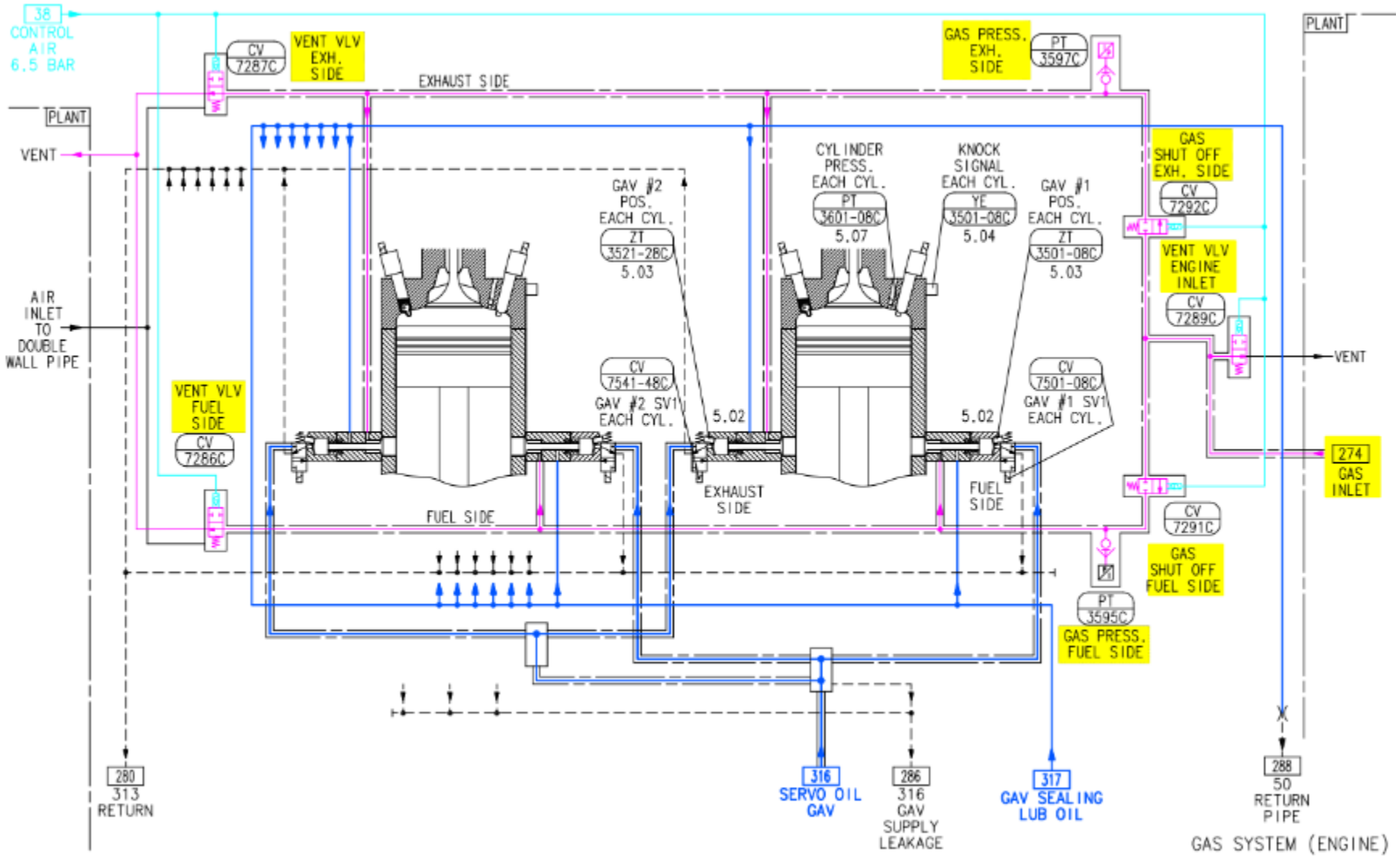
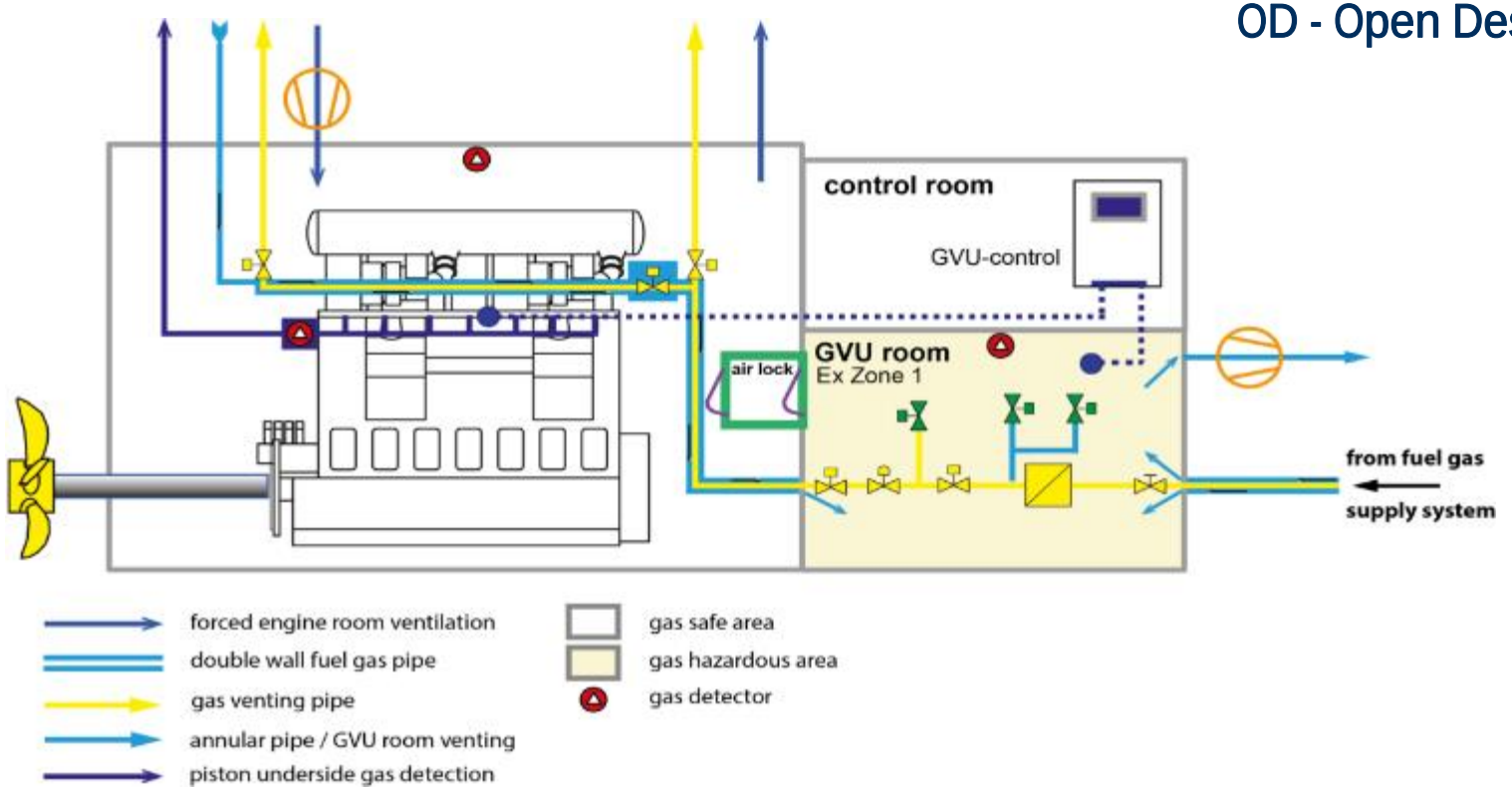
LNG PACK

Gas Systems



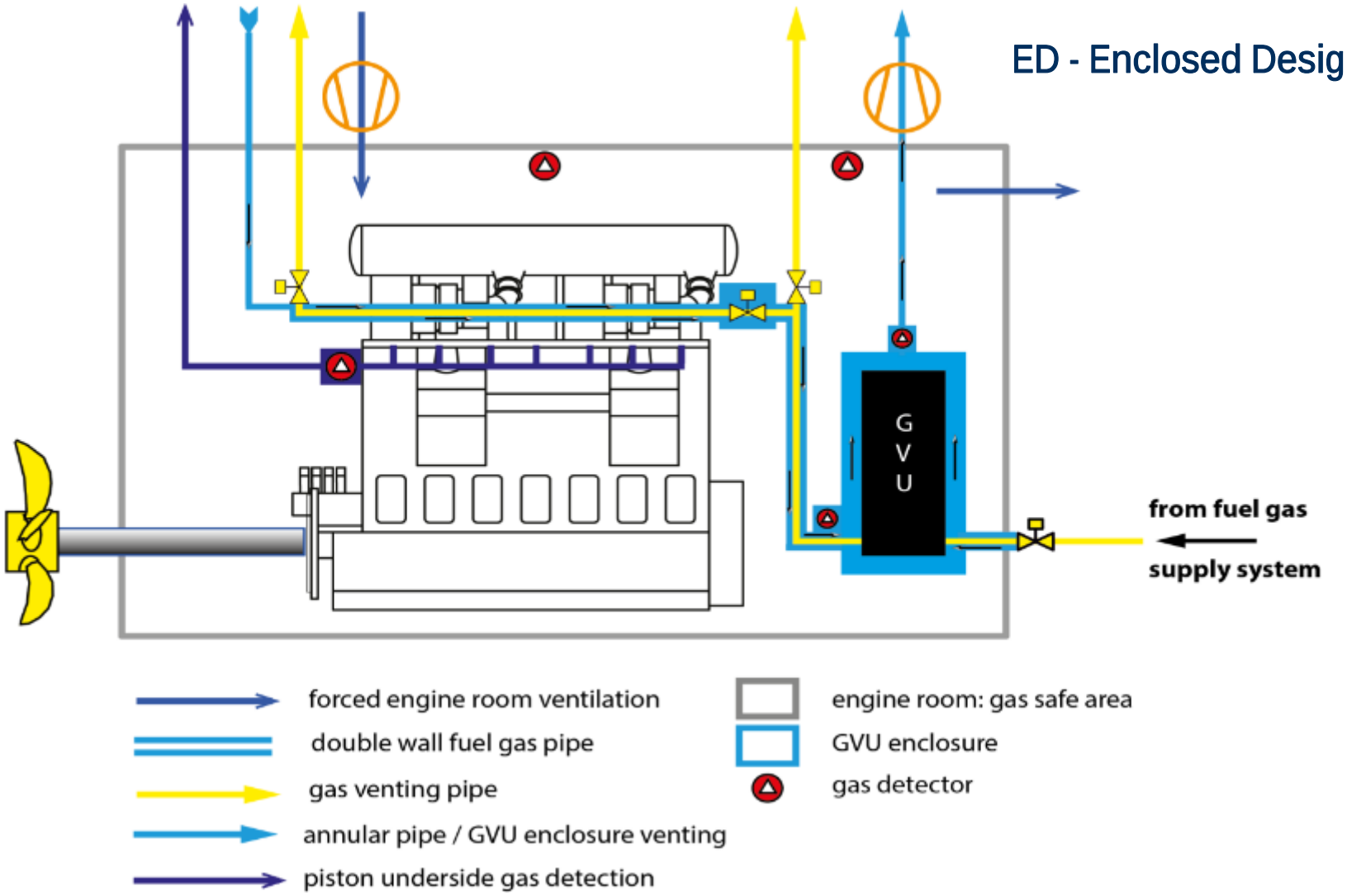
GVU-OD Installation Aspects

OD - Open Design

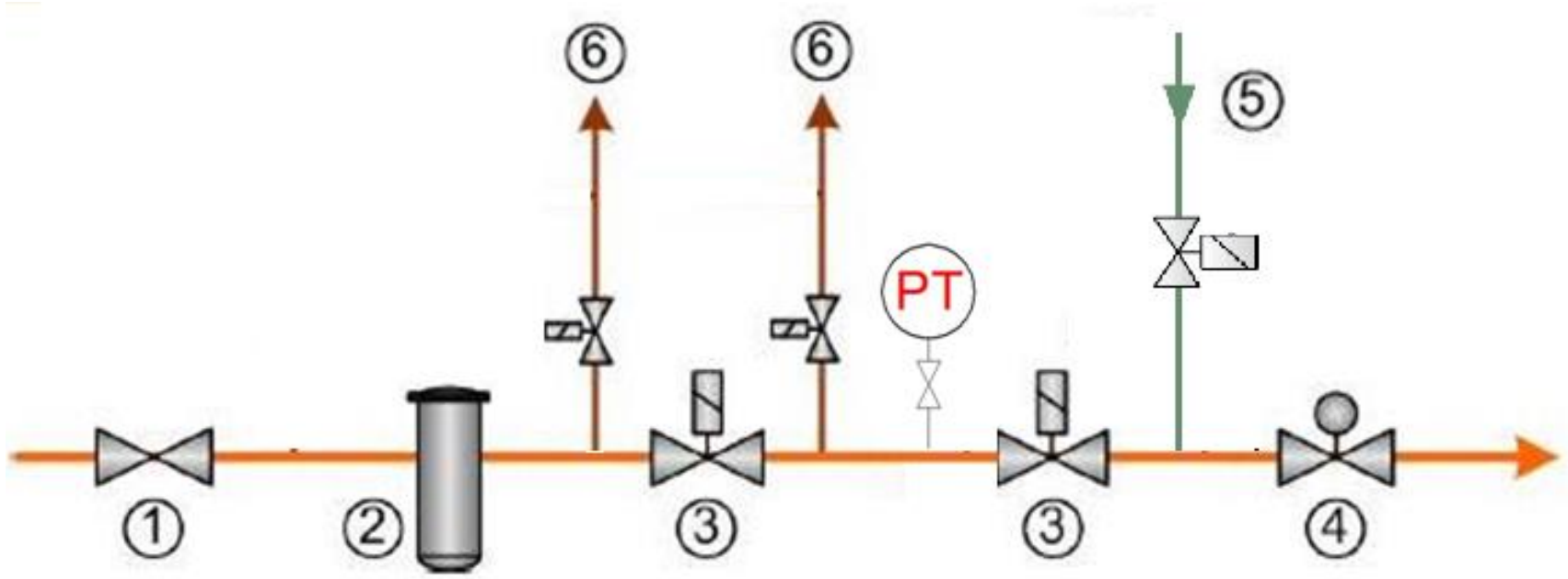


- Requires dedicated compartment, including explosion duct
- Lightning and other equipment has to be Ex Zone 1 compatible
- Airlock is required between GVU room and surrounding space
- Recommended maximum distance from GVU to engine 30 m

GVU-ED™ Installation Aspects



Basic Principle of Gas Valve Unit (GVU)



1 Gas inlet valve
2 Gas filter
3 Automatic shut-off valves
4 Gas regulating valve
5 Inert gas connection
6 Venting lines

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Gas Valve Unit (GVU) – General

- The Gas Valve Unit – GVU comprises of the following components
  - Manual shut off valve
  - Gas filter
  - Valve block
  - Pressure control valve
  - Purging valves
  - Ventilation valves
  - Flow-meter (option)

- The main functions of the GVU
  - Gas pressure regulation
  - Leak test – sequence
  - Inerting and venting

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GVU-ED™ Layout (Vertical Design)

Air ventilation to fan

Manual gas inlet valve lever

Enclosure includes:

- Manual inlet valve
- Vent, inert, shut off valves
- Pressure regulator
- Gas filter
- Sensors

Gas supply from LNG supply system

Gas to engine from bottom of the unit

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GVU Control Panel

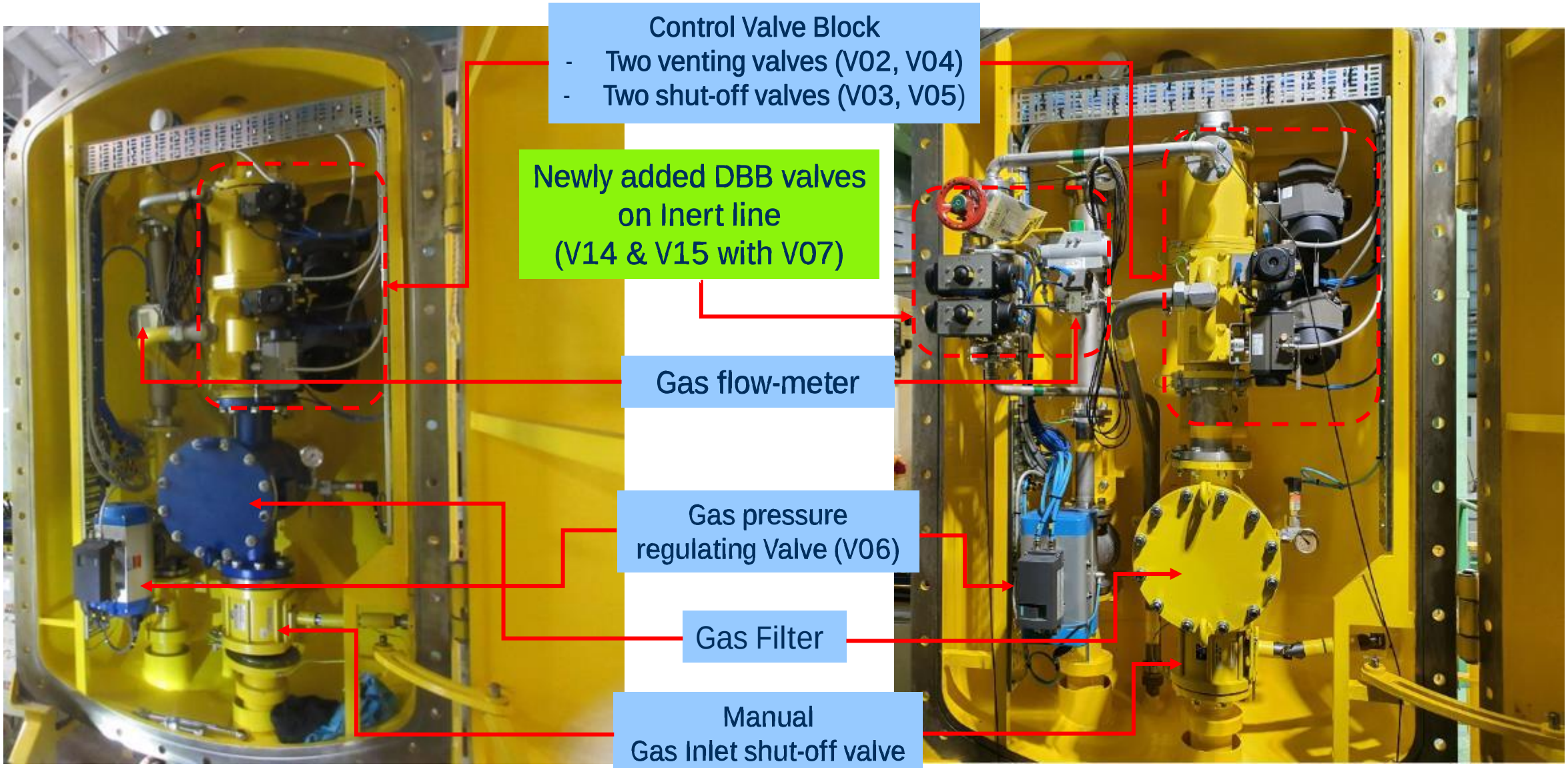
Control cabinet including:
- Controller, intrinsically safe isolators, terminals, fuses & relays

Indication lamp of Gas pressure in System and Push Buttons of Watchdog trip reset and Lamp test

Local display Unit

Manual Gas leakage test and Manual Inerting buttons

GVU Details



Solenoid Valve Cabinet

- Manual shut-off valve
- Control air filter
- Manual pressure regulator (Control air, 6 ~ 8 bar)
- Solenoid valves for:
  - Automatic venting valves
  - Automatic shut-off valves
  - Inert gas valve
- Pressure transmitter

