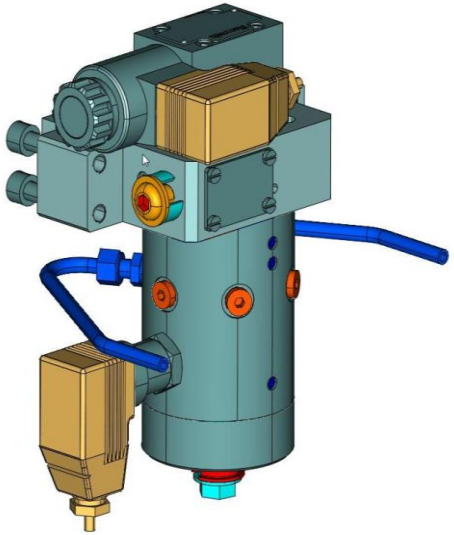
UNIC DF Training

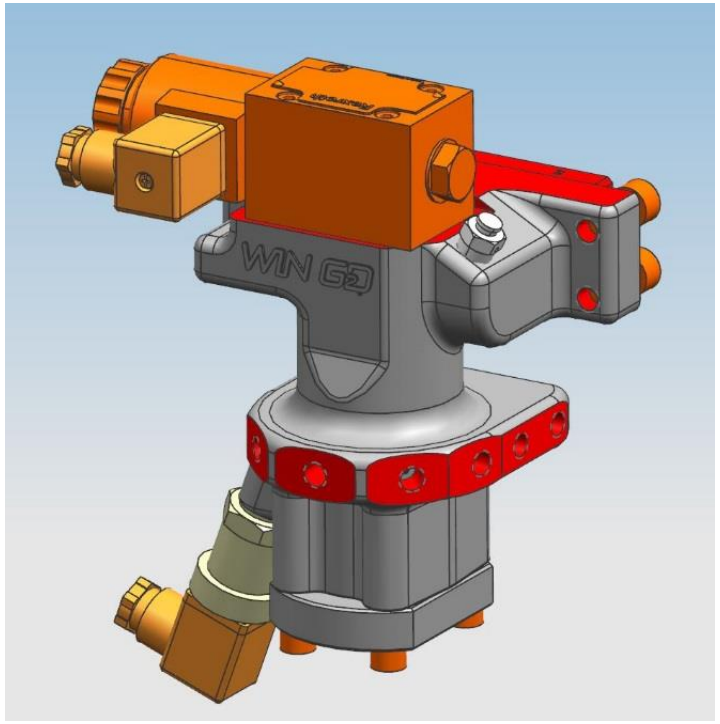
Function of the flexLube Cylinder Lubrication System

Aim of this Chapter

The aim of this training is:

- to understand the function of flexLube cylinder lubrication system
- to know how to adjust feed rate
- to know the basic maintenance to be carried out





General

Cylinder lubrication has various functions:

- Building an optimal oil film between cylinder liner and piston rings
- Neutralisation of sulphuric acid formed during combustion
- Detergent and dispersant property in order to keep piston, piston rings and cylinder liner free from deposits

NOTE:

- The recommended base feed rate is 0.9 g/kWh at CMCR for flexLube cylinder lubricating systems
- More details can be found in Technical Bulletin

General

History

- **CLU1:** Cylinder lubricating pumps driven by hydraulic motor.
  Feed rate adjusting by setting screws and lever position.
  Load dependence controlled by lever on fuel linkage.

- **CLU2:** Cylinder lubricating pumps driven by constant speed electric motor.
  Feed rate is controlled by pulses from remote control system.

- **CLU3**: Cylinder lubricating pumps driven by variable speed electric motor.
  Feed rate is controlled by frequency signals from remote control system.

- **CLU4:** Pulse feed and pulse jet.
  Cylinder lubricating oil injection controlled by electronic / hydraulics.

- **CLU5:** Only for some X35 and X40 engine types
  Cylinder lubricating oil injection controlled by electronic / hydraulics.

- **flexLube: Cylinder lubricating oil injection controlled by electronic / hydraulics applicable for all new 2-stroke engine types**

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Functionality and Design

Benefits of flexLube

- Smaller cylinder lube oil injection volume ➔ higher injection frequency, less “dry” revolutions
- Engine specific volume with one Injection per revolution at “running in” and 100% load
- Driven by servo oil, no addition pump required
- No accumulators and no double wall piping needed ➔ maintenance free
- Fully compatible with UNIC-flex control systems

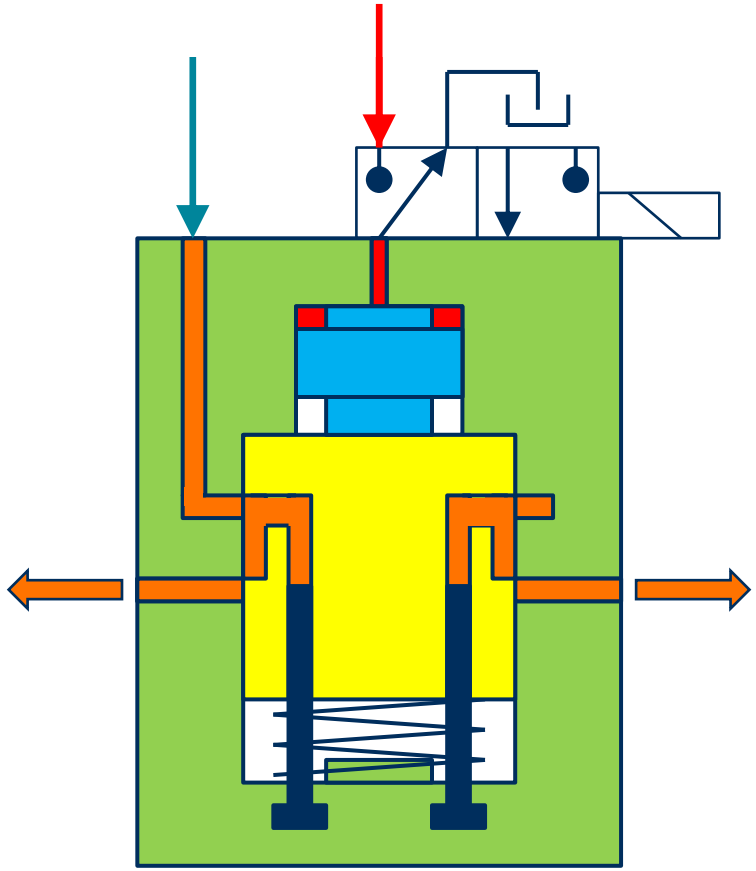
Working Principle

- The flexLube cylinder lubrication system is operated by servo oil
- The cylinder oil is filtered by a double filter to 40 µm
- The flexLube pump has no accumulator anymore
- Energising the solenoid 4/2 way valve activates the flexLube pump by releasing hydraulic pressure to the control piston
- The control piston is then moving, pushing down the main piston, displacing via fix mounted injection pistons, the fixed lubrication oil volume
- The main piston is acting as the barrel for the injection pistons and pressing cylinder lube oil to the individual lube oil quills

Working Principle

- The lube oil is sprayed to the cylinder liner wall above, below or into the piston
- Lubrication- and servo oil rail pressures are observed with pressure transmitters for detecting clogged filter element on lubrication oil rail or low/high servo oil pressure in servo oil rail
- A pressure transmitter measures the current cylinder lube oil injection pressure in one of the lines
  Pressure above 10 bar is recognized as successful injection
- De-energising the solenoid valve releases the hydraulic pressure on the control piston and the main piston is pushed back by the spring
- The delivery volume of the lubricating pump is constant. If feed-rate set to 1.2 g/kWh, on 100 % MCR every piston stroke is lubricated

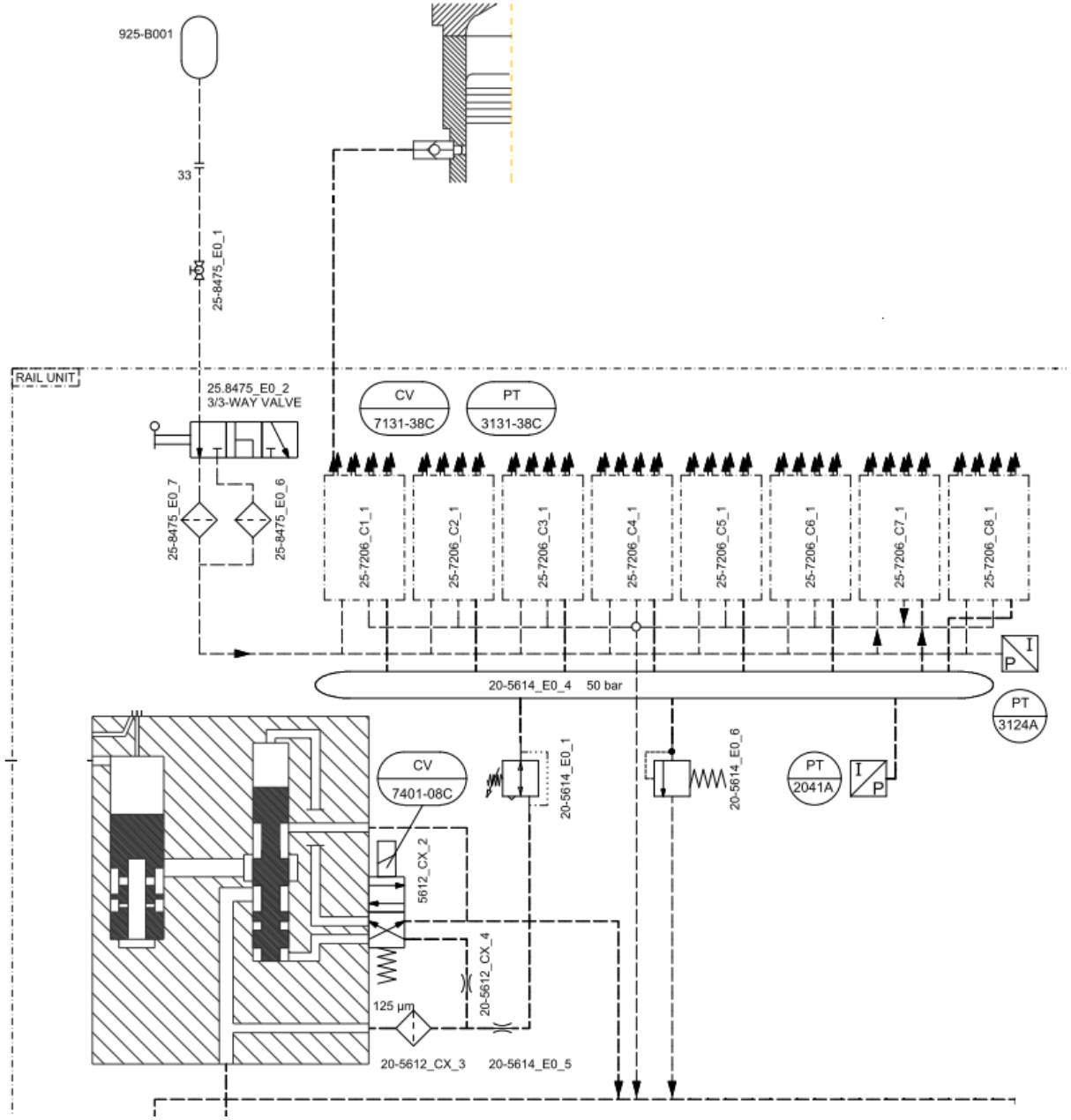
Schematic



flexLube Series

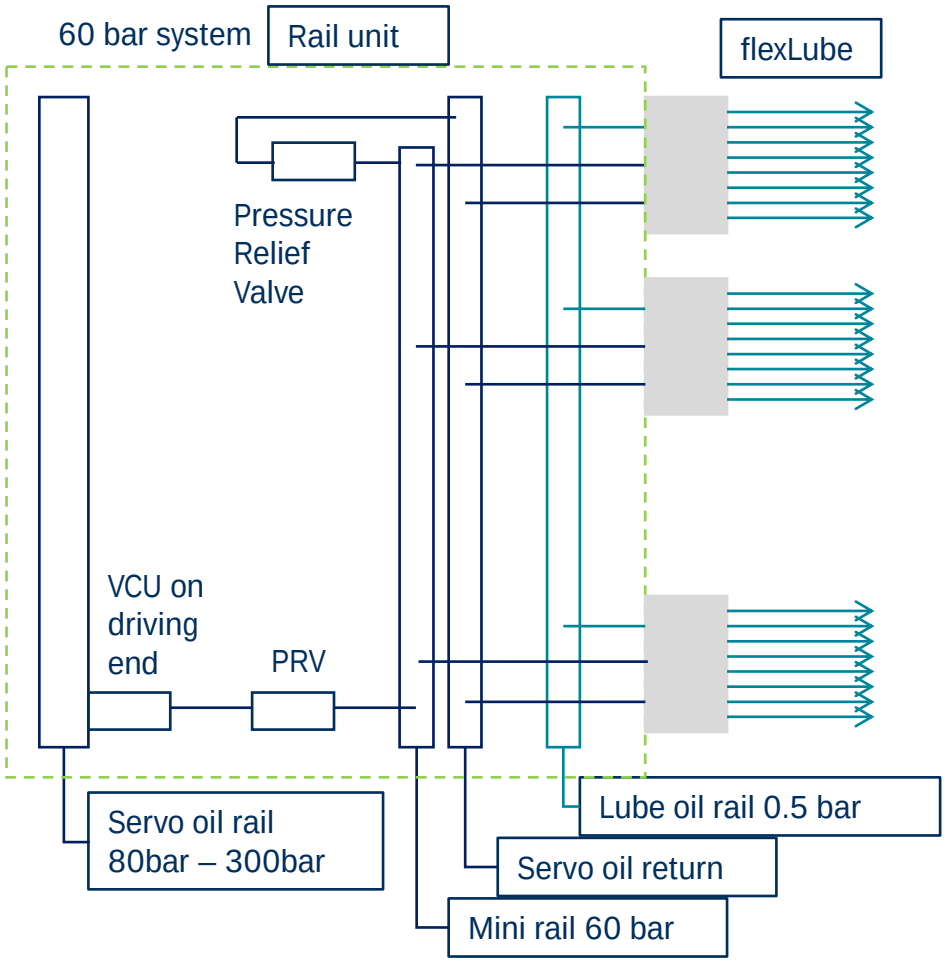
flexLube series	No. of outlets	Engine type
S	4	X35
		X40
M	6	RT-flex48T-D
		RT-flex50D
		X52
		RT-flex58T-D
		RT-flex60C-B
		X62
L	8	RT-flex68D
		X72
		RT-flex82C
		RT-flex82T-B
		RT-flex84T-B
		RT-flex96C-D
XL	10	X92

Schematic



System Design Mini rail

- Servo oil via first VCU on driving end and a 60 bar pressure reduction valve to a “Mini rail”
- A pressure relief valve relieves the mini rail pressure in case that the pressure reduce valve fails
- All high pressure pipes are installed inside the rail unit
  - Preassembly of components
  - Preconditioning of high viscous lubrication oil in “warm” rail unit
  - Same hydraulic condition for all pumps connected to servo rail
  - No double-wall piping needed



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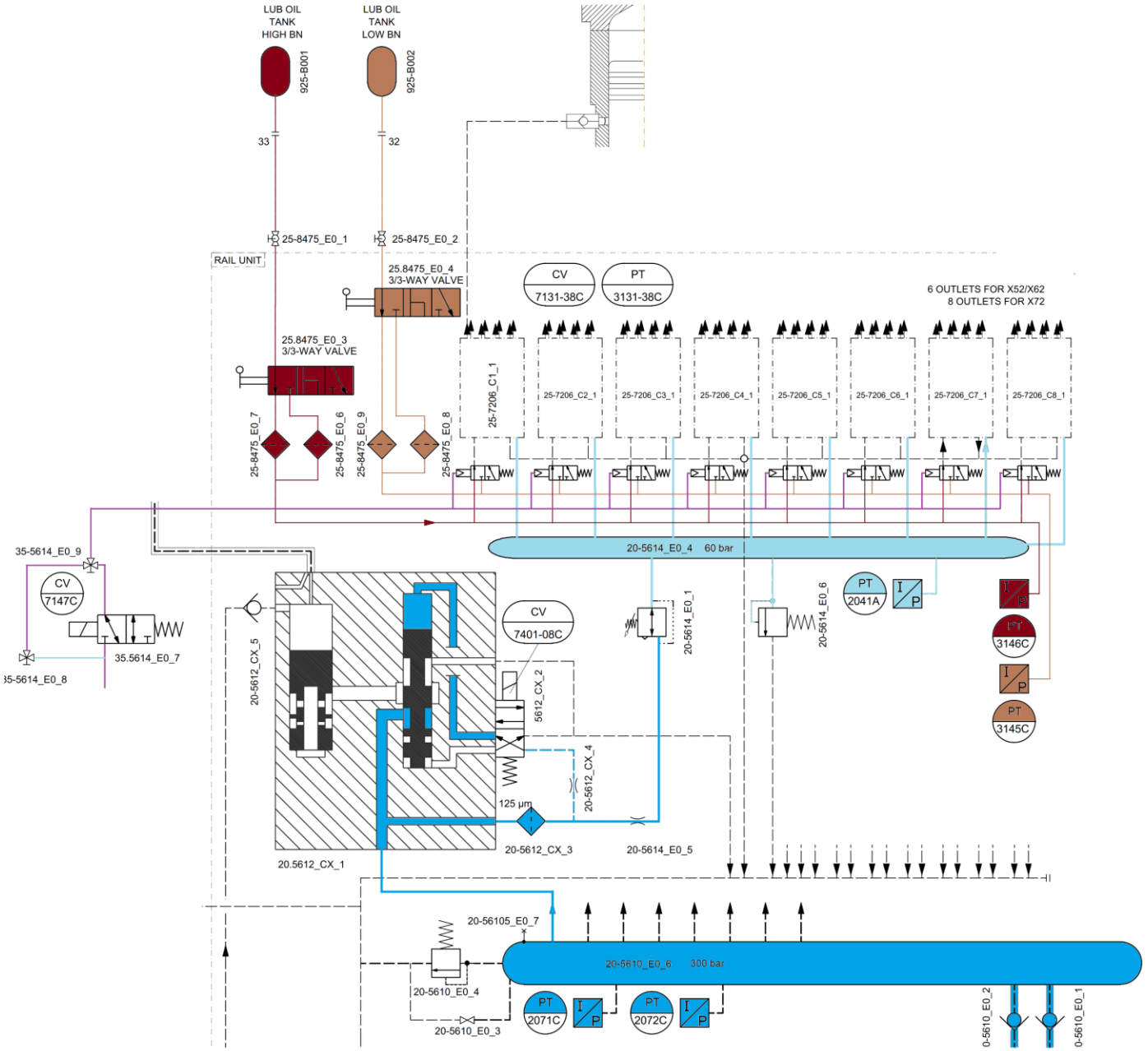
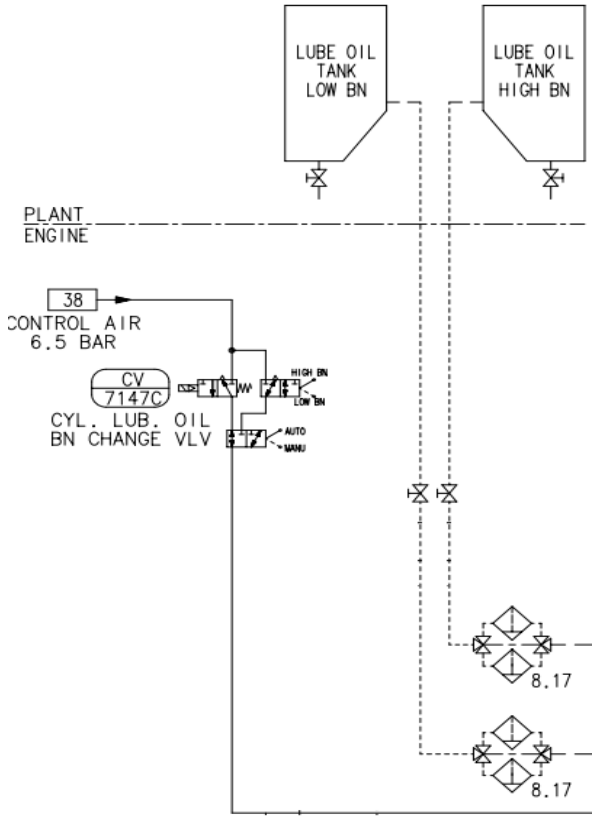
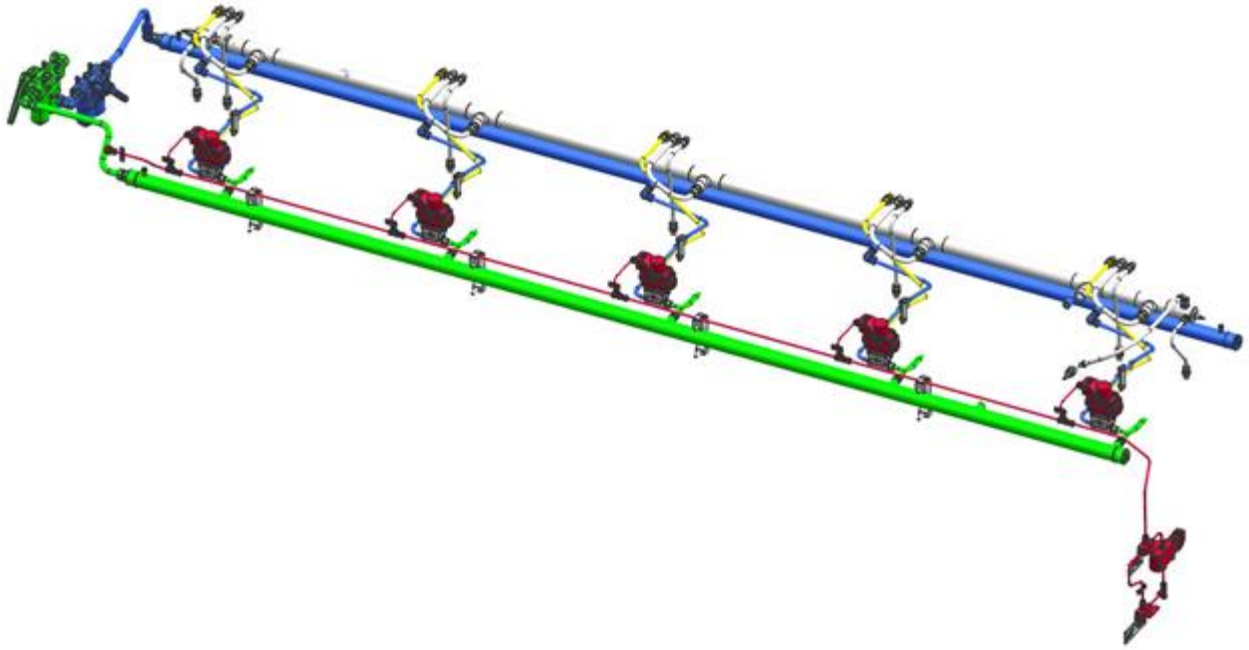
Schematic