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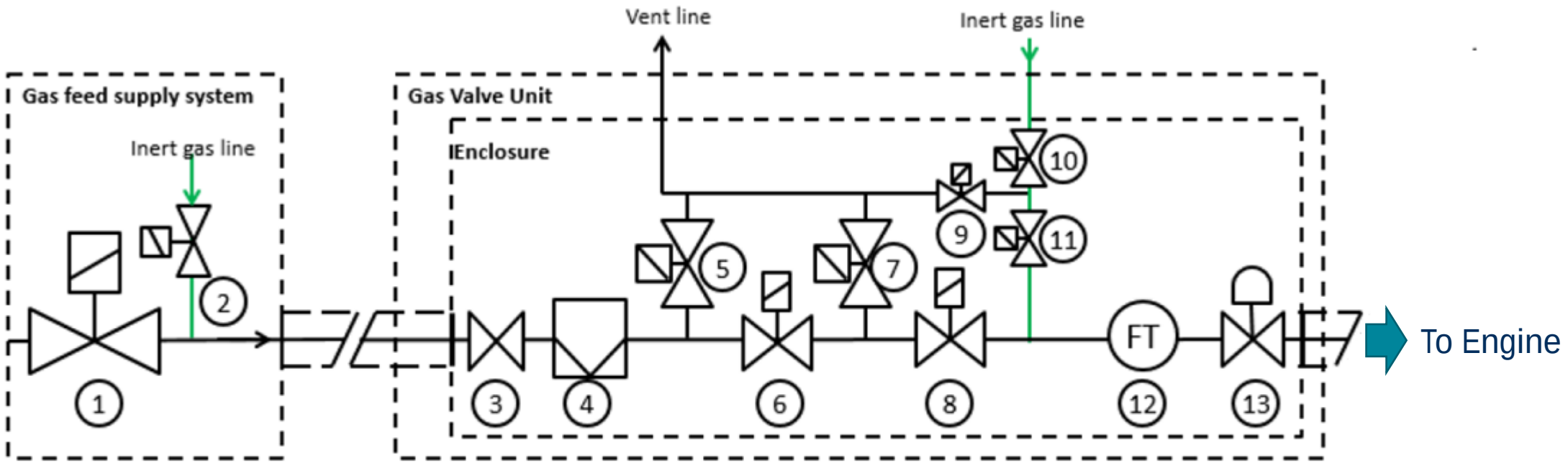
GVU Mass Flow Meter (optional)

The GVU utilises a **Coriolis type** mass flow meter to monitor the engine gas consumption as optional equipment

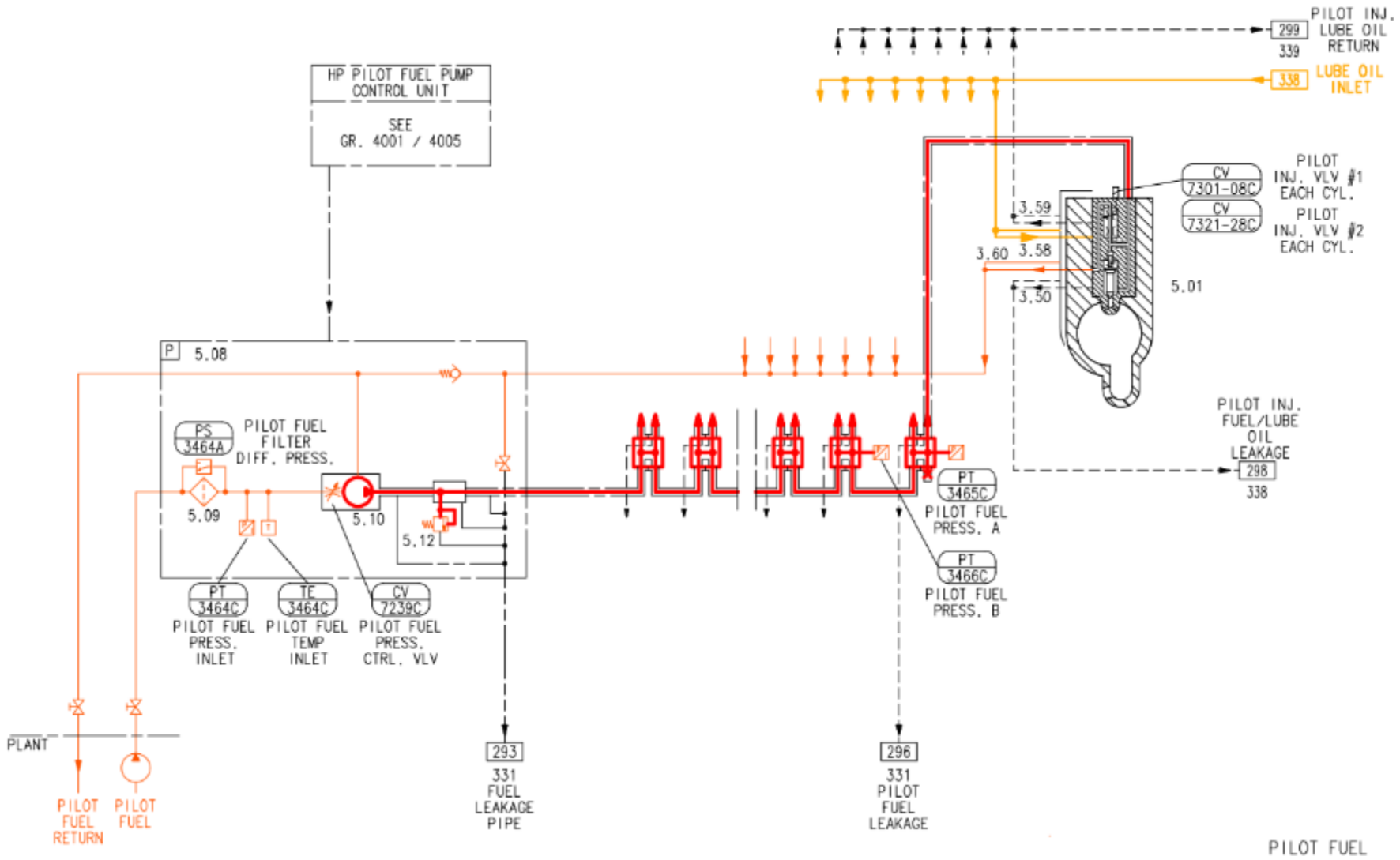
- The meter utilizes Coriolis forces to calculate the mass flow
- The benefit with this principle is that it operates independently of temperature, pressure, viscosity, conductivity and flow profile
- The meter can record mass, density and temperature at same time
- The measuring system consists of a sensor mounted inside the enclosure and a control box mounted next to the GVU control cabinet
- The equipment can easily be used as input in engine or vessel optimization programs

Nitrogen DBB valves added on GVU

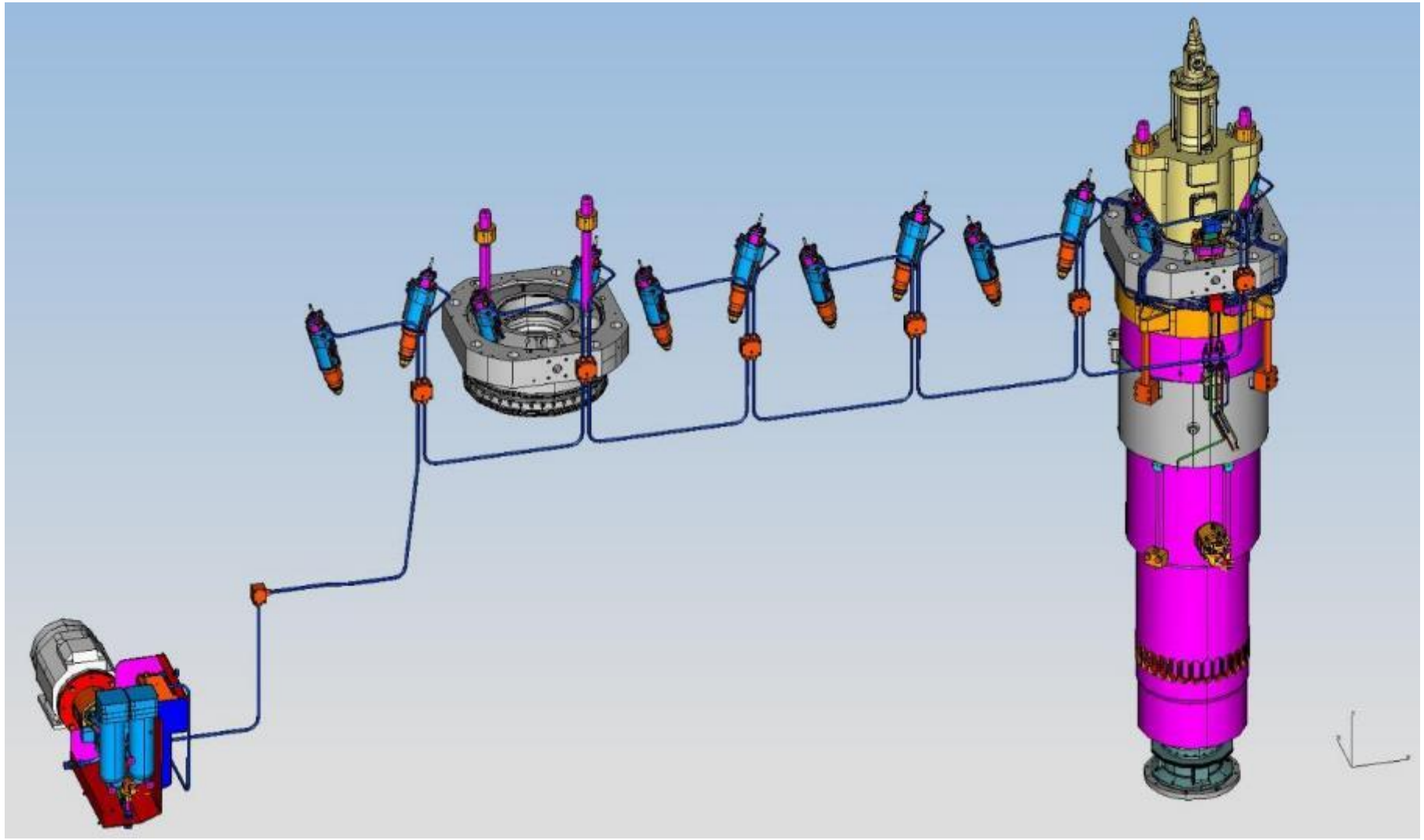


1) Master gas Valve
2) Inert gas valve
3) Manual Shut-off valve, V01
4) Gas filter
5) Gas Ventilation Valve, V02
6) Shut-off valve, V03
7) Gas ventilation valve, V04
8) Shut-off valve, V05
9) Gas ventilation valve, V15
10) Nitrogen block valve, V14
11) Nitrogen block valve, V07
12) Flowmeter (optional)
13) Gas control valve, V06

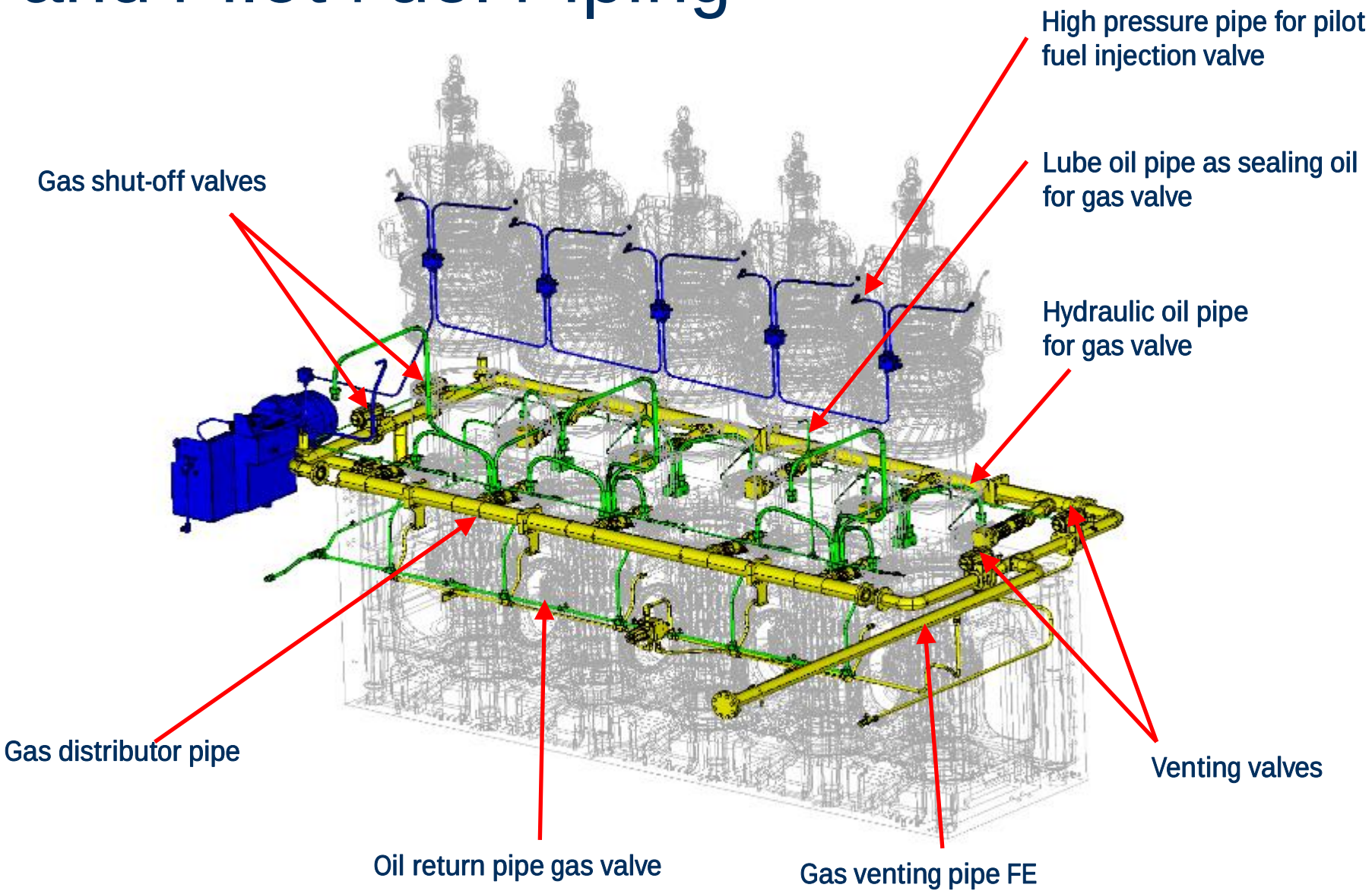
Pilot Fuel System



Pilot Fuel System



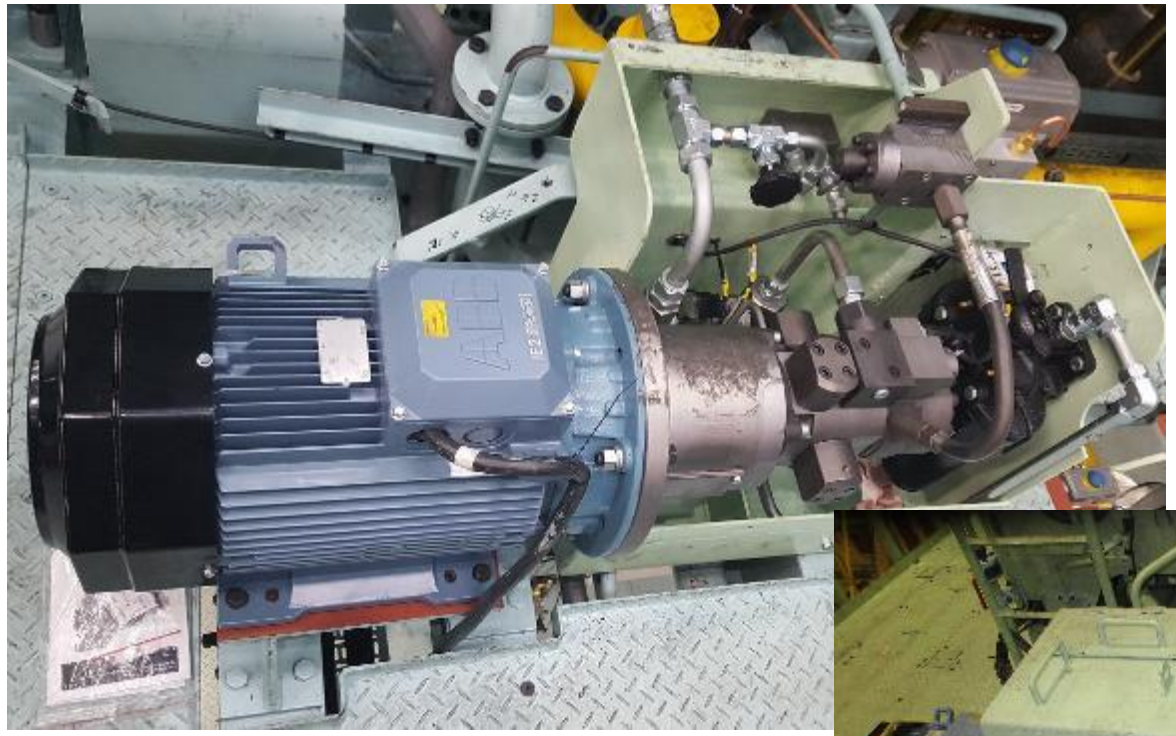
Gas and Pilot Fuel Piping



Pilot Fuel System

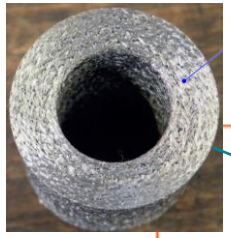
Pilot fuel pump

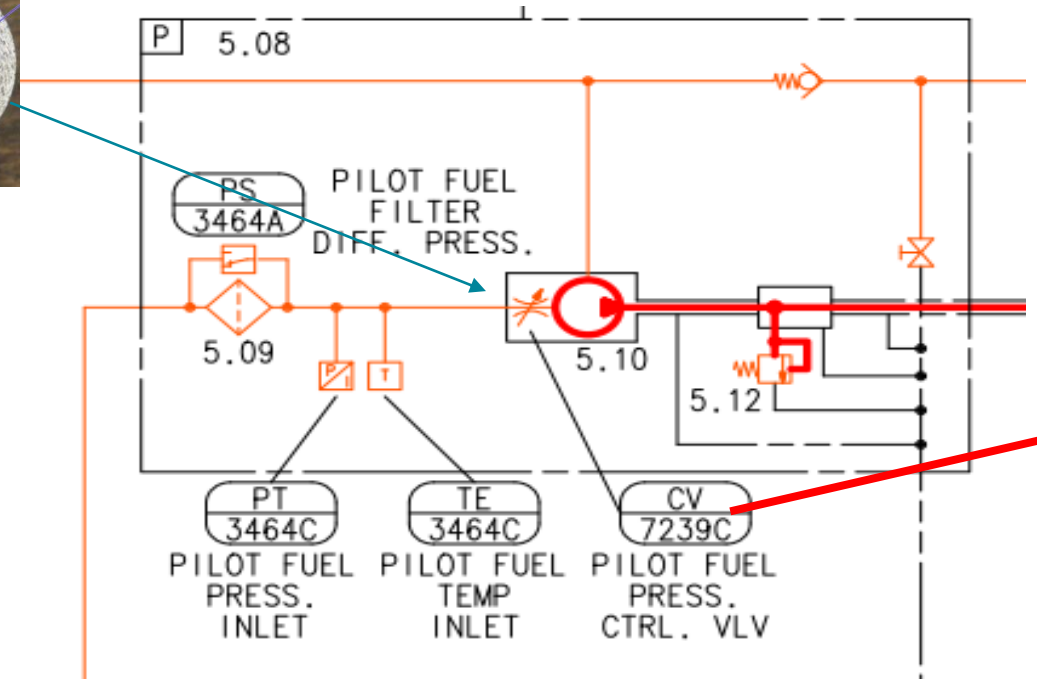
- Electrical driven
- L‘Orange radial piston pump
- Flow controlled (inlet throttling)
- Duplex fine filter
- Safety valve (overpressure)
- Dry running protection, inlet pressure and temperature monitored