i-CAT



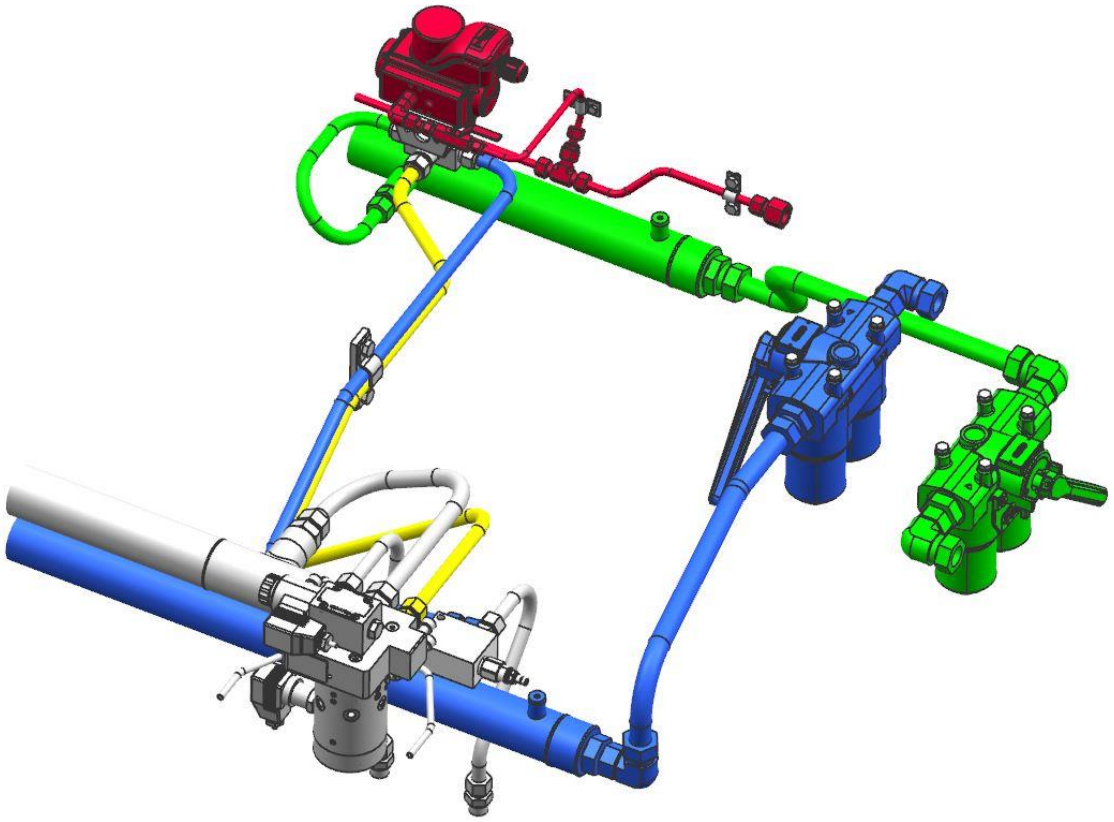
System Design with i-CAT





- The blue coloured oil rail and the corresponding Duplex filter are the same already existing on the engines.
- New components are the second oil rail (coloured green), all valves, actuators, additional Duplex filter, piping, cabling etc.

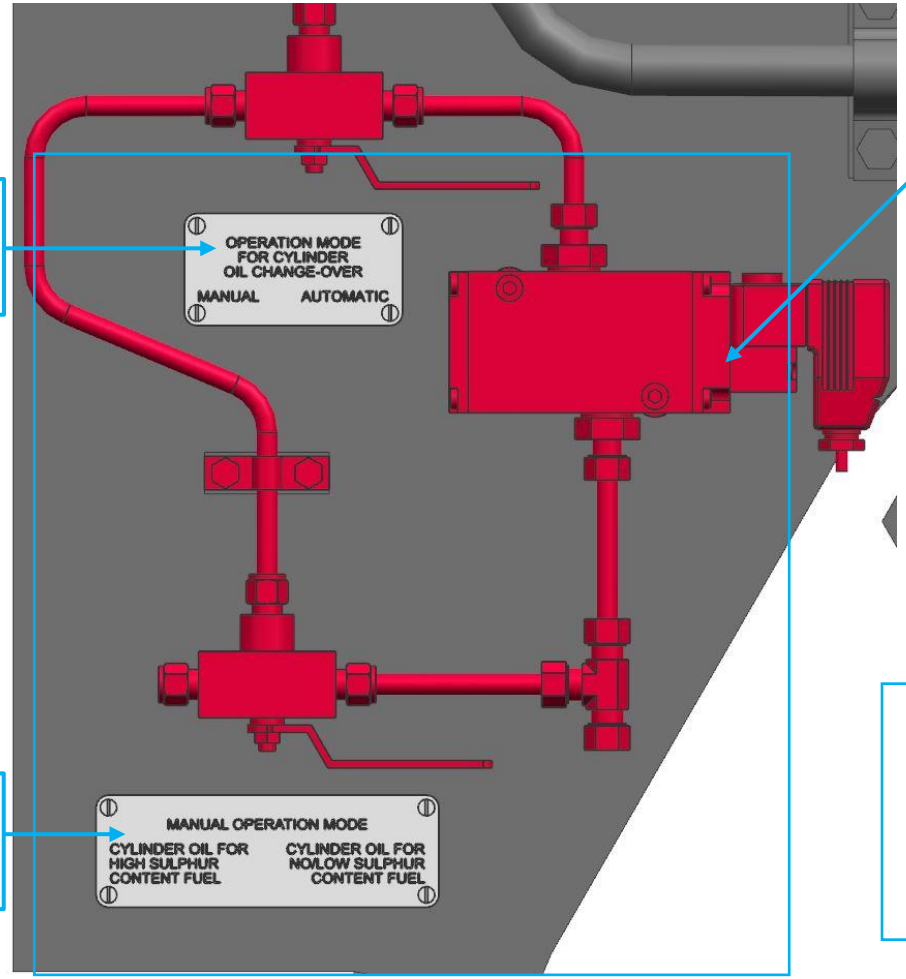
System Design with i-CAT



- The red coloured pneumatic actuators drive 3/2-way valves which feed the correct BN oil to the cylinder lubrication pumps at each cylinder unit.