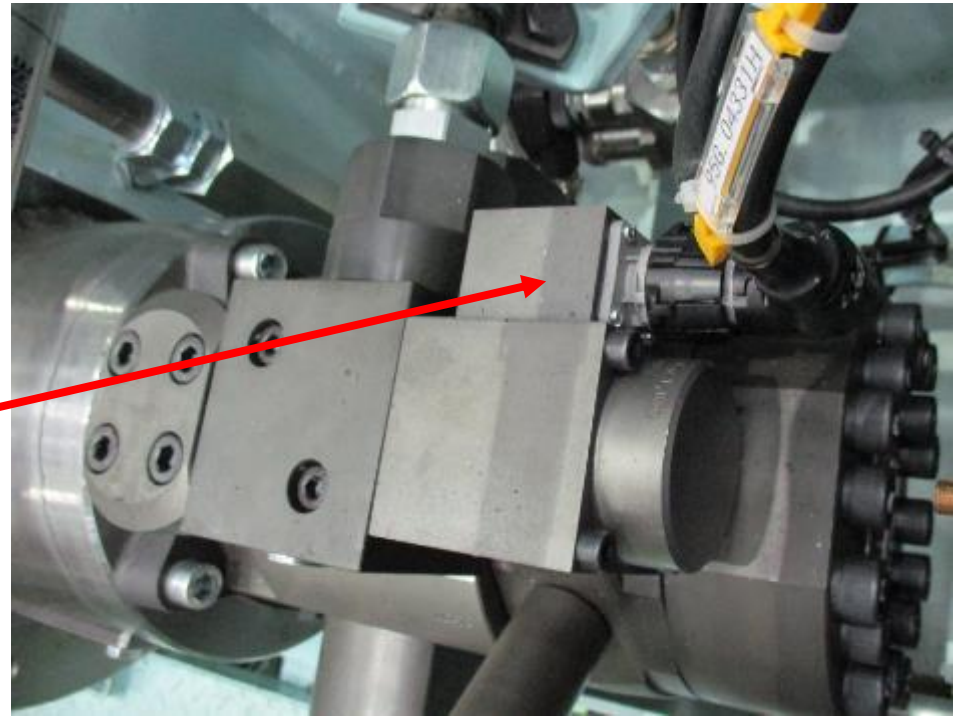


Pilot Fuel System

Pilot fuel pump







Pilot Fuel System

Filter

To prevent dirty and clogged pilot fuel being injected at all operating modes

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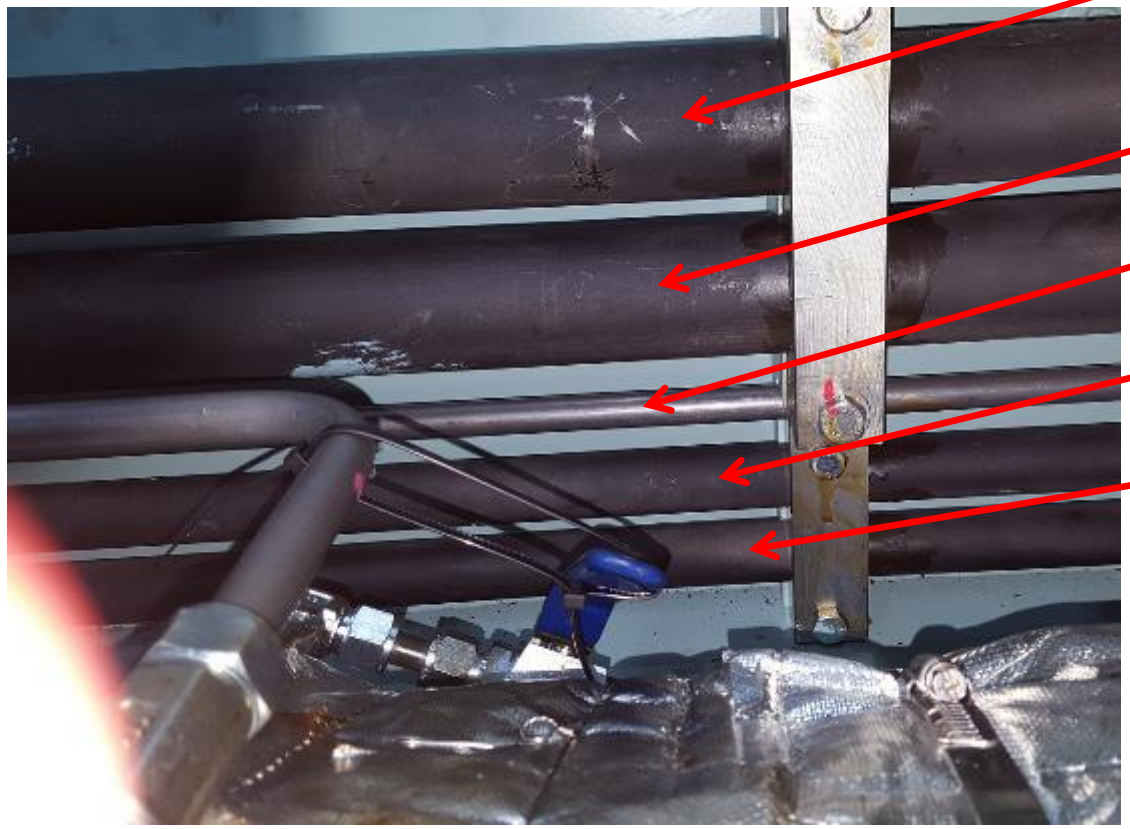
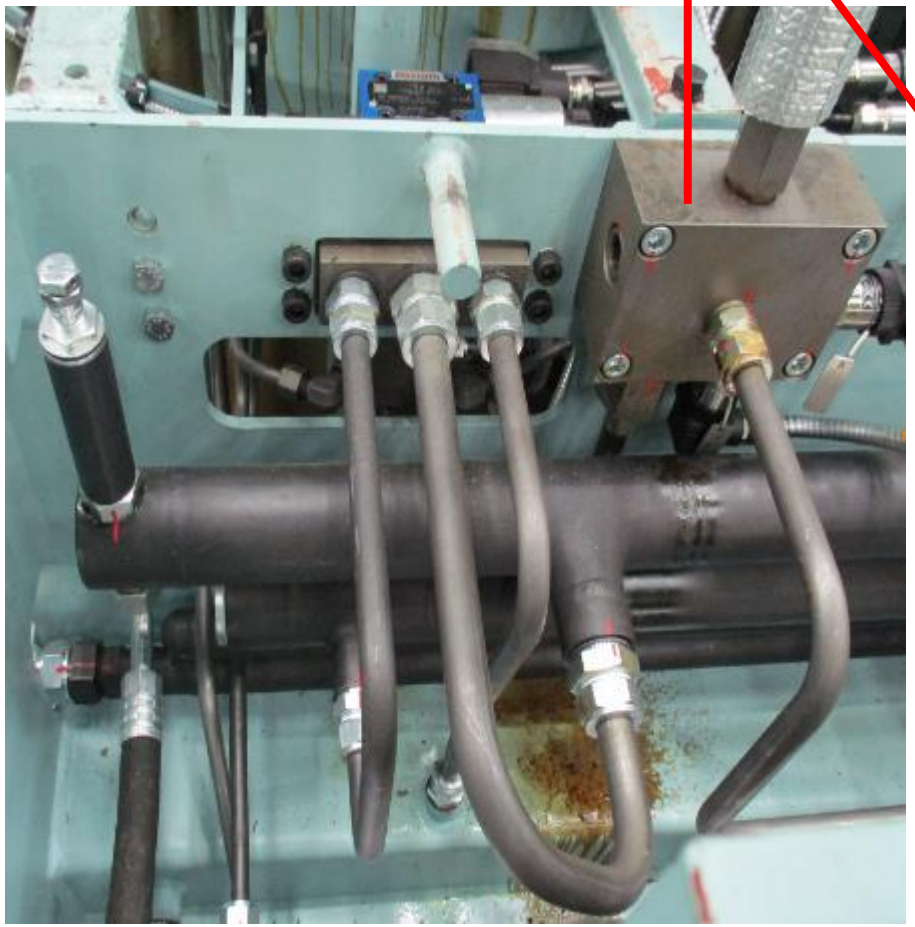
Pilot Fuel pipe

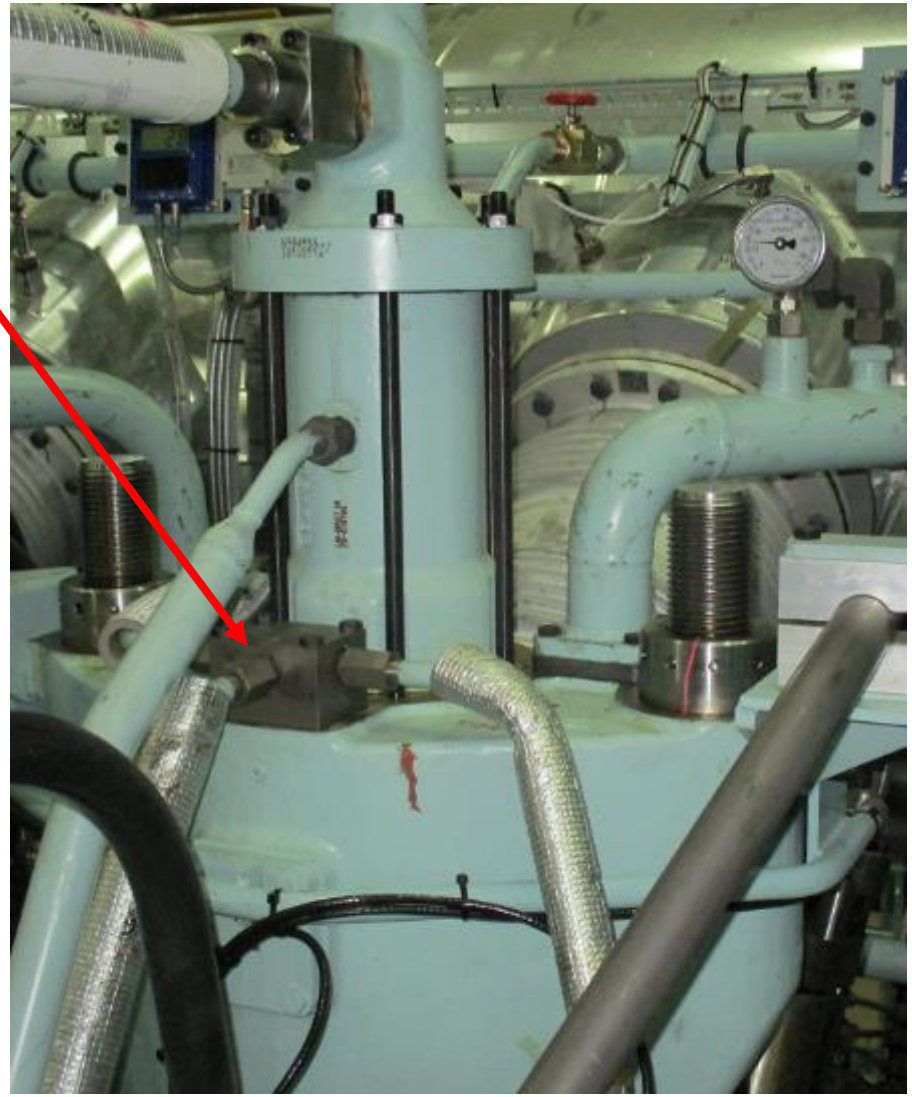


X62/72DF

Pilot Fuel pipe

Pilot Fuel High pressure Pipe





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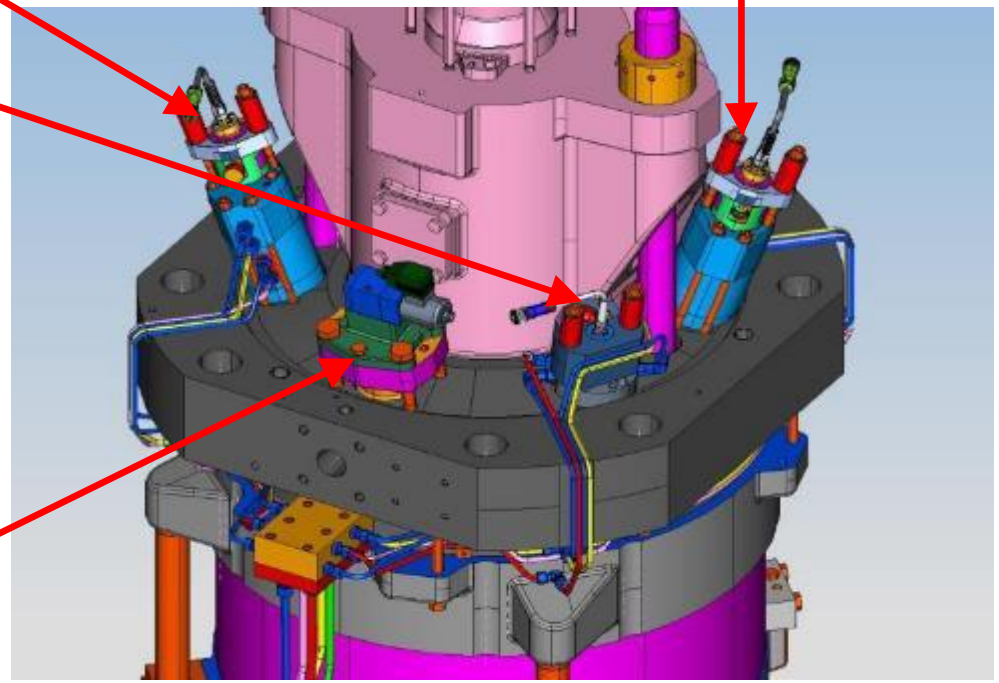
Arrangement on Cylinder Cover

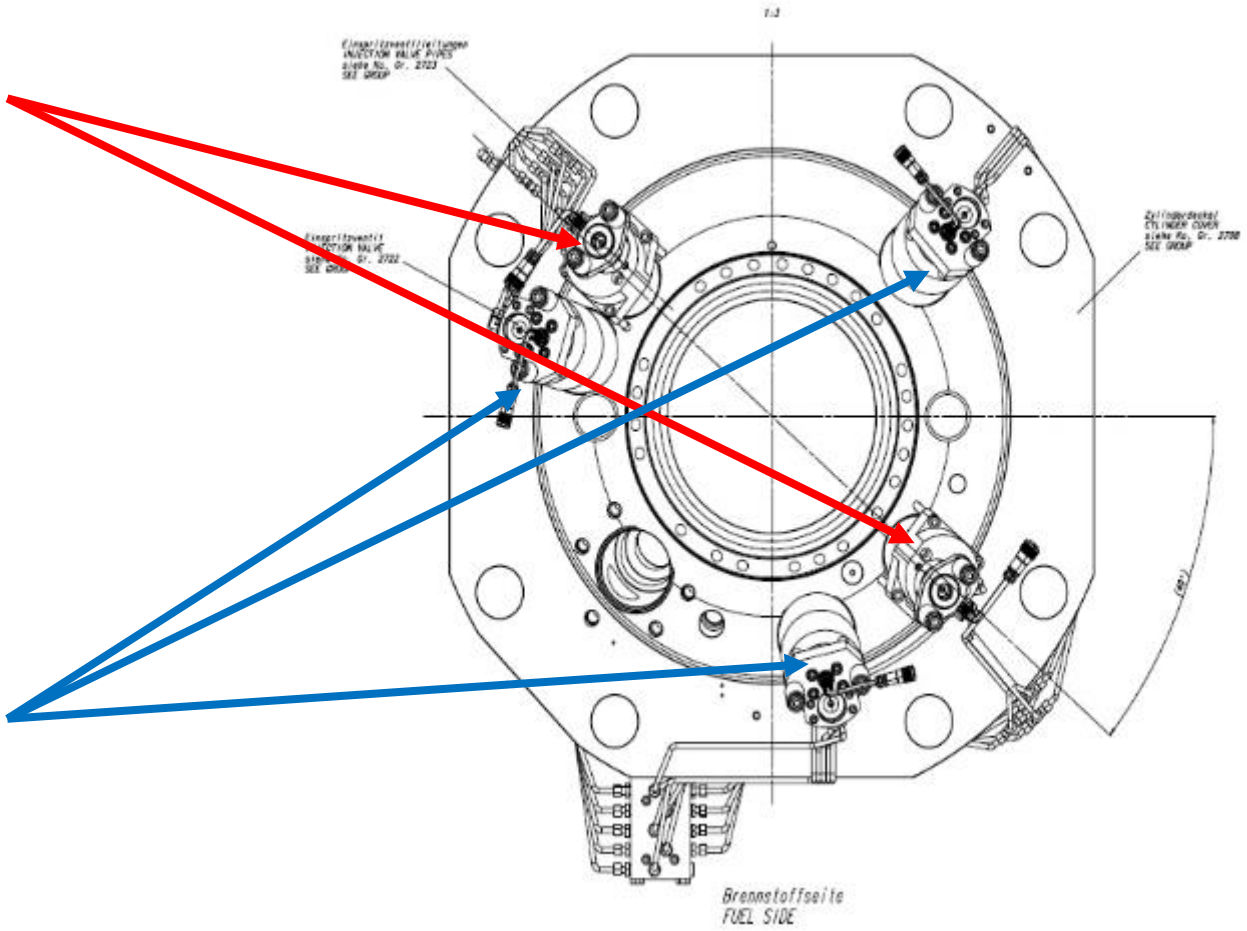
- 2 x L'Orange pilot fuel injectors
- L'Orange main fuel injectors
  (2 x for RT-flex50DF)
  (3 x for X52DF, X62DF, X72DF)
  - High pressure fuel in
  - Control fuel out
  - Mixed leakage out
  - Lubricating oil in
  - Lubricating oil out
  - Electrical cable
- Pilot starting valve



RT-flex50DF

Arrangement on Cylinder Cover

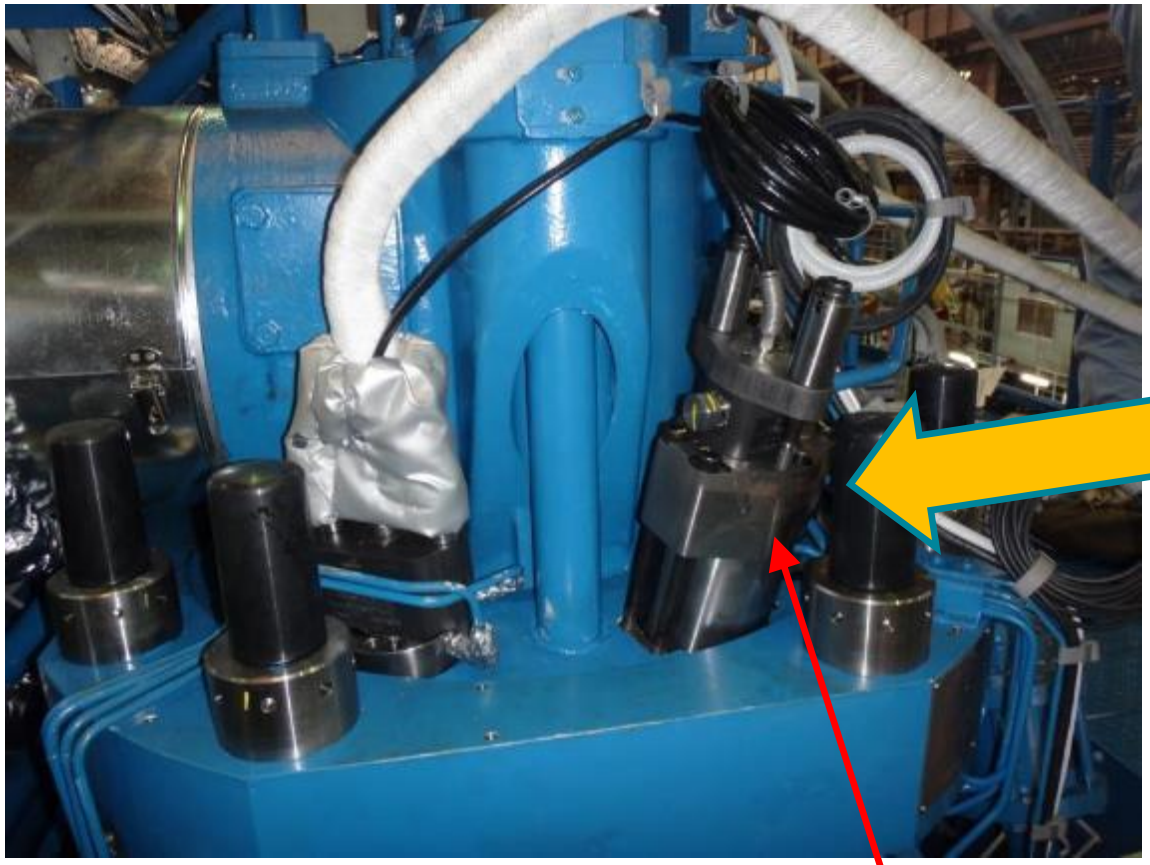
- 2 x L'Orange pilot fuel injectors
- 3 x L'Orange main fuel injectors