System Design with i-CAT

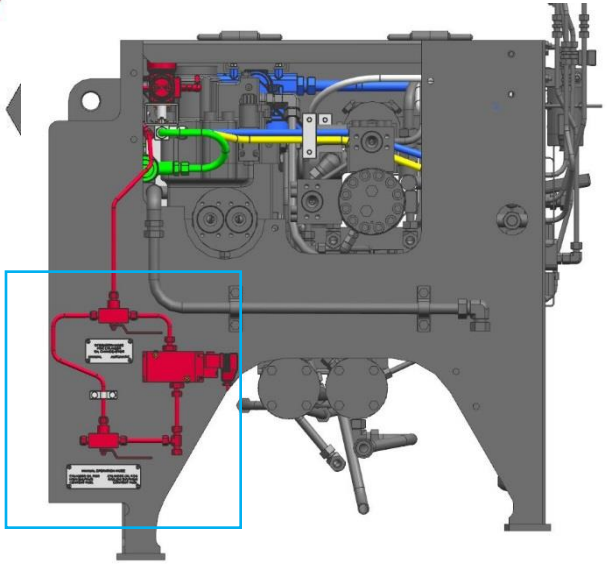
For commissioning, maintenance etc. manual control is possible.



Control:
Auto/Manual

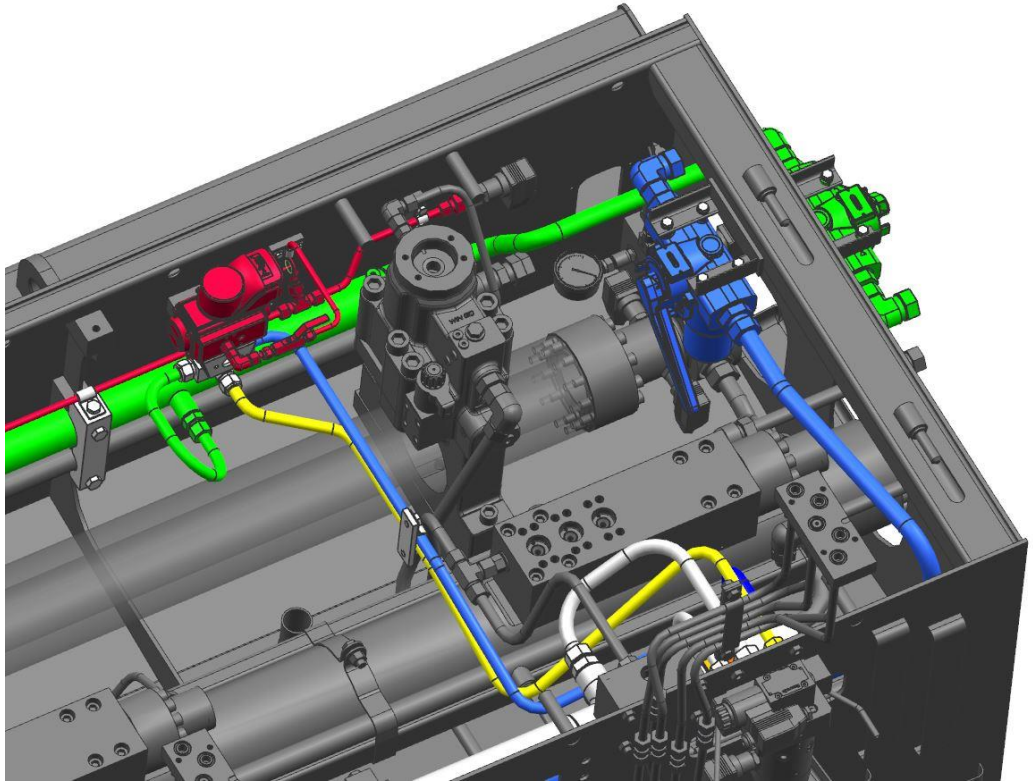
When manual:
Hi/Low BN

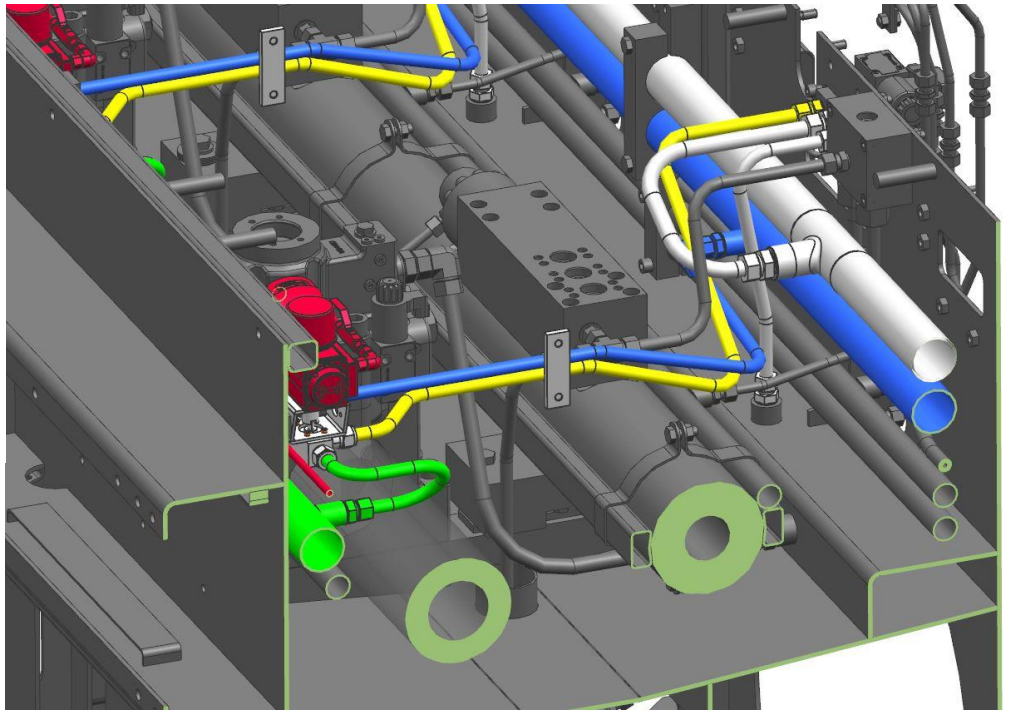
Solenoid valve
for Auto mode



System Design with i-CAT

System Design with i-CAT

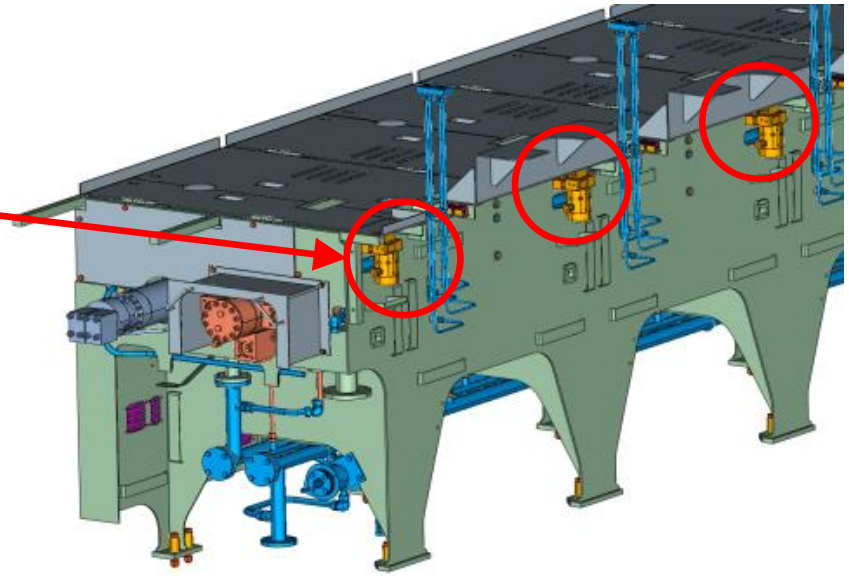


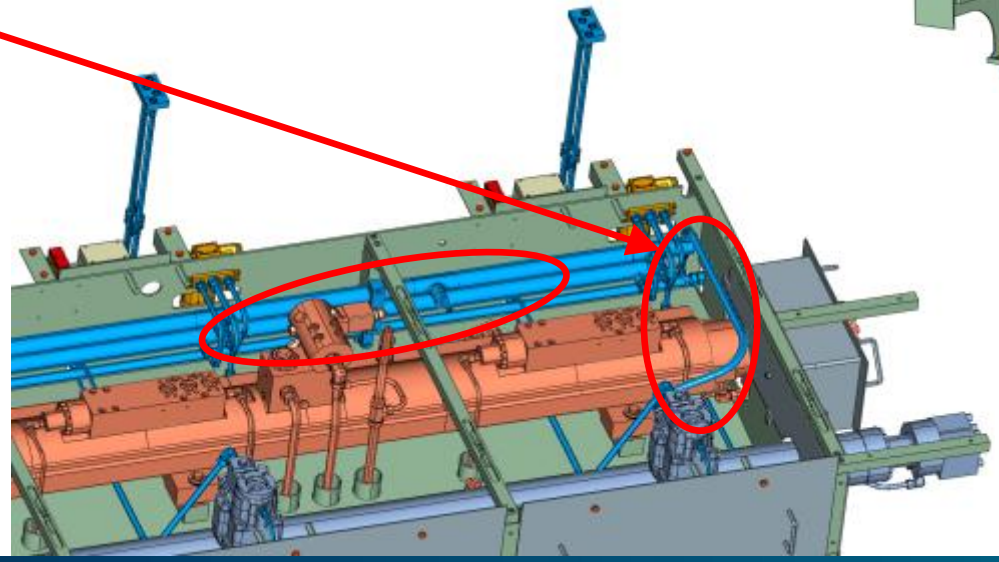


System Design with i-CAT

Installation

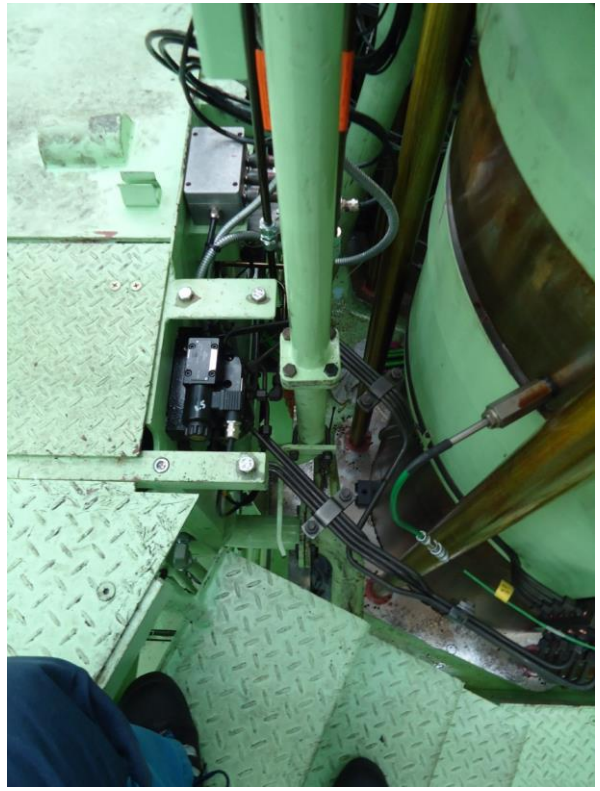
- flexLube pumps are mounted outside, on the backside of the rail box
- The pressurized rails (mini rail, servo oil return, cylinder lube oil) are installed inside the rail box
- Servo oil supply for the mini rail via a connection pipe and pressure reduction valve from the VCU at the driving end



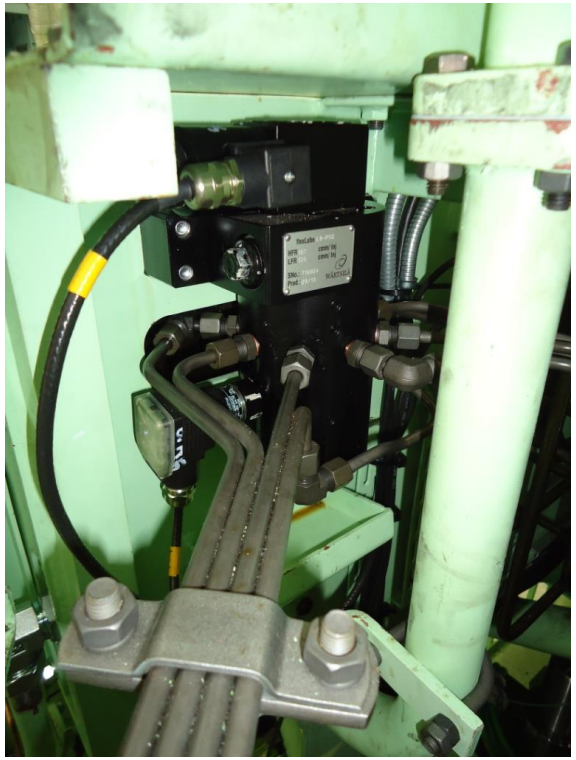


Installation

- Connection block on the cylinder liner for easier cylinder liner change
- The spaghetti pipes are positioned as a star

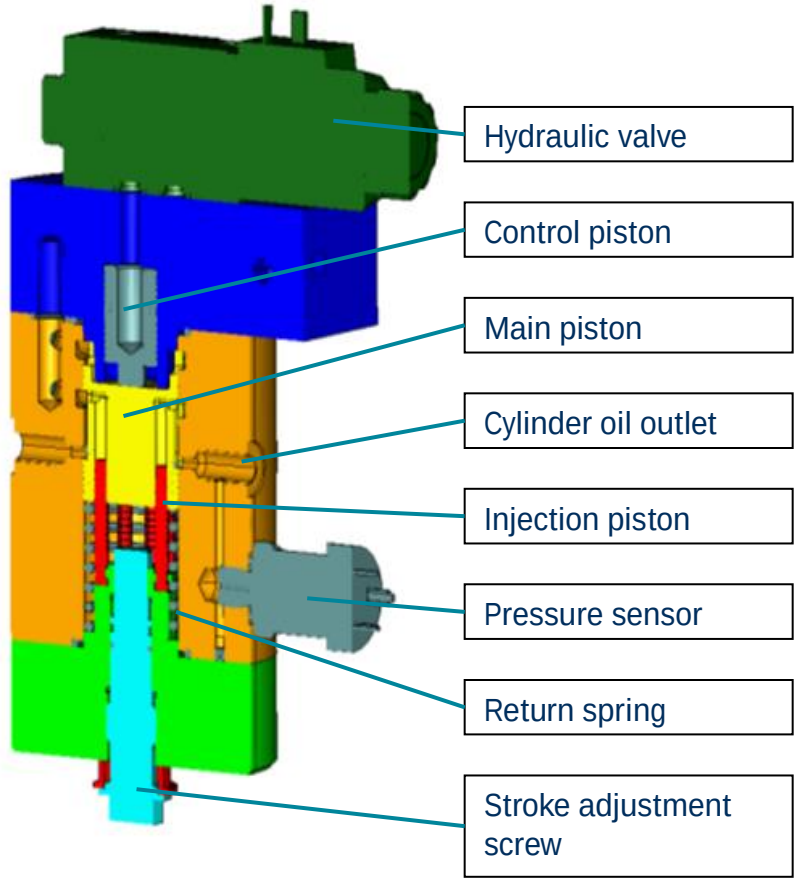


flexLube Pump



Functionality and Design

- Controlled by a 4/2 solenoid valve
- Working piston moves the main piston over the fix injection pistons pressure rising the injection chamber
- Refilling of the injection by a control edge
- Push back the piston to the start position by a spring

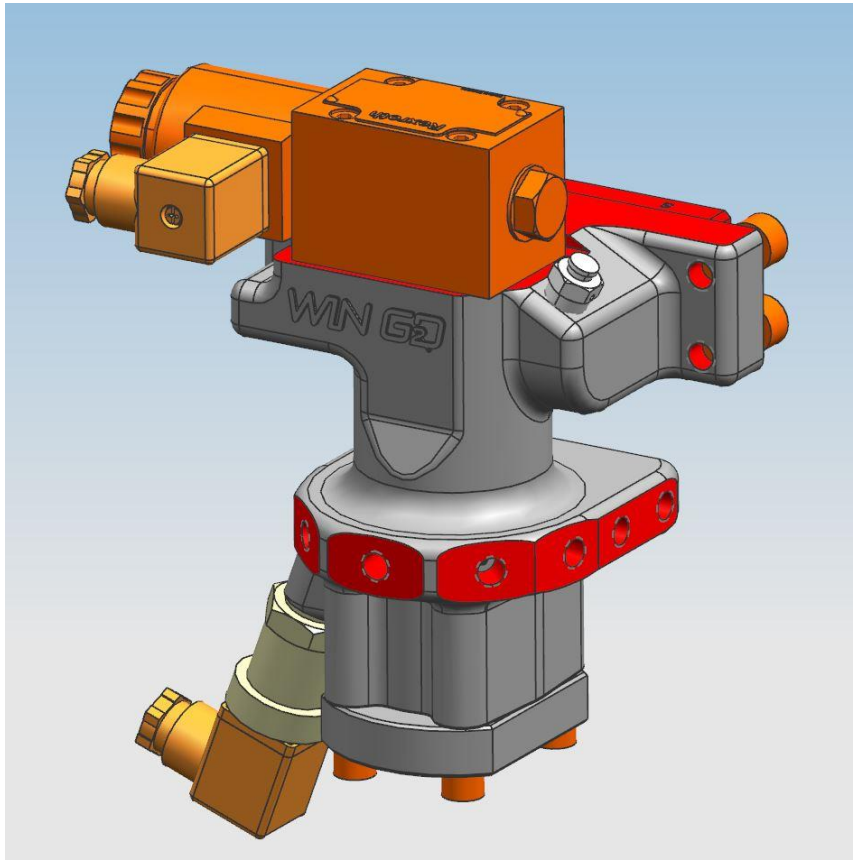


Introducing the Mk-ε

Introducing the Mk-ε

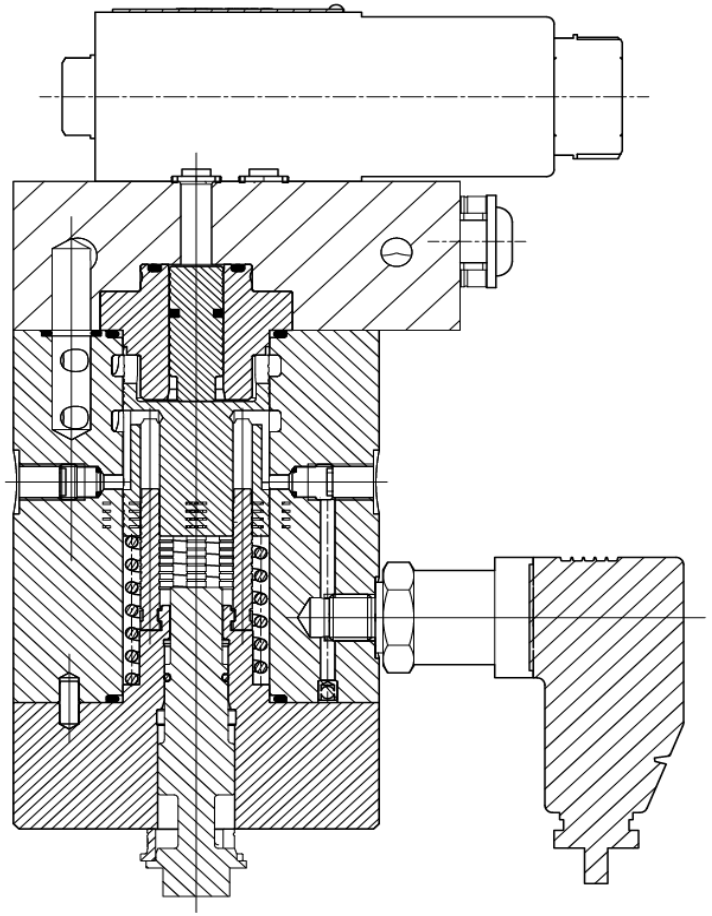
A new pump was developed to realise the following improvements:

- Improved pump priming
- Ensure constant pump output, independent of the surrounding system configuration & conditions
- Improved access to pump outlet connections
- Simplified installation, setup & use of the pump
- Improved manufacturability and reduced pump cost
- Reduced pump weight
- Reduced pump servo-oil consumption

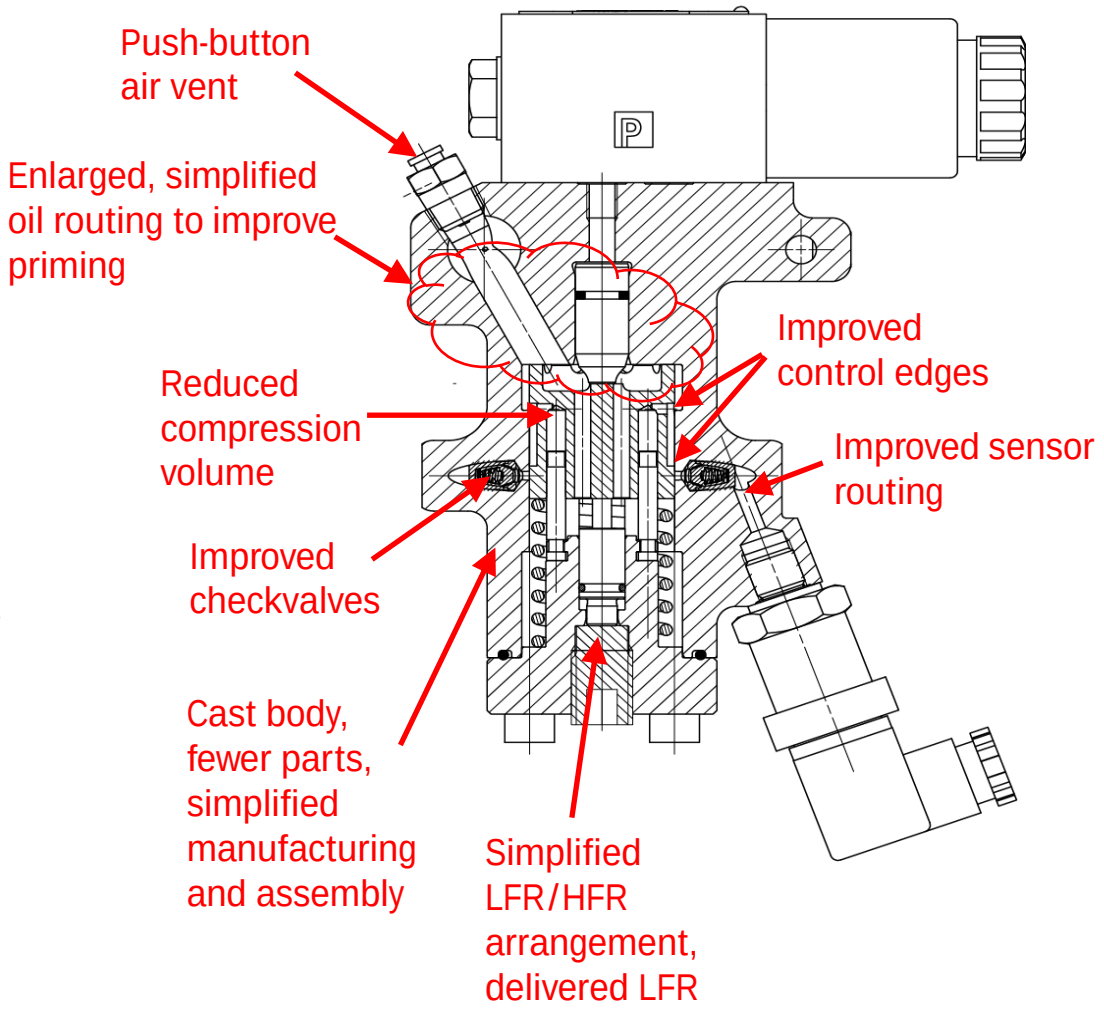


Comparing flexLube Mk 1 and Mk-ε

flexLube Mk-1



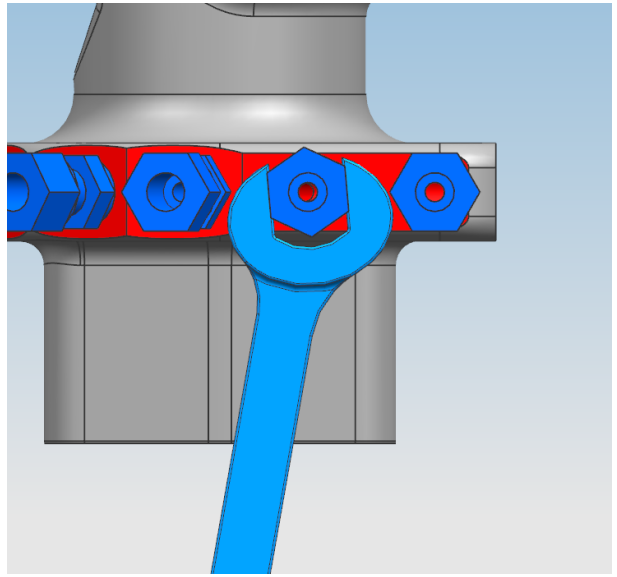
Mk-ε

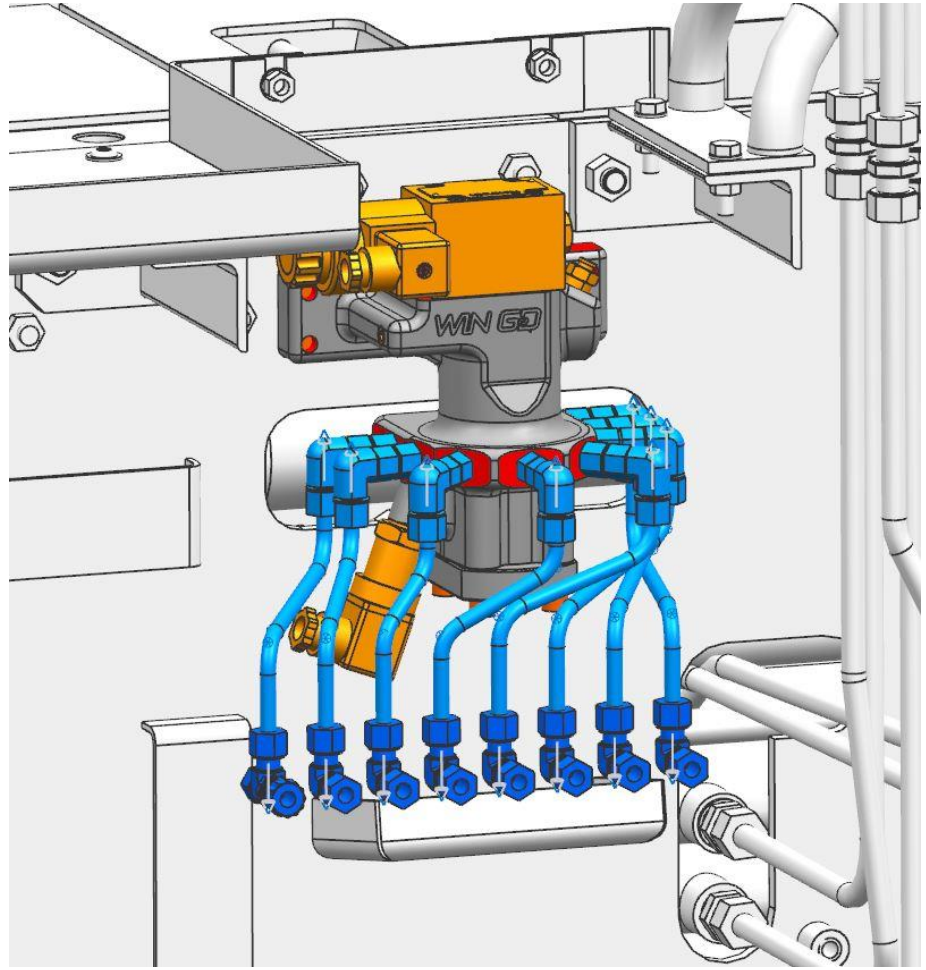


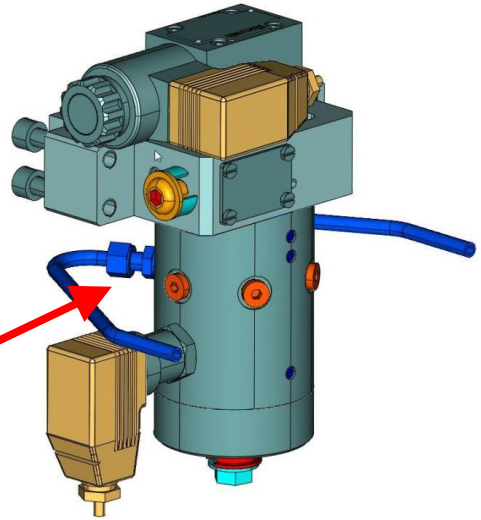
The flexLube Mk-ε outlets

Pump outlets are no longer directed toward the rail unit box (shown cut-out in box is no longer necessary)