X62/72DF

Pilot Fuel Injector and Sleeve

RT-flex50DF

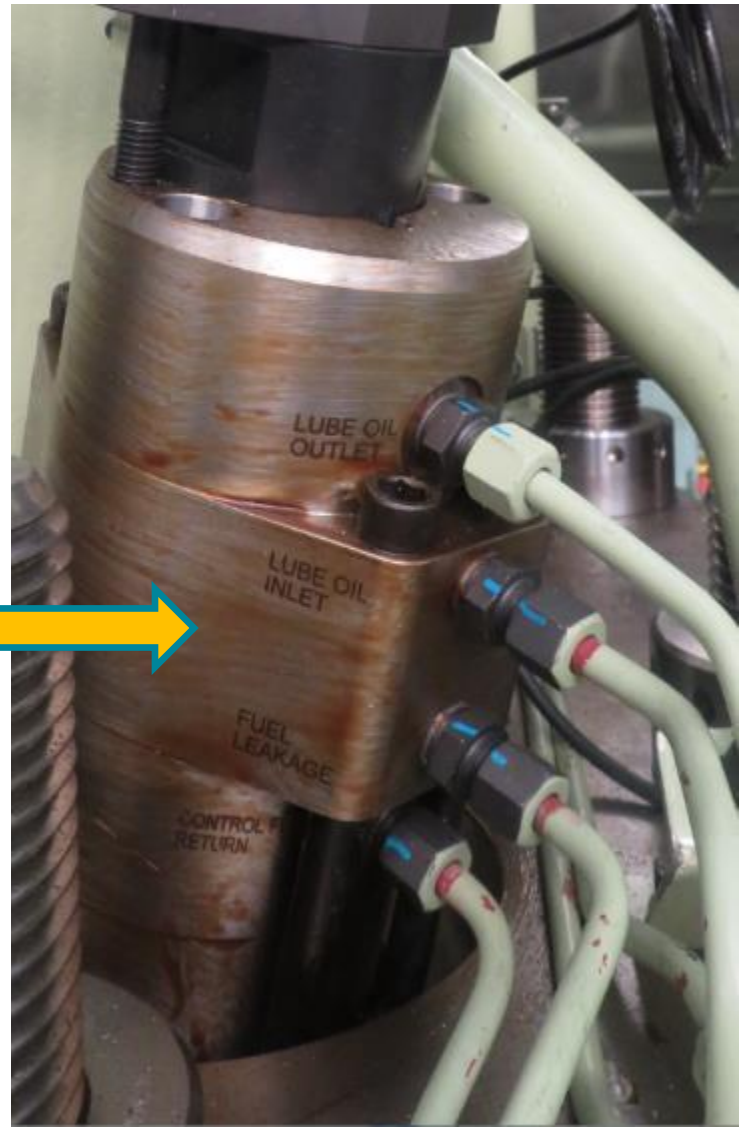


Pilot fuel injector

Pilot Fuel Injector and Valve bush

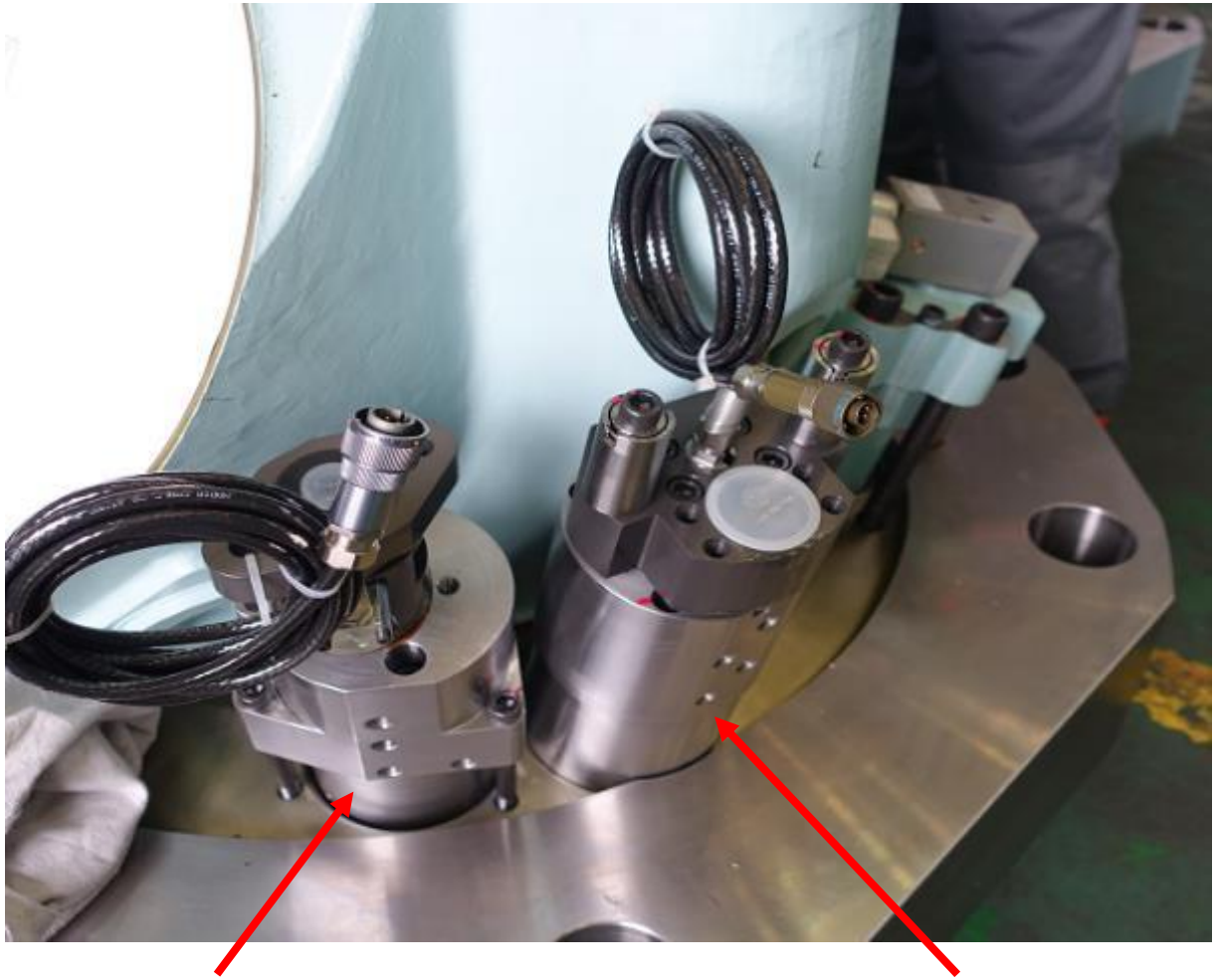
X52DF

Pilot fuel injector

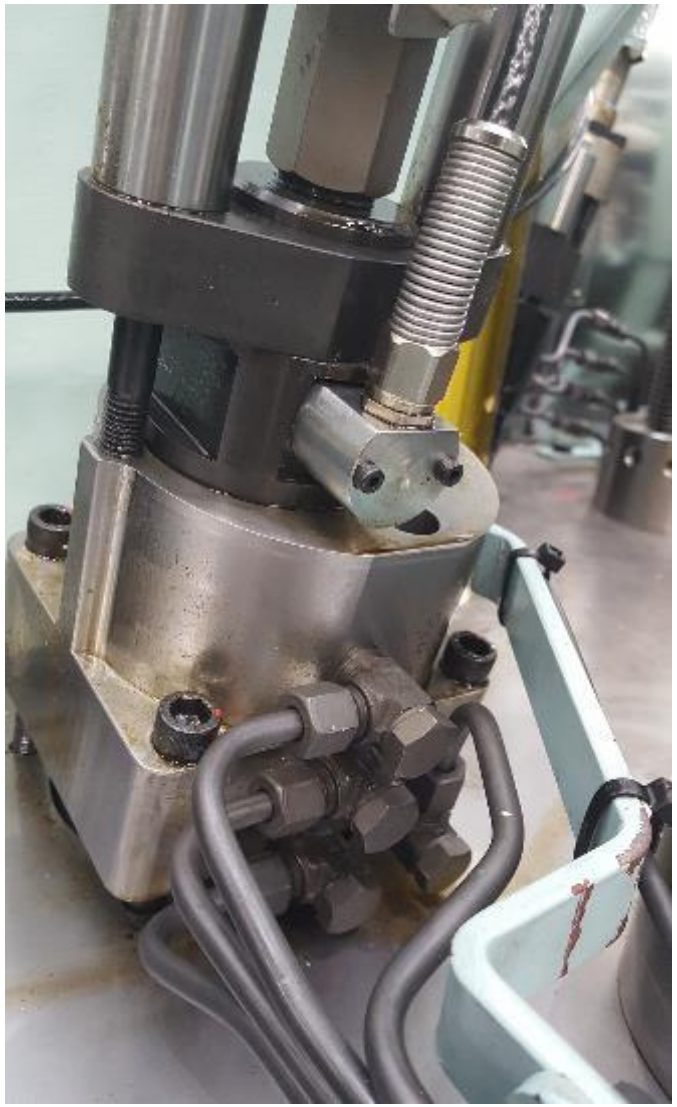


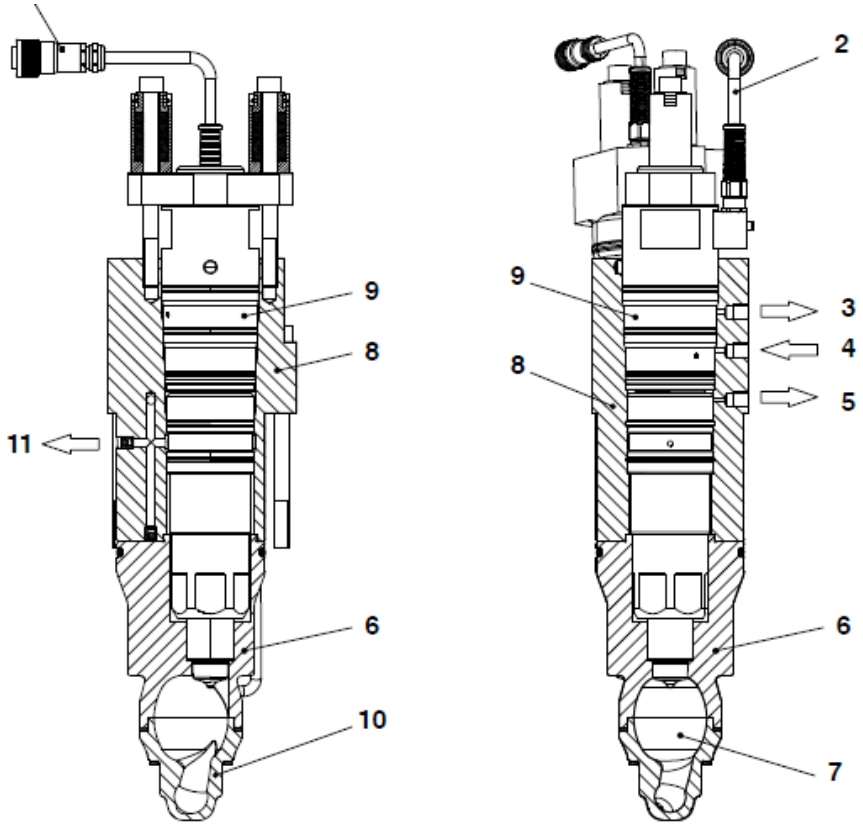
Pilot Fuel Injector for X62/72DF

X62/72DF



L’Orange Pilot Fuel Injector for X62/72DF

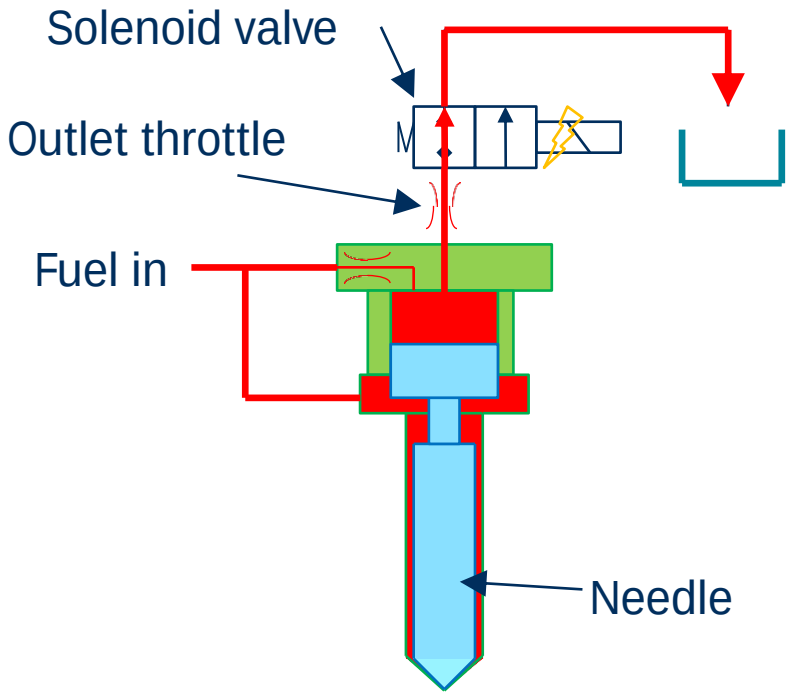


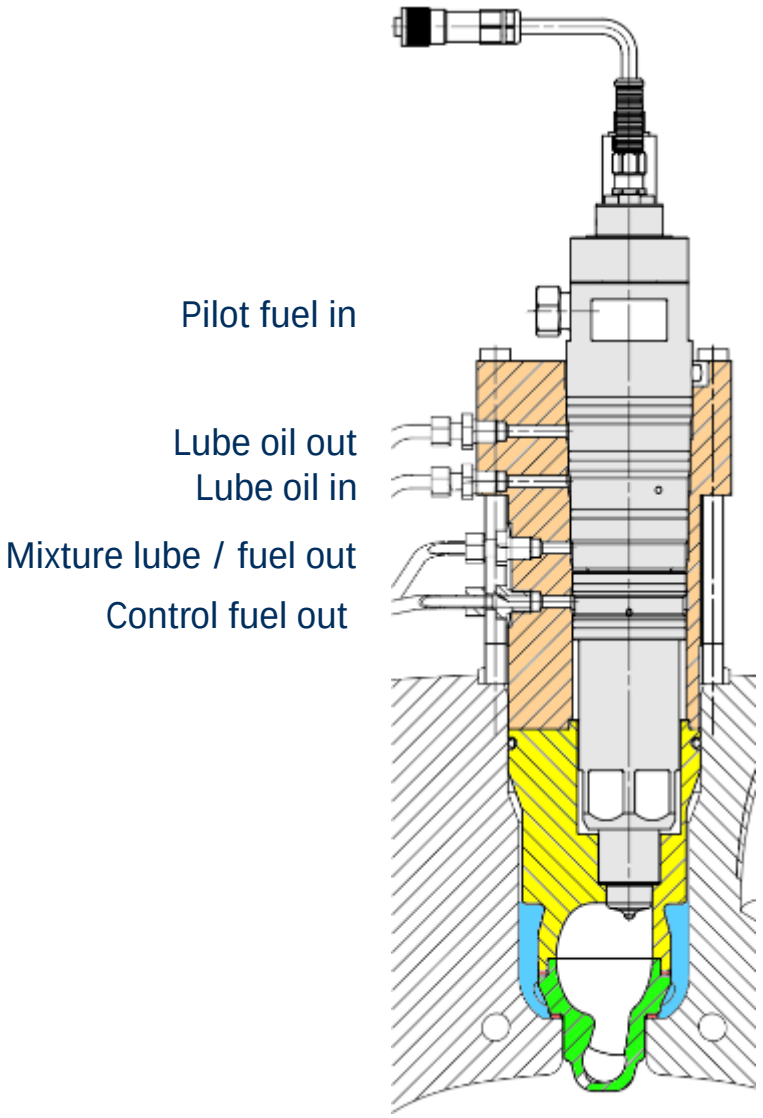


1 Pilot fuel inlet (from pilot fuel pump unit)
2 Electrical cable to solenoid valve
3 Lubricating oil outlet
4 Lubricating oil inlet
5 Lubricating oil and fuel leakage mixture
6 Top housing
7 Prechamber
8 Flange
9 Pilot injection valve
10 Bottom housing
11 Pilot fuel return (pilot injection)
12 Connecting plate

Pilot Fuel Injector / Pre-chamber

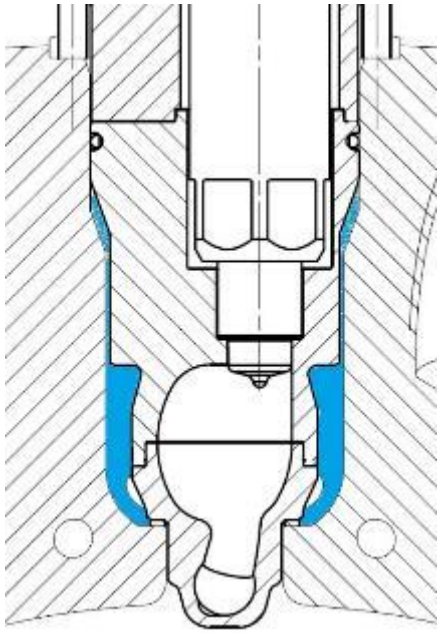
- Electrical pilot fuel valves injecting into pre-chambers
- Injector installed in sleeve for simple removal
- Pre-chambers water cooled
- Pre-chamber tips replaceable
- Pilot fuel injected at any fuel mode

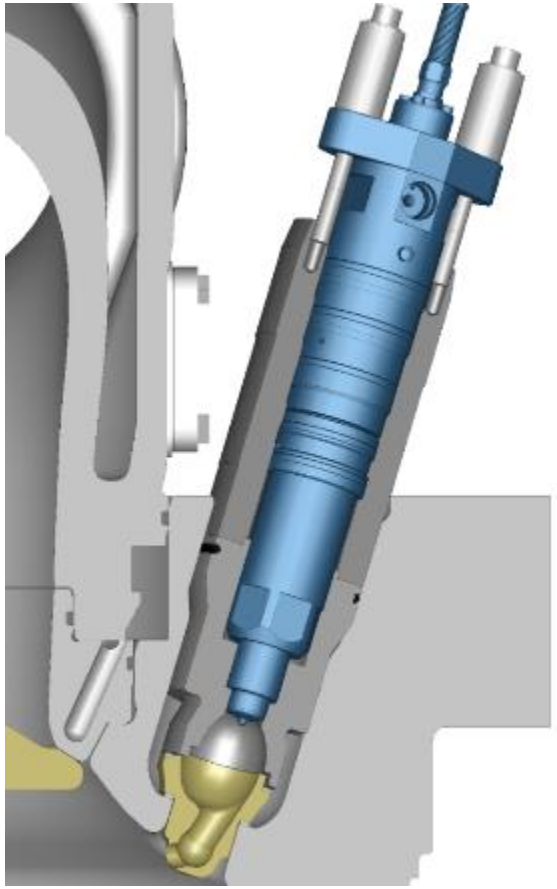




RT-flex50DF

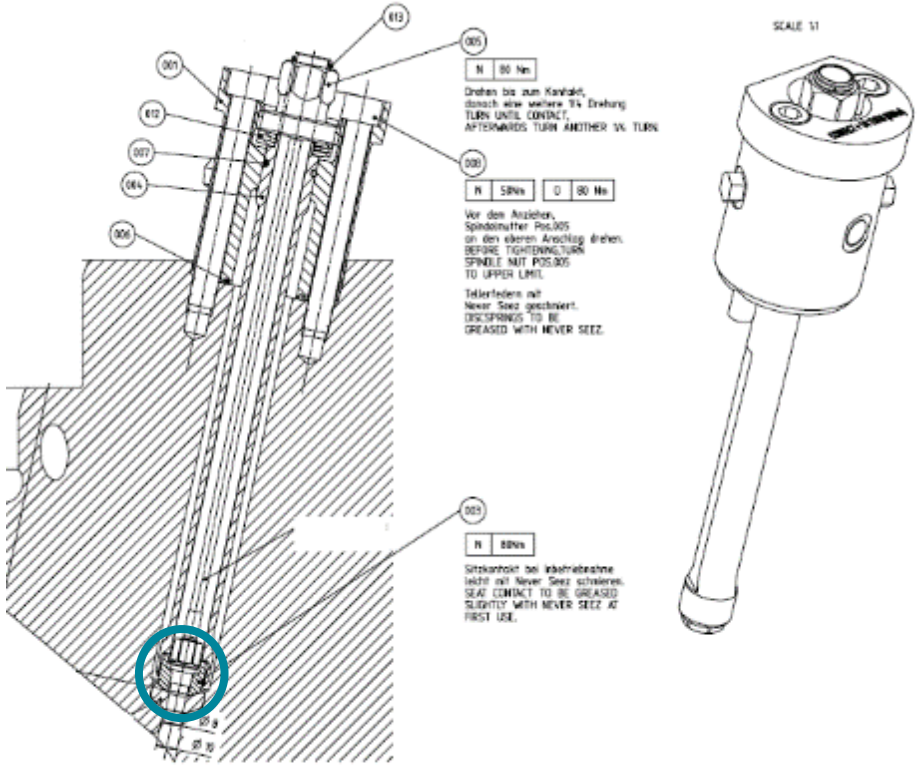
Pilot Fuel Injector / Pre-chamber





Relief Valve for flex50DF(new) & X52DF

- Since no gas-pocket in combustion chamber permitted, no traditional indicator valve installed
- Never open the relief valve while engine running !
- Cylinder pressure sensor on bottom of relief valve