- ***Access to all pump outlets while installed***

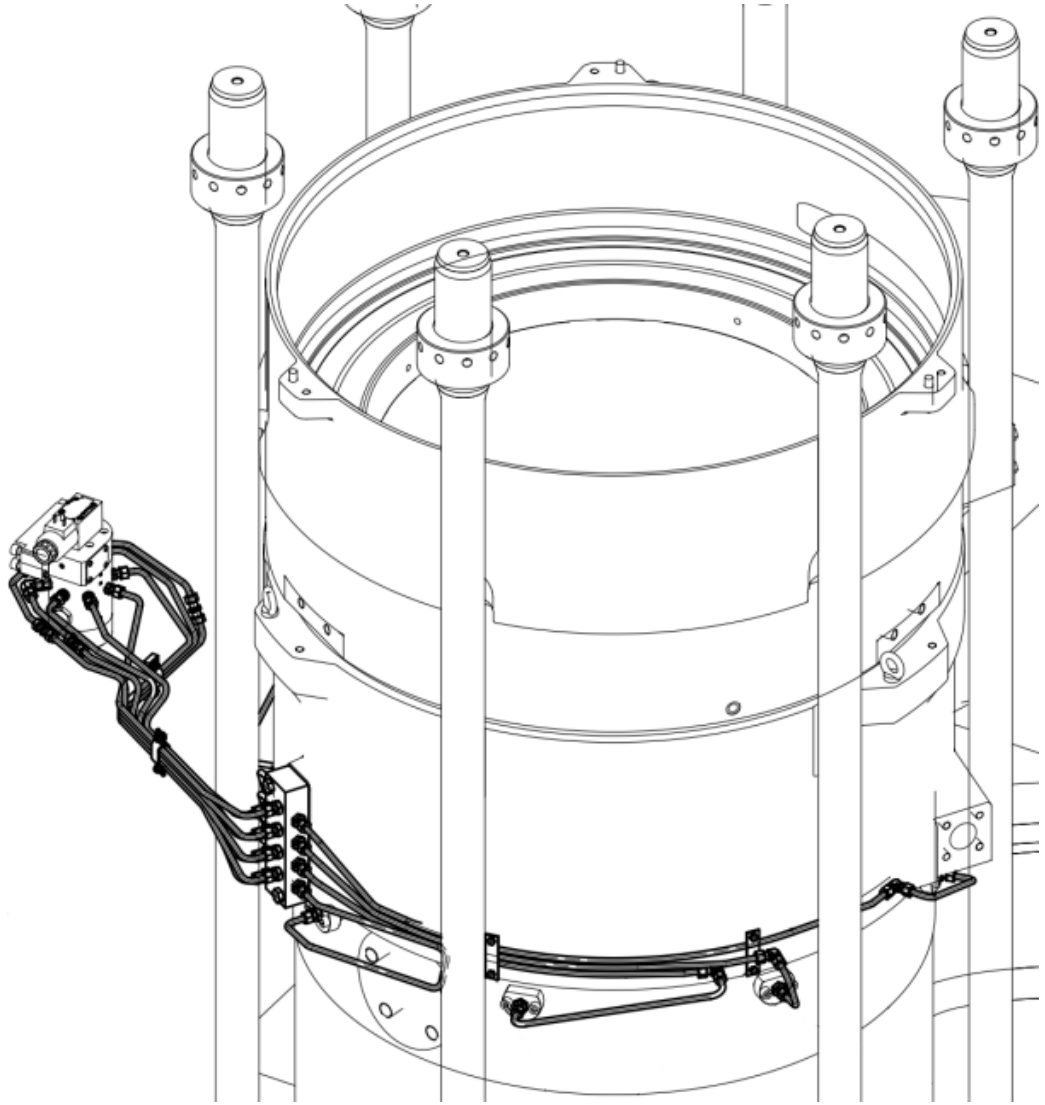




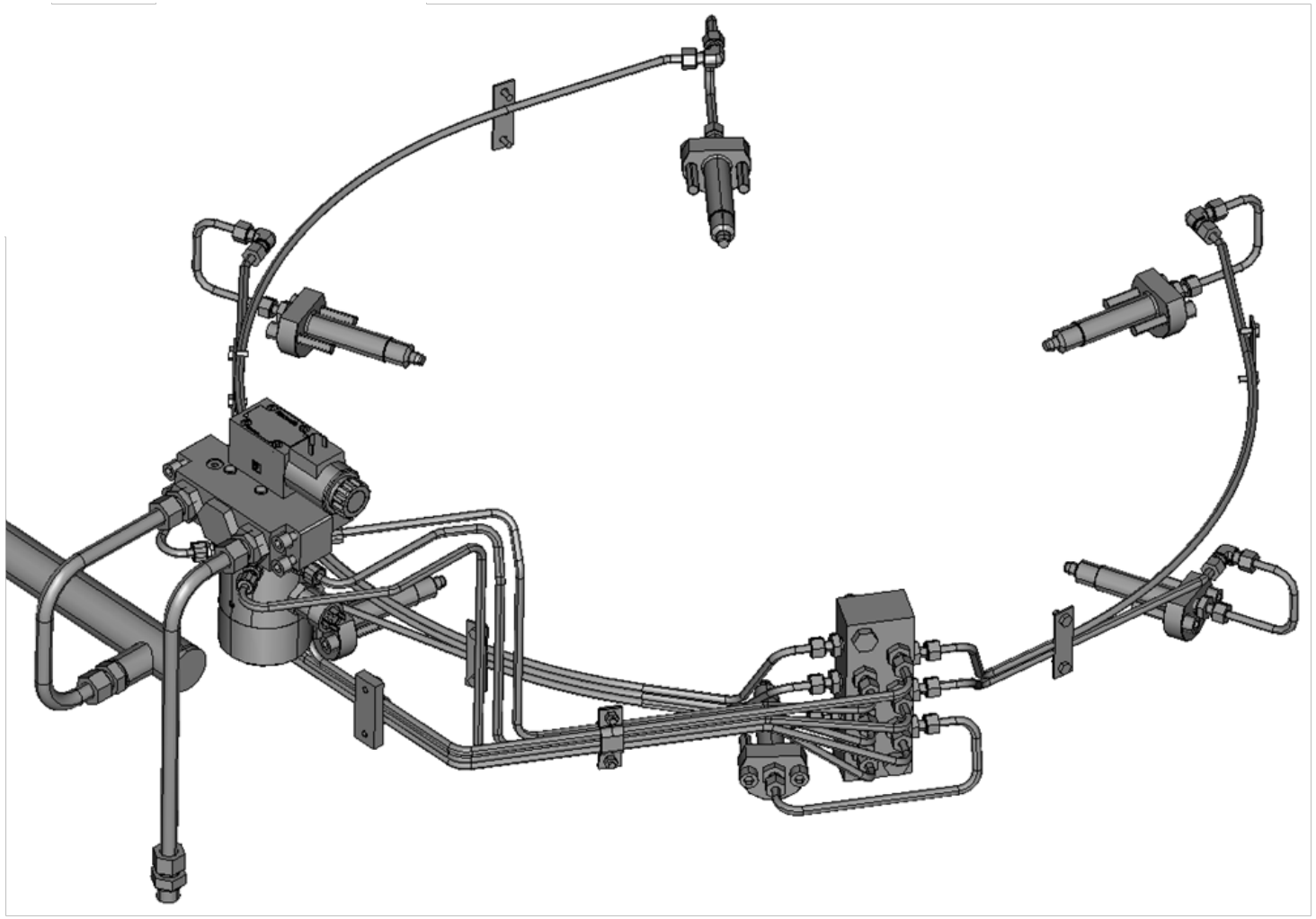


Some old pump outlets faced rail box wall

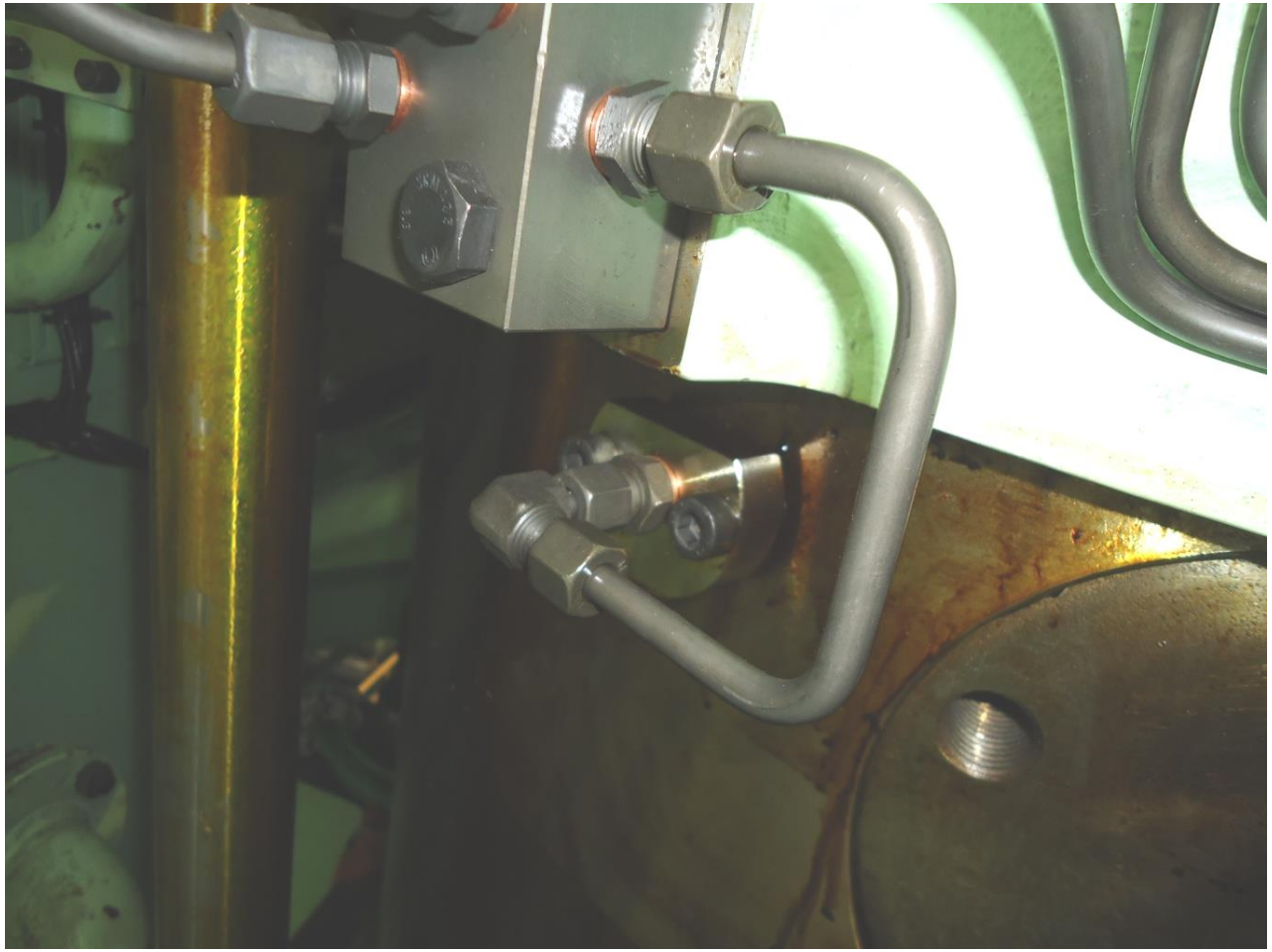
Piping



Piping

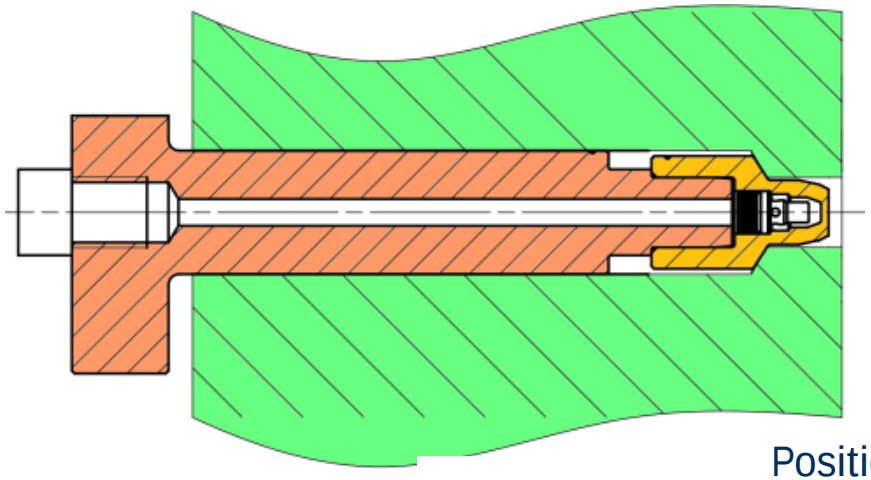


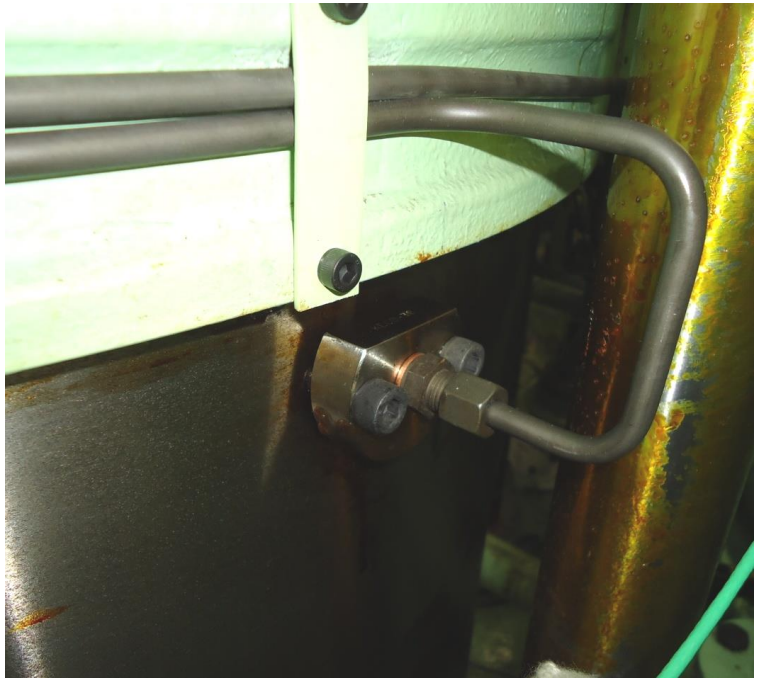
Quills



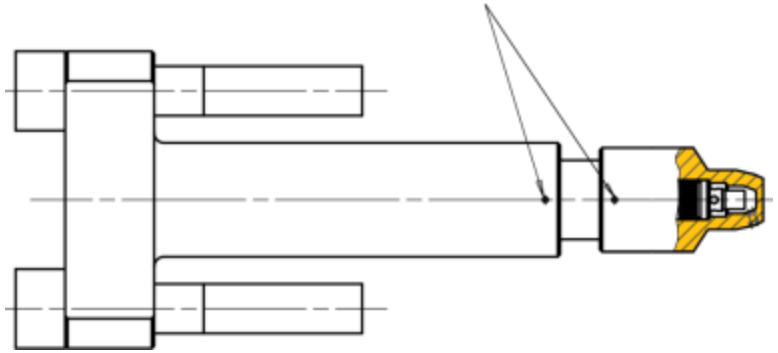
Quills

Four to ten quills located on the circumference of the cylinder liner





Position marks



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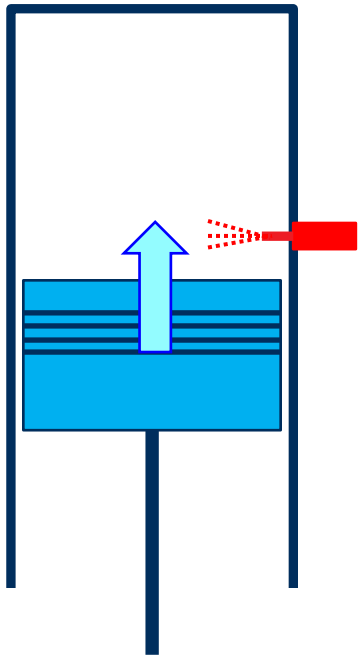
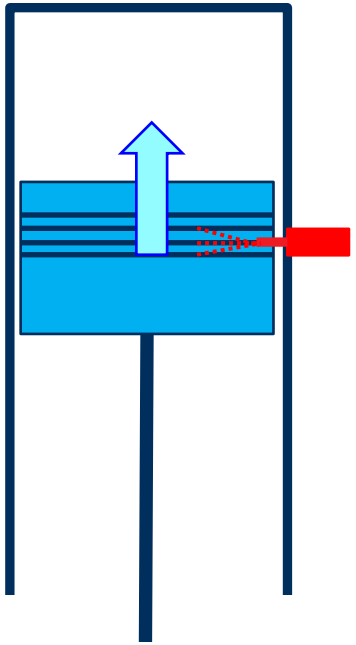
Vertical Oil Distribution

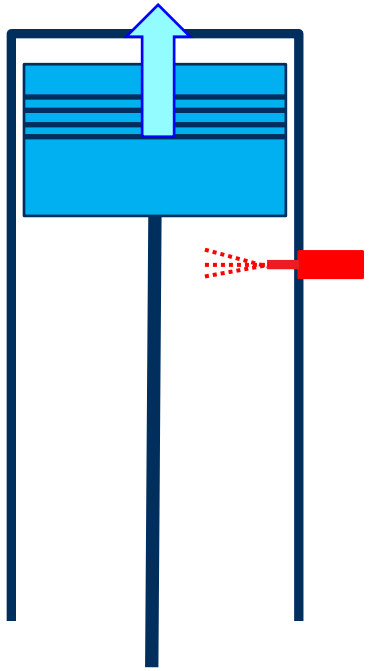
Electronically Controlled Flexible Timing of Cylinder Lube Oil Feed



Distribution to the cylinder liner above the piston by the jet-spray



Lube oil distribution to middle part of piston and piston ring package by “feeding”



Distribution to the cylinder liner below the piston by the jet-spray

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Power Dependent Feed rate break points

Feed Rate Break-Point Table				