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Relief Valve for flex50DF(old), X62DF & 72DF

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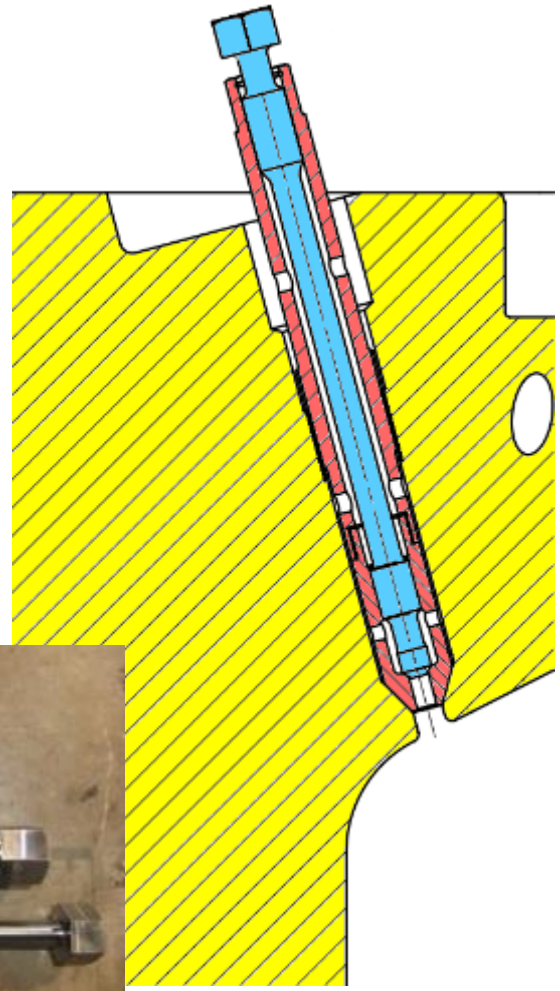

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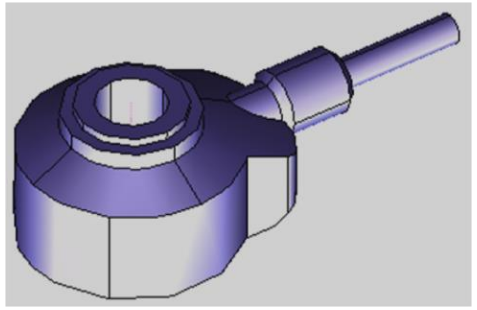
Knocking Sensor

- Knocking in diesel engines is defined as sharp sounds, caused by the combustion of parts of the compressed air / fuel mixture in the cylinder before the calculated ignition
- Knock sensors are installed on each cylinder cover. If the knock sensors sense combustion that is too fast (knocking) the engine control system activates an alarm
- Knock sensors monitor the combustion process in a specified range of the nominal engine load



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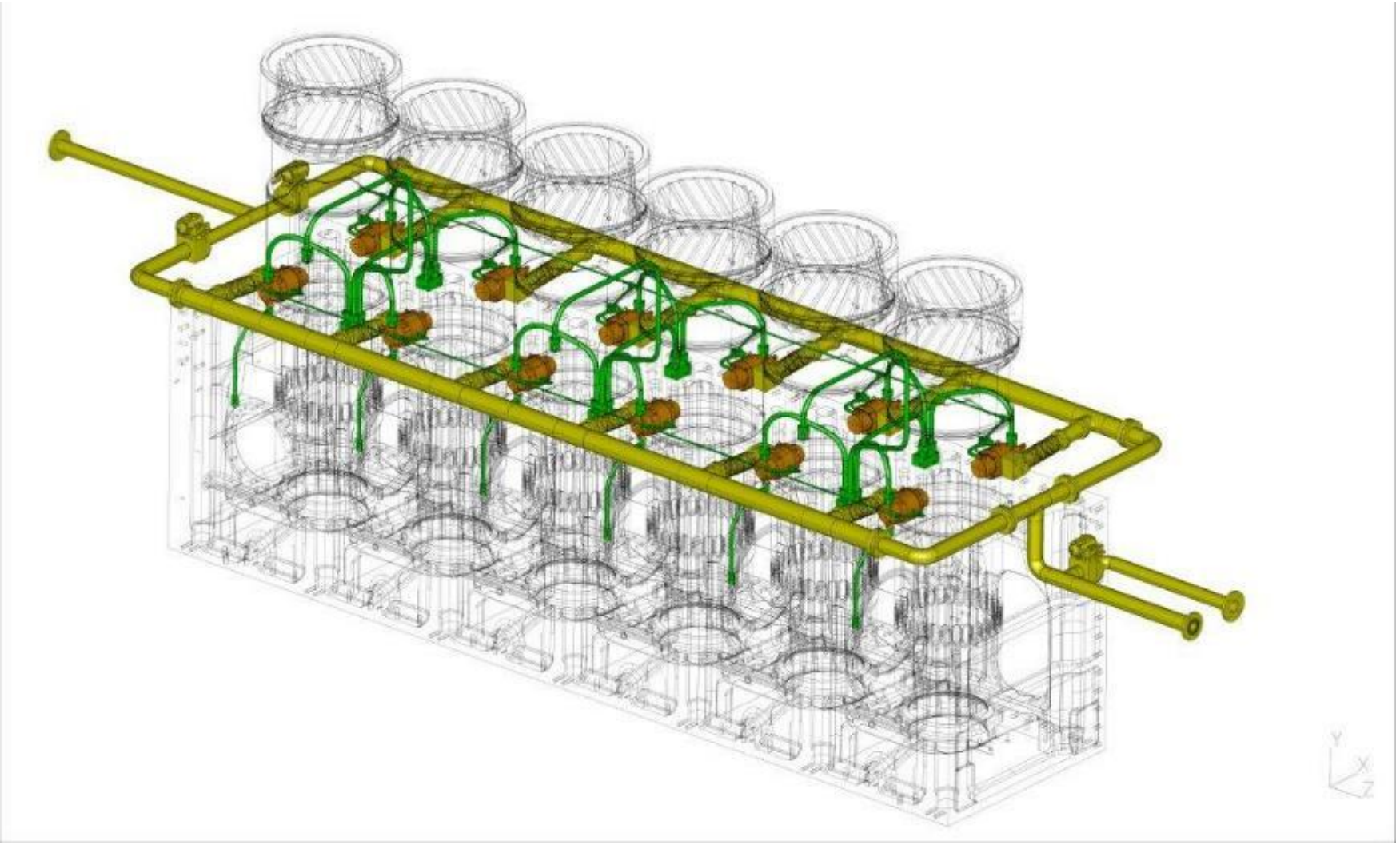
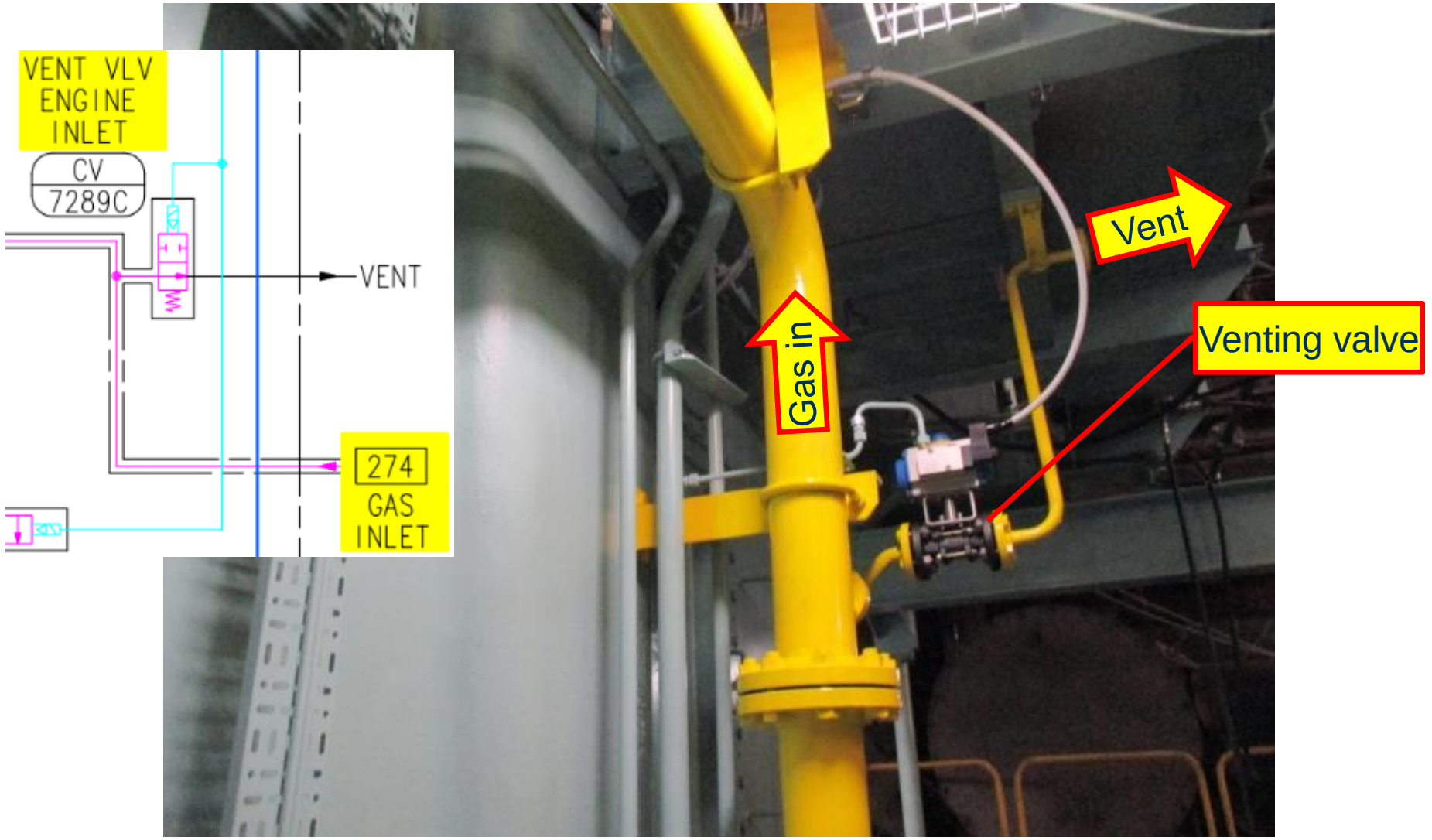
Schema Gas System



Gas Venting Valve Engine Inlet



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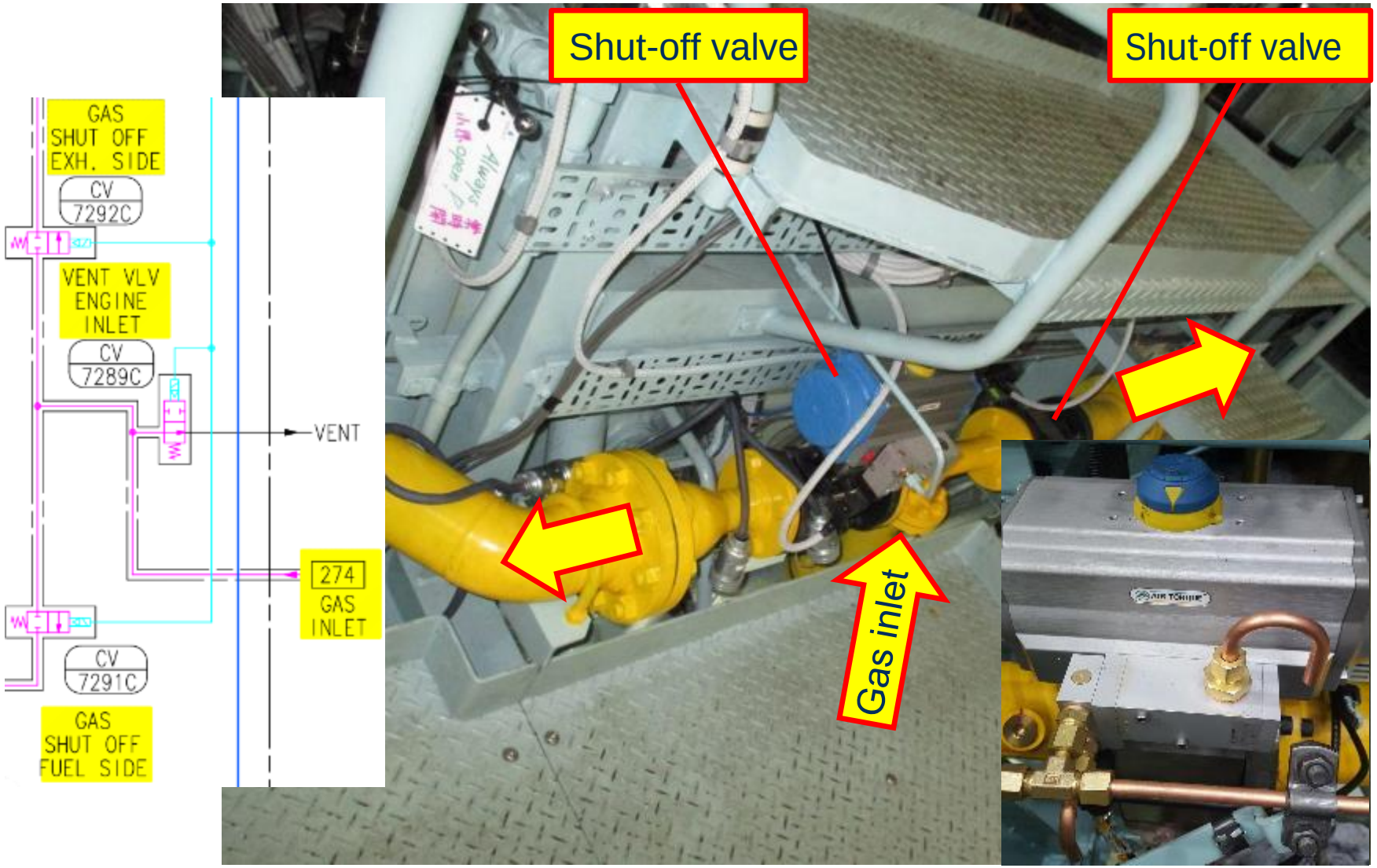
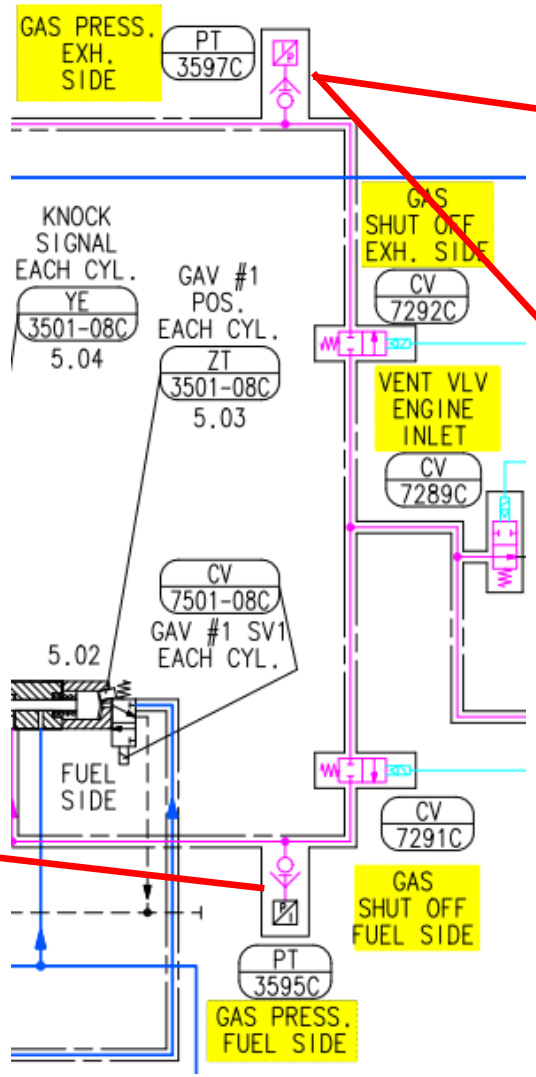
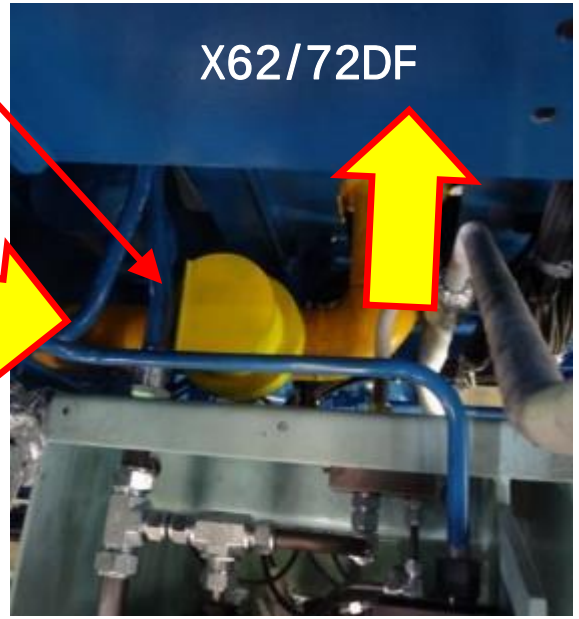
Gas Shut-off Valves

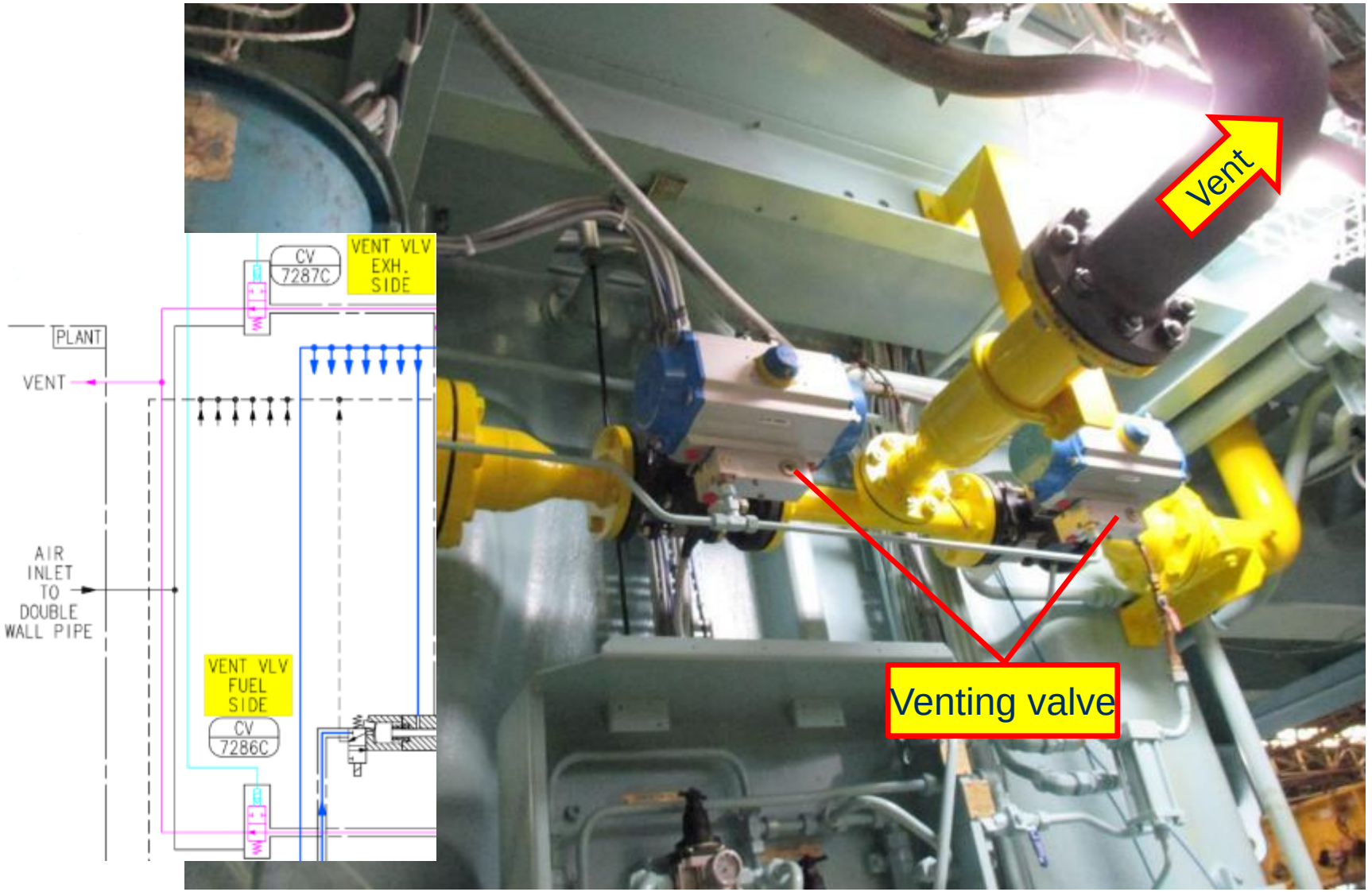


Gas Pressure Sensors



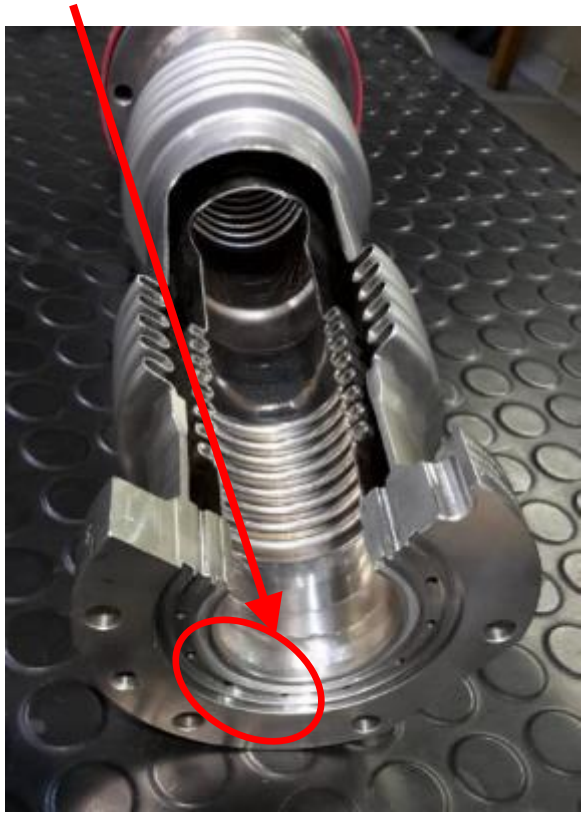


Gas Venting Valves



Double-Wall Gas Piping

- All gas pipes are of double-wall design
- Leakage-gas pass through the flanges



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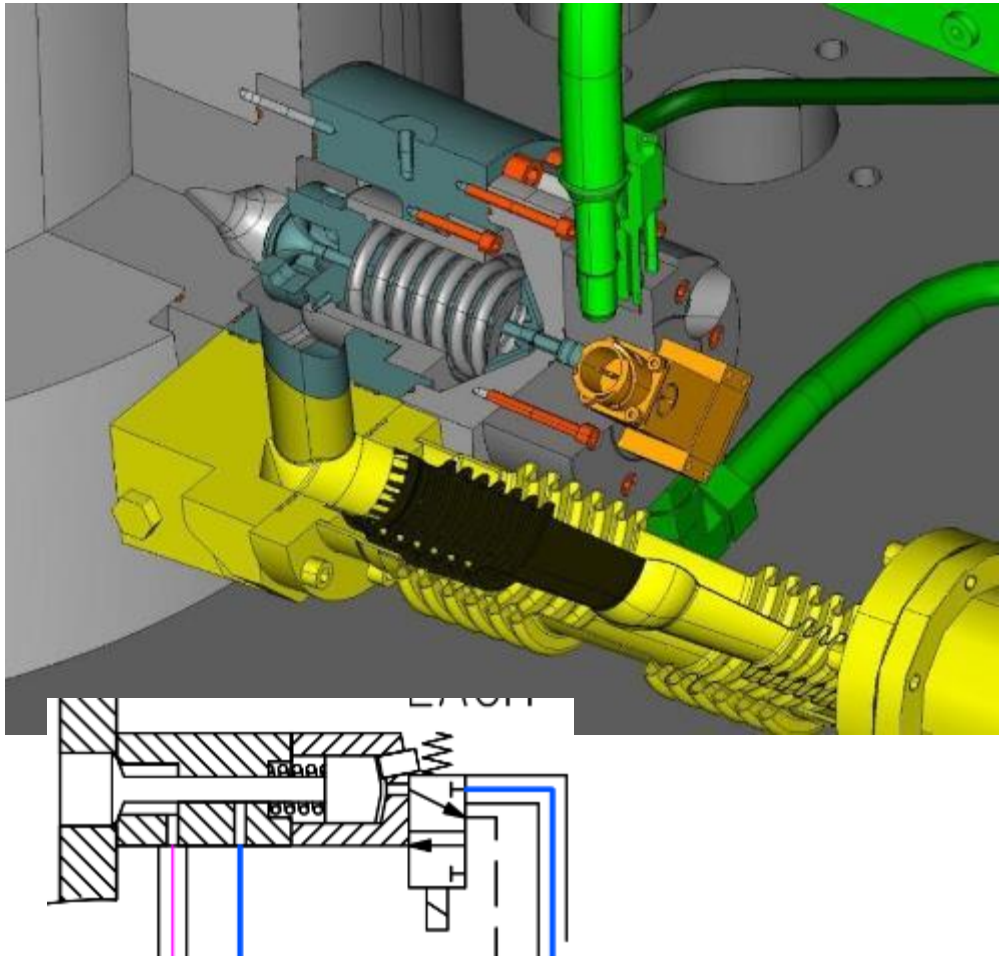
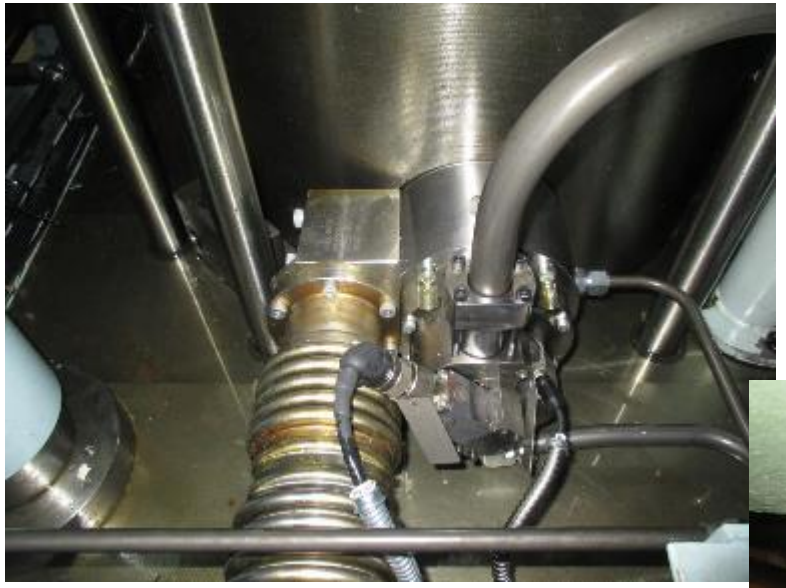
Gas Admission Valve (GAV)

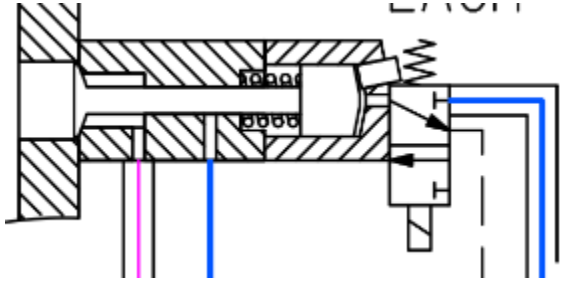


- Two gas admission valves (GAV) per cylinder
- Opening by servo oil and closing by mechanical spring
- Electronically control by mono-stable rail valve
- Monitored by stroke sensor
- Sealing oil in valve guide
- Spring space ventilated through oil return pipe

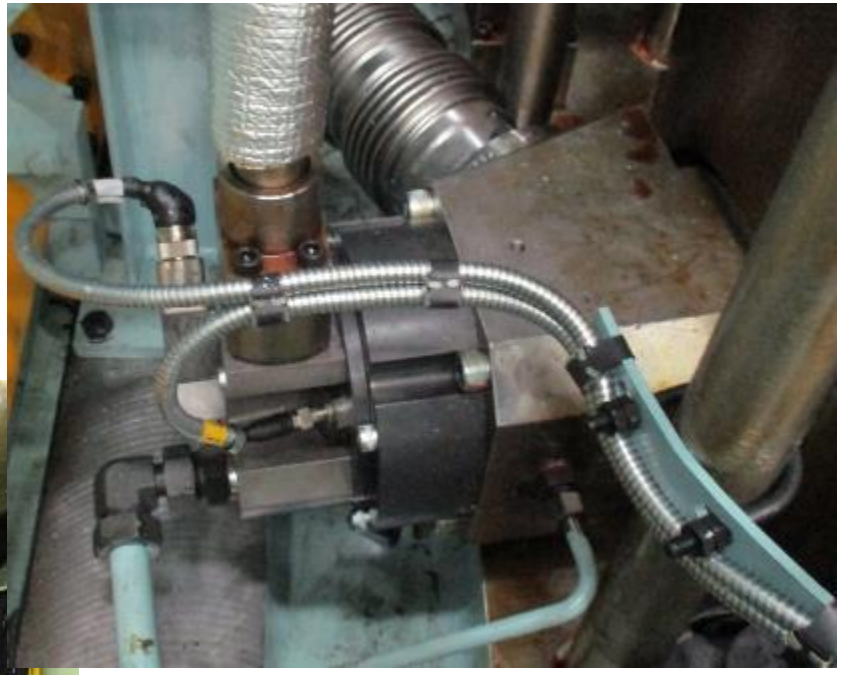
Gas Admission Valve



RT-flex50DF

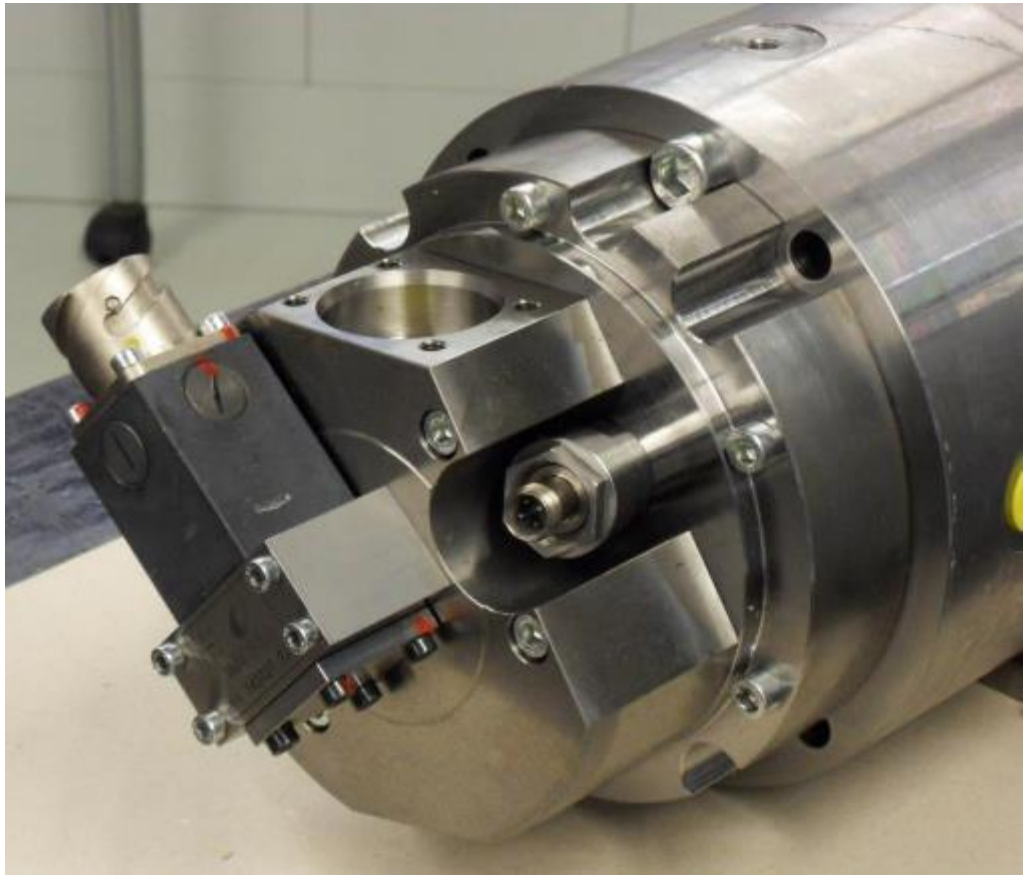


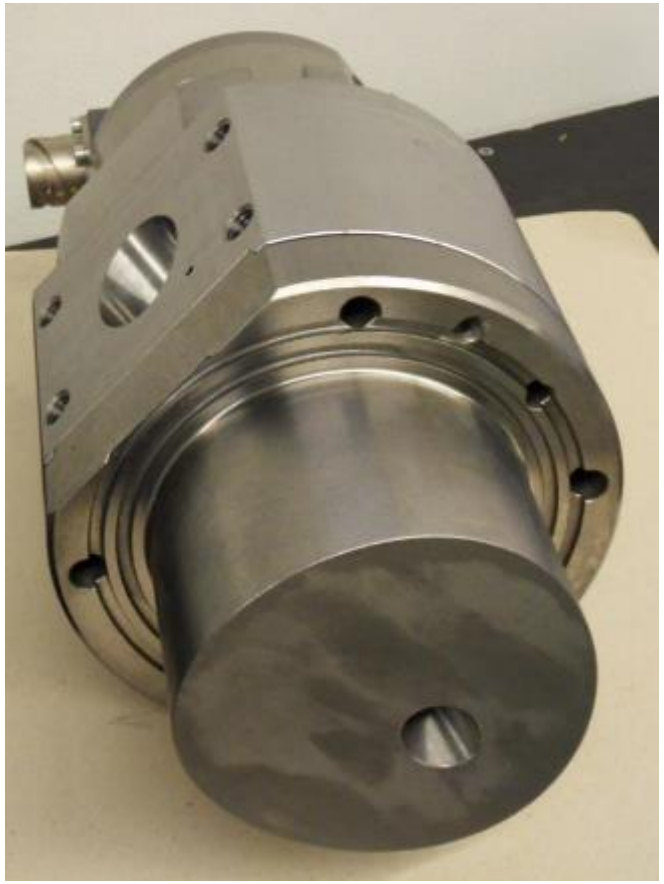
X52DF



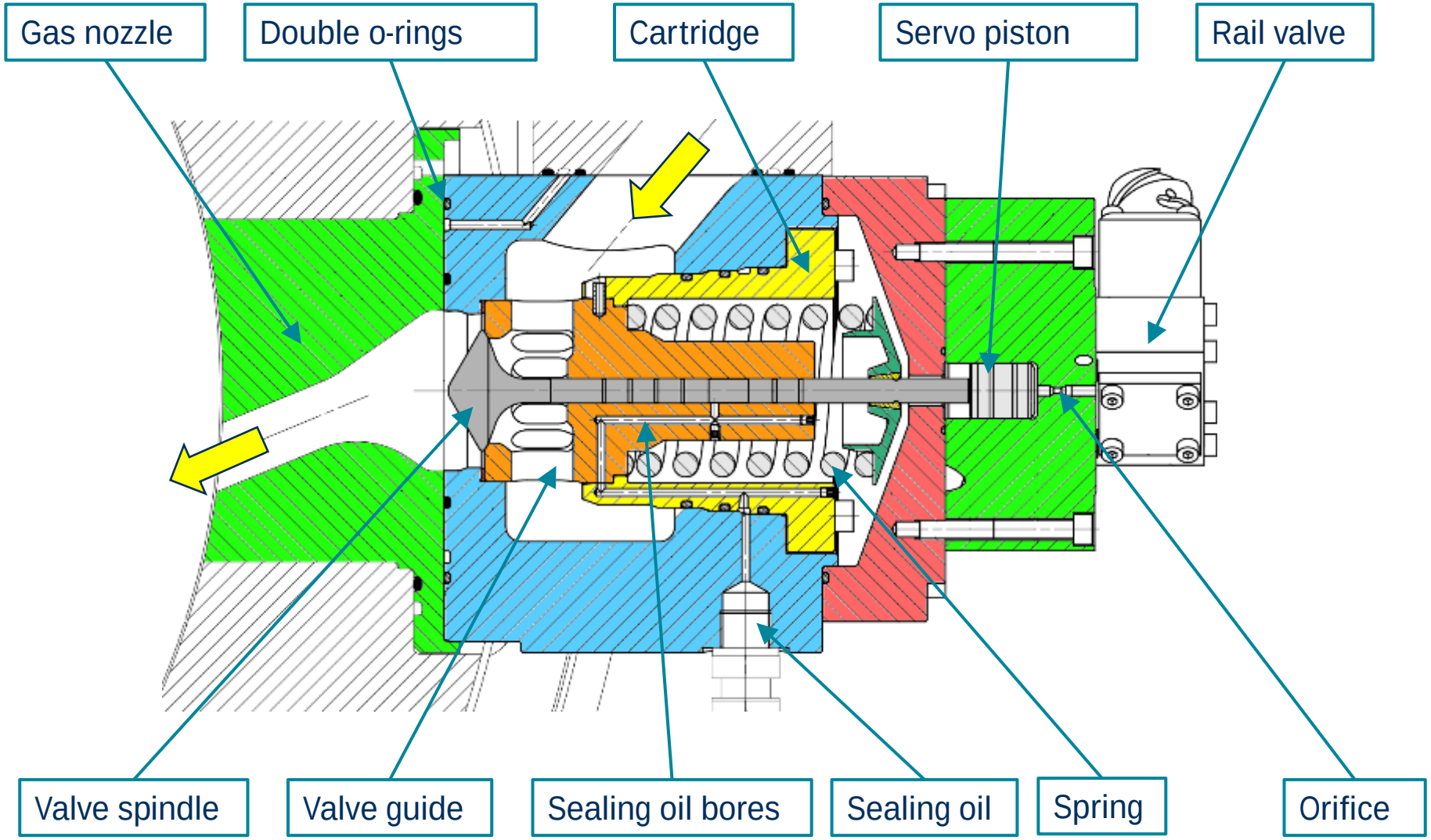
X62/72DF

Gas Admission Valve

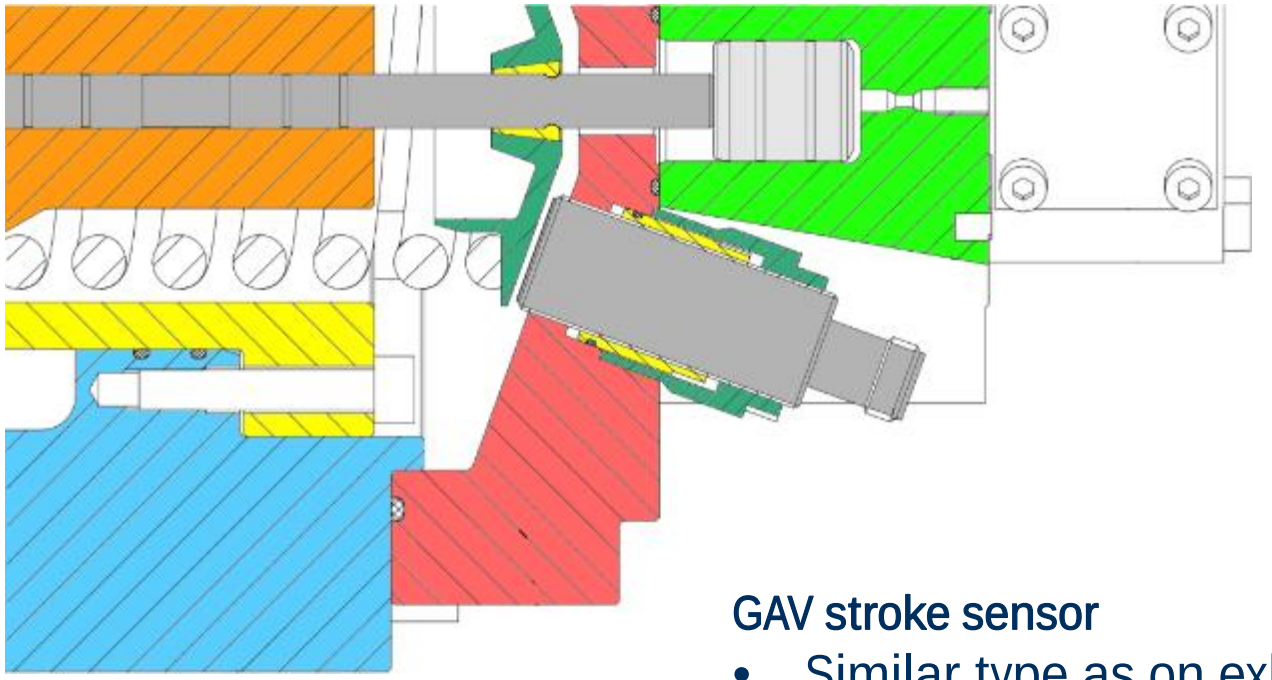


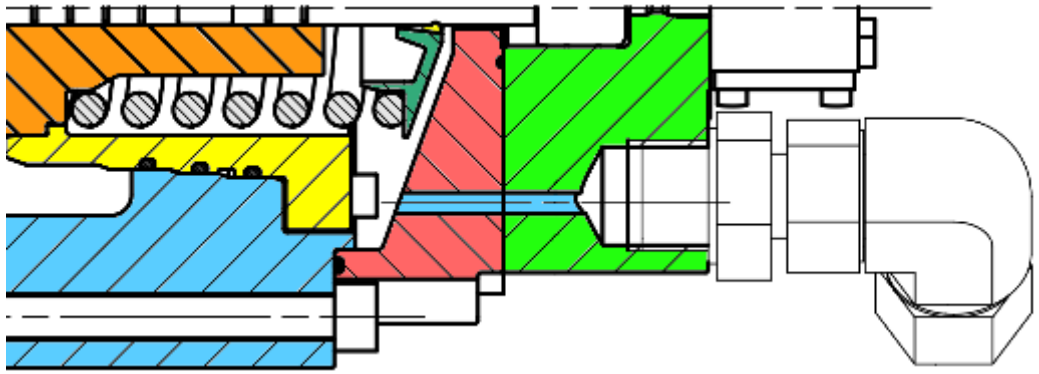


Gas Admission Valve



Gas Admission Valve





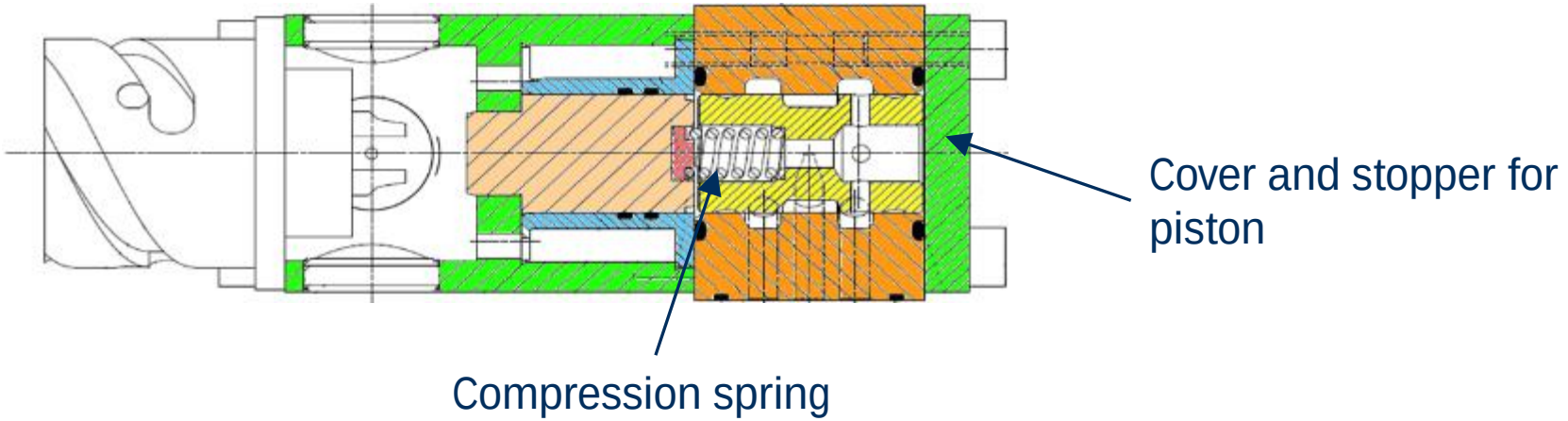
GAV stroke sensor

- Similar type as on exhaust valve
- Continuous signal
- Feedback signal is used for monitoring of closing

Gas Admission Valve

Rail valve

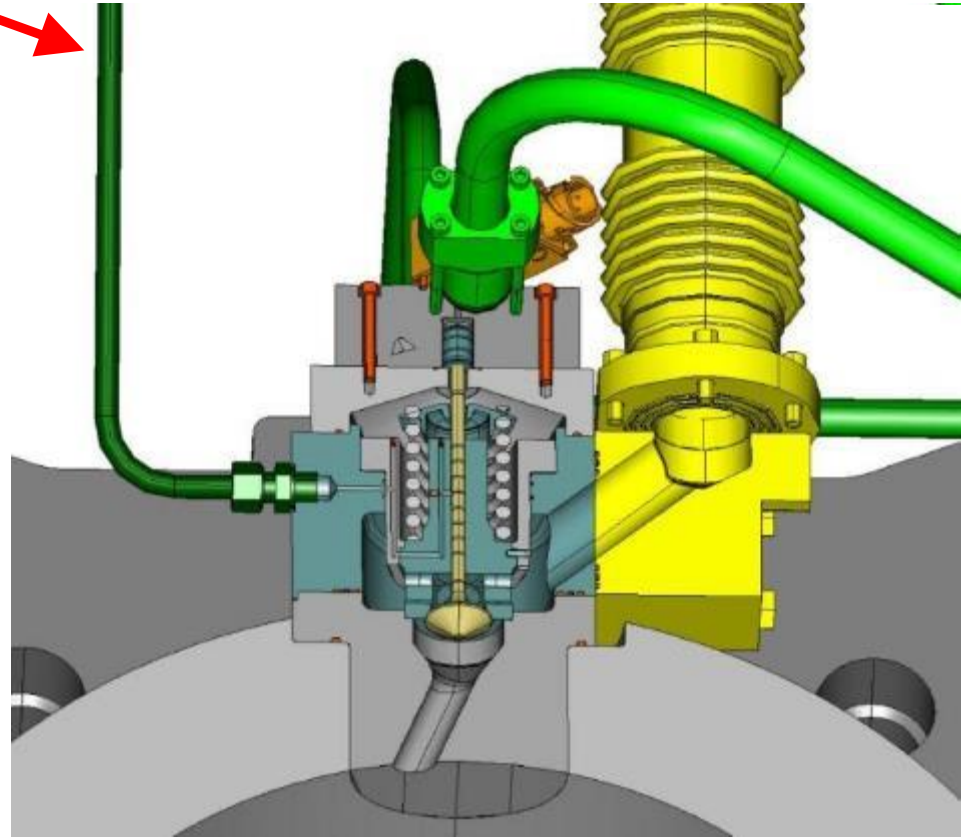
- Mono-stable rail valve RV-4
- Used for gas admission valves
- Lower electrical current (approx. 15A)
- Switching times of 2ms to 4ms



Gas Admission Valve

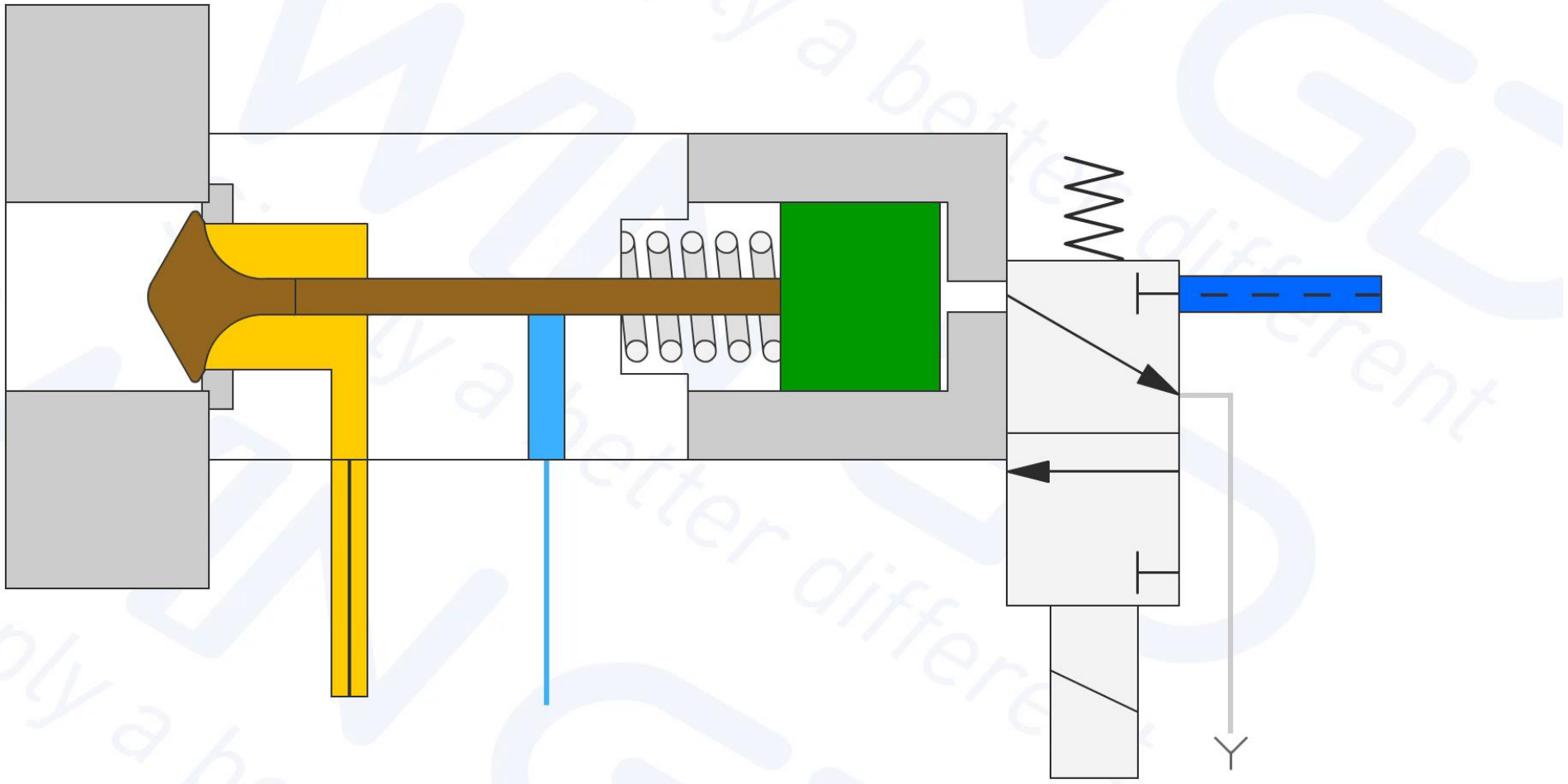
Sealing oil

- Oil taken from servo oil rail at reduced pressure
- Prevents gas leakage along valve guide/stem into spring space
- Spring space is connected to servo return pipe for ventilation
- Lubrication of valve spindle
- Small leakage of sealing oil into gas
- Valve stem and valve guide are hardened to prevent wear

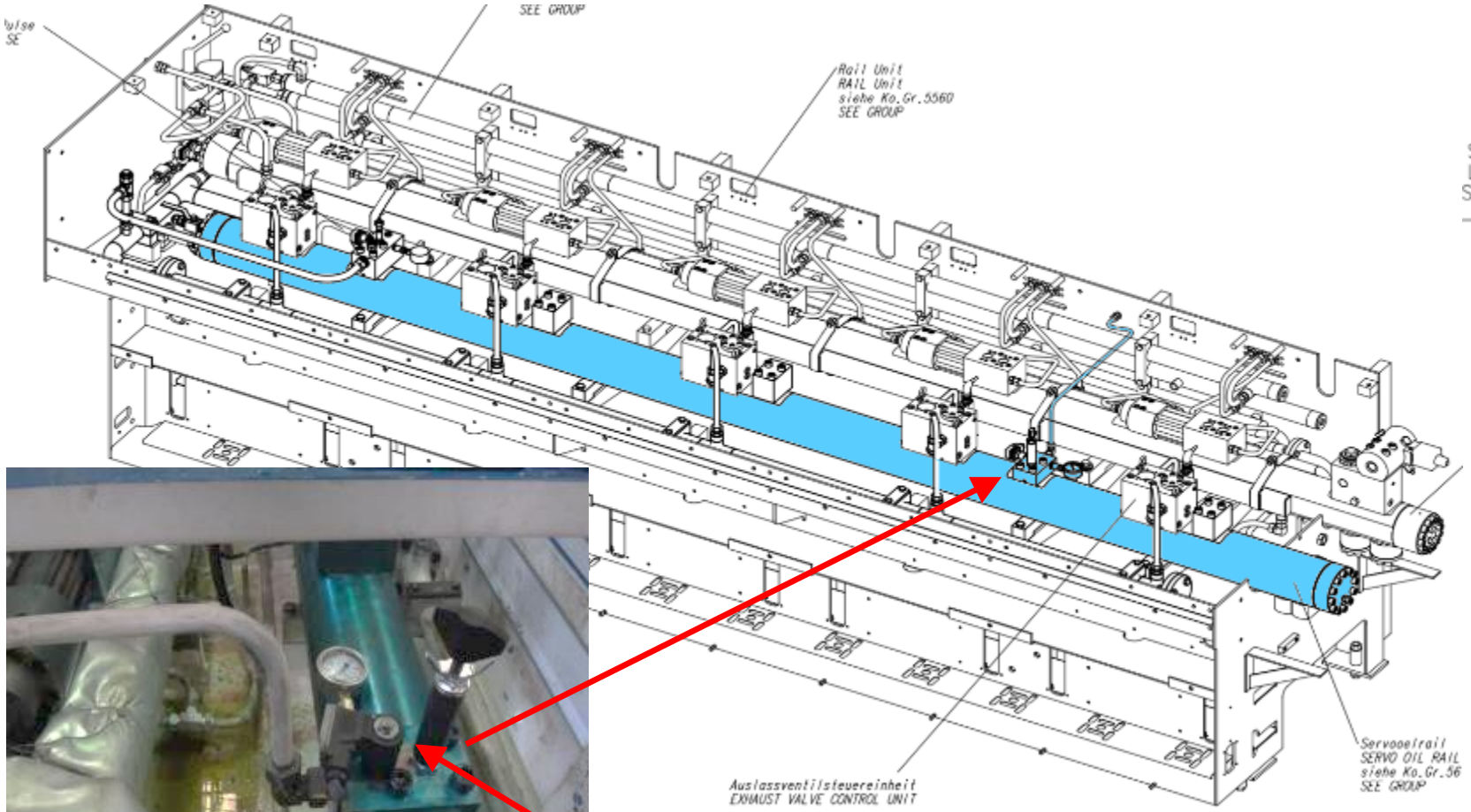


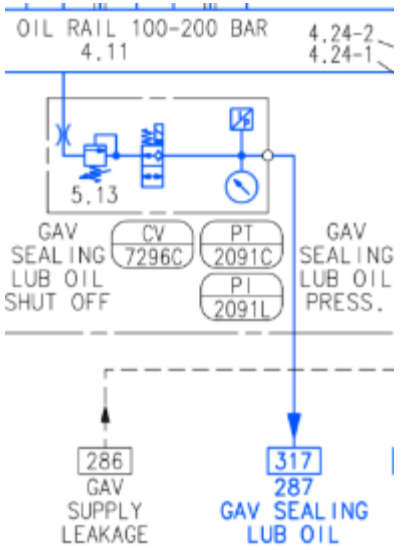
Gas Admission Valve

Animation



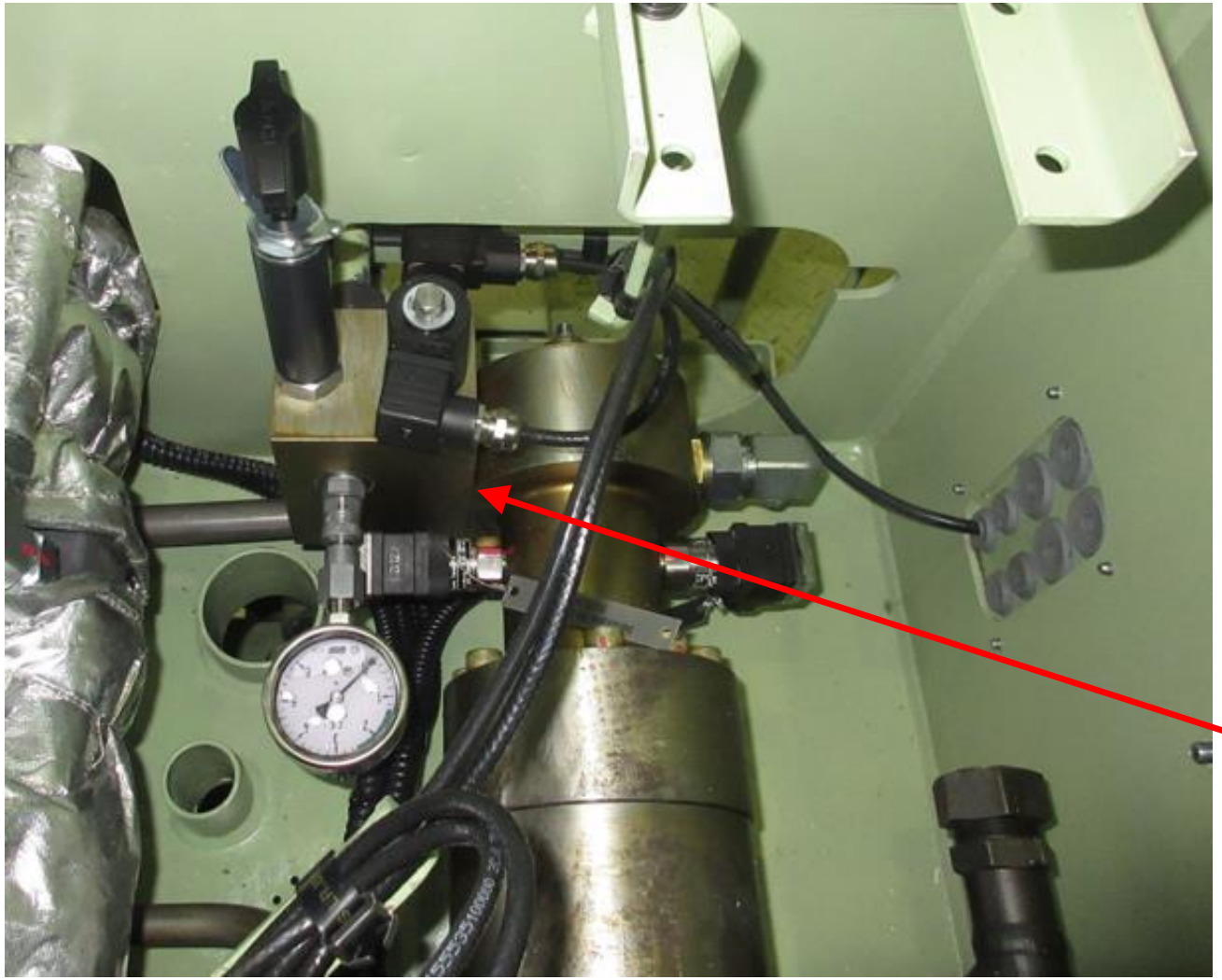
GAV Sealing oil RT-flex50DF





Pressure reduction of sealing oil (16bar)

GAV Sealing oil - X52DF



Pressure reduction of sealing oil (16~20bar)

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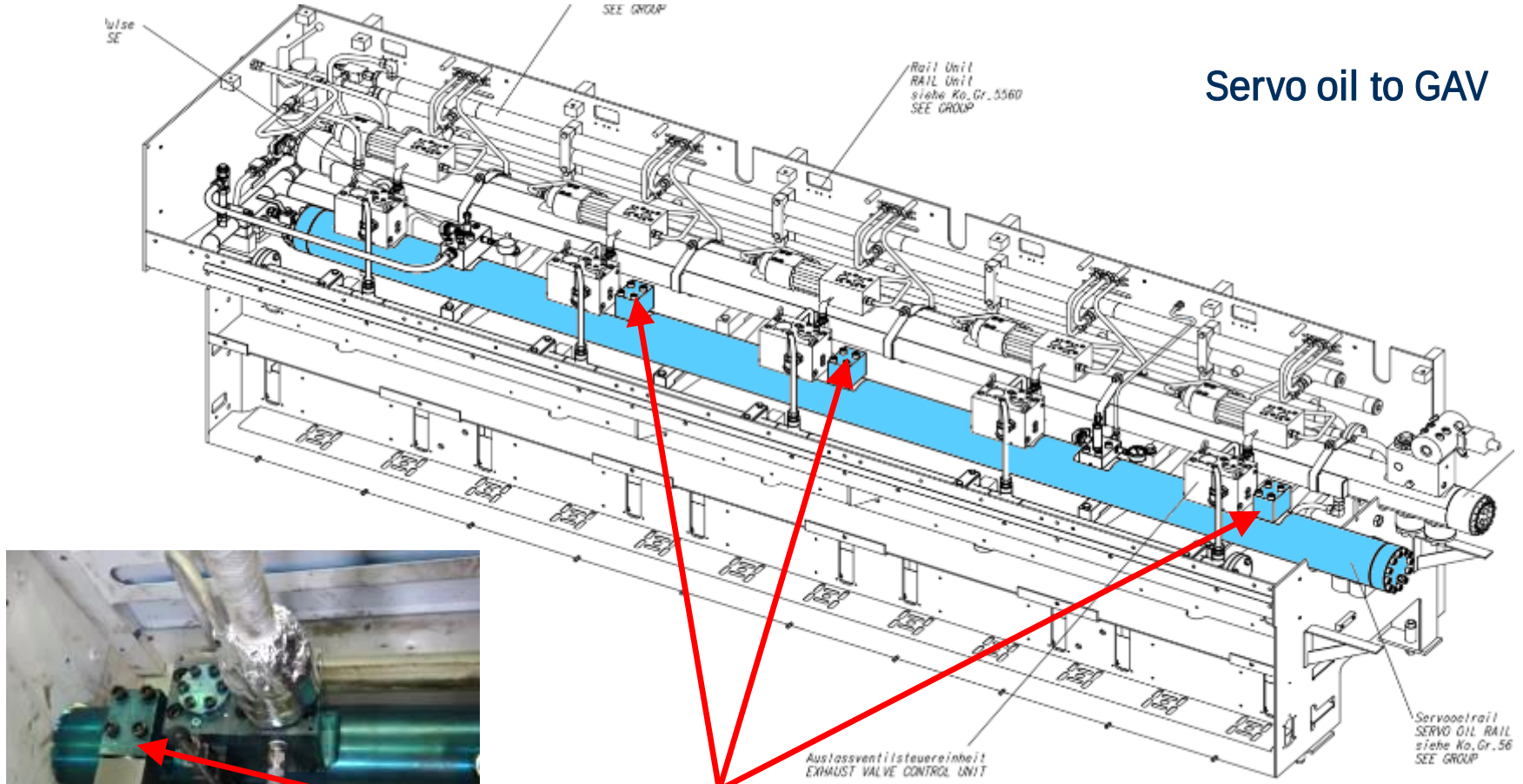
GAV Sealing oil - X62/72DF

X62DF

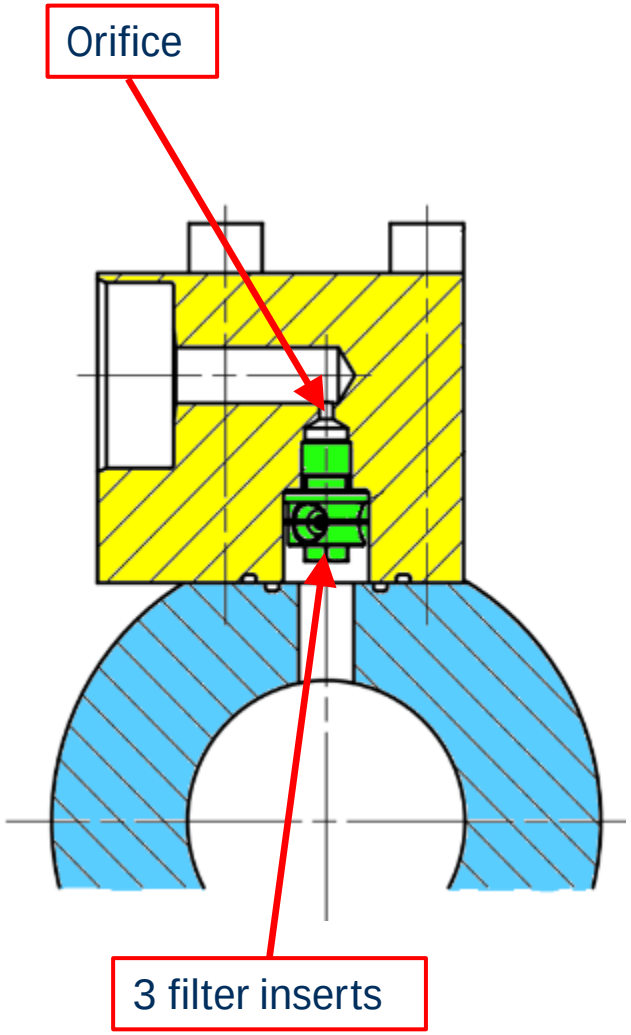
X72DF

Pressure reduction of sealing oil (16~20bar)

GAV S.O Supply RT-flex50DF



GAV S.O Supply RT-flex50DF



Servo oil pipes

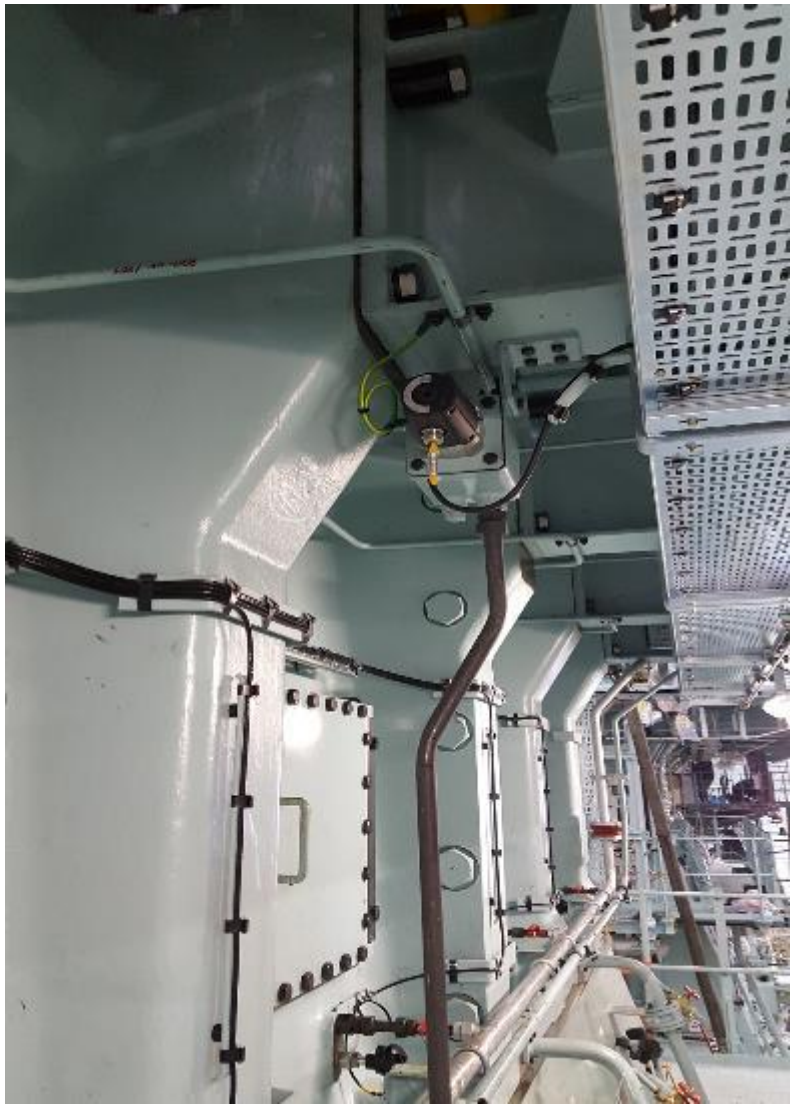
- Double wall pipes, similar to servo oil rising pipes and actuator pipes
- One branch pipe for two cylinders / four gas admission valves
- Orifice in connecting block as flow limiter
- Filter in connection block as protection for the rail valves

GAV Servo oil Supply

RT-flex 50DF

X-DF

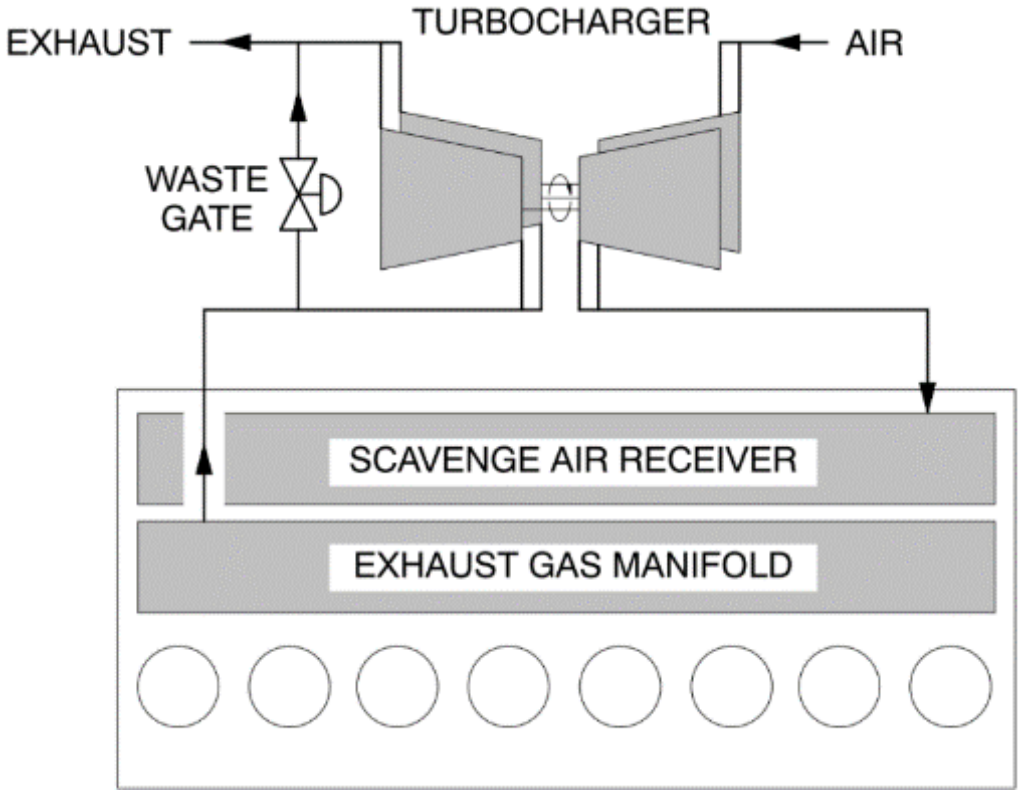
Gas Detector, Piston Underside



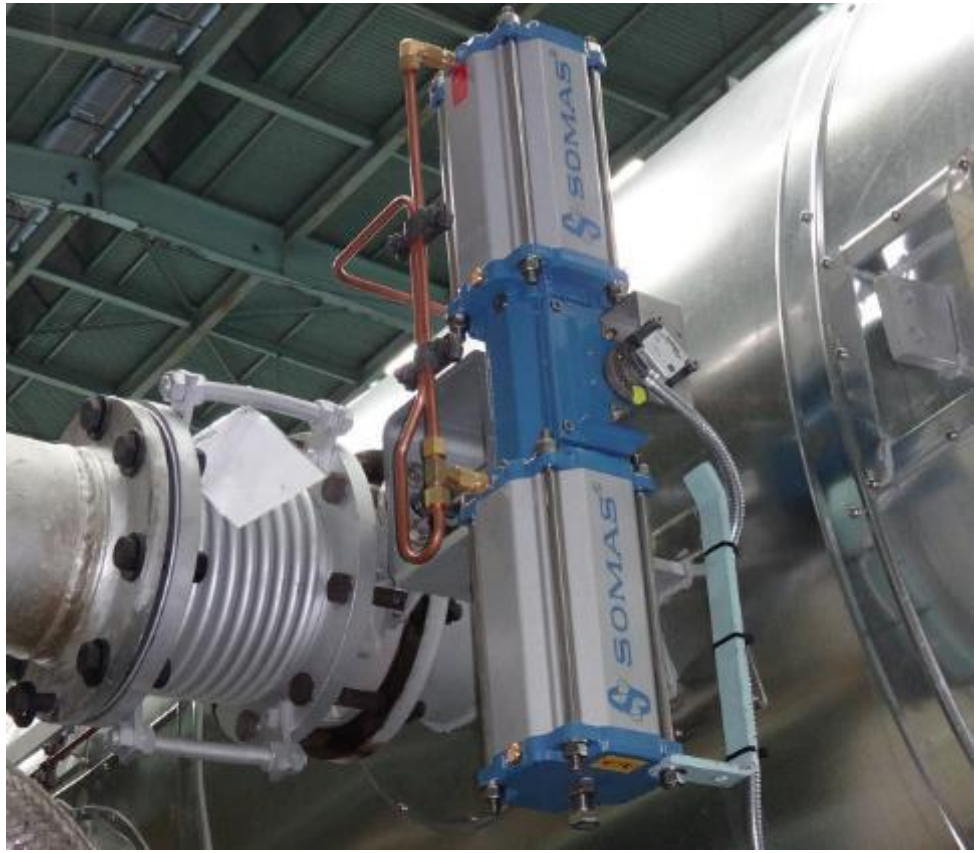
- A gas detector on fuel side continuously monitors the gas concentration at piston underside
- The gas detector is connected to the CCM-20 G4
- In case of high concentration, the ECS triggers an alarm and a Gas trip will be initiates

Waste Gate

- X-DF engines are equipped with an exhaust gas waste-gate valve, which is controlled electronically.
- The position of the valve is set automatically for reaching a desired air receiver pressure.
- When the valve is completely closed, maximum air receiver pressure is achieved.

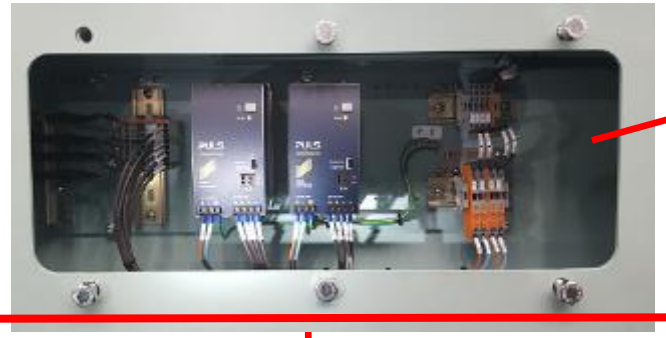


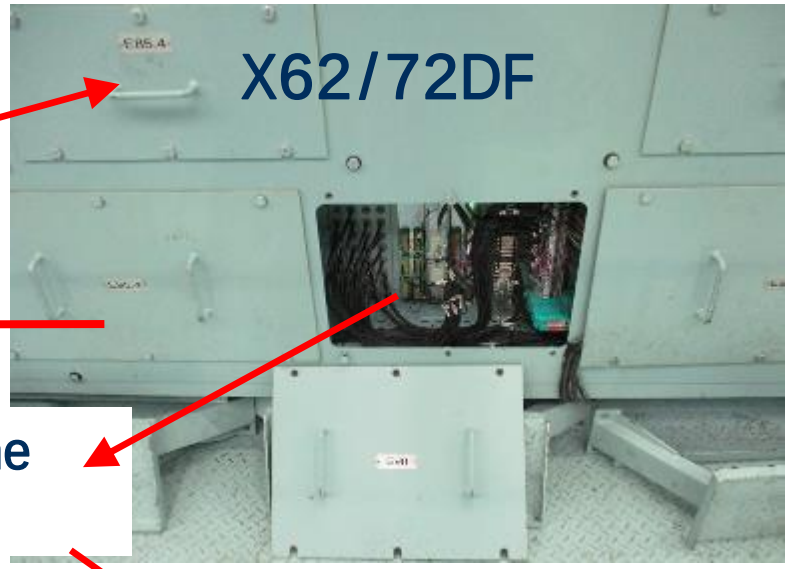
Waste Gate Actuator



CCMs, IOM and Power supply

Power supply for CCM's

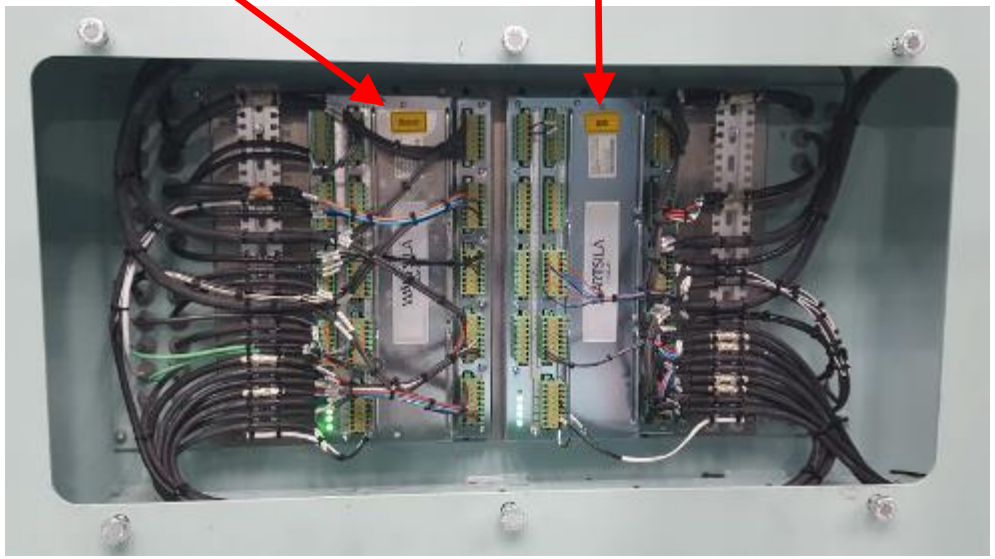


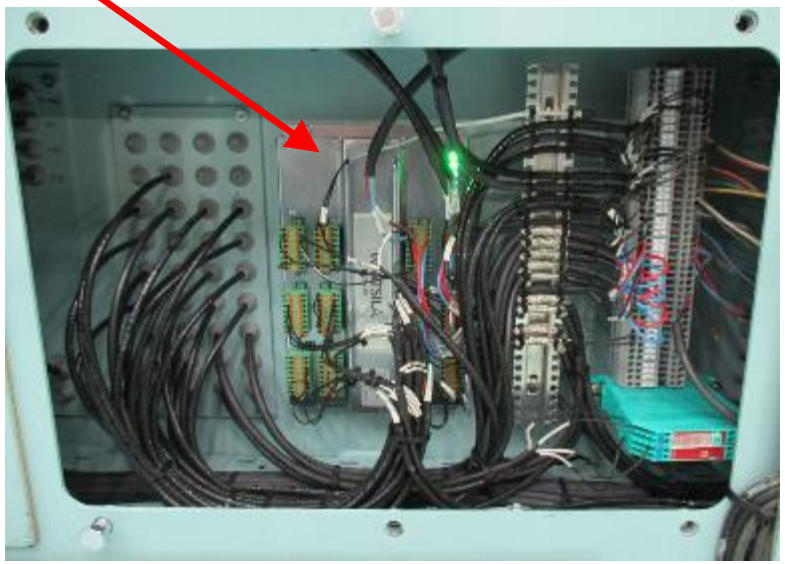


IOM in the E90 box

CCM for Diesel

CCM for Gas





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