	UNIC		WECS	
Break-Point	Power %	Factor %	Power %	Factor %
1	0	6500	0	6500
2	1	1560	1	1560
3	2	780	2	780
4	5	312	5	312
5	10	156	10	156
6	15	141	20	125
7	20	125	50	106
8	50	106	75	102
9	75	102	100	100
10	100	100	150	100
11	125	100		
12	150	100		

System Parameters

		DEFAULT RATING (°)			DISTRIBUTION			VOLUME PER INJ (MM^3)		OUTLET
Engine	Puls System	ABOVE	INTO	BELOW	ABOVE (Diesel/Gas)	INTO (Diesel/Gas)	BELOW (Diesel/Gas)	LFR	HFR (LFR*1,33)	
X35-B	JET	260	314	340	70	25	5	121	162	4
X40-B	JET	260	314	340	70	25	5	182	242	4
X52	JET	260	317	340	70	25	5	401	536	6
X62	JET	260	319	340	70	25	5	633	852	6
X62-B	JET	260	314	340	70	25	5	633	852	6
X72	JET	260	317	340	70	25	5	1005	1336	8
X82-B	JET	260	321	340	70	25	5	2480	N/A	8
X92	JET	260	318	340	70	25	5	1767	2370	10
RT-flex50DF	JET	260	304	340	70	25	5	249	333	6
X52DF	JET	260	313	340	70	25	5	309	413	6
X62DF	JET	280	317	340	70 / 10	25 / 80	5 / 10	498	665	6
X72DF	JET	280	318	340	70 / 10	25 / 80	5 / 10	785	1049	8
X82DF	JET	XX	XX	XX	XX	XX	XX	XX	XX	8
X92DF	JET	260	318	340	70	25	5	1453	1941	10

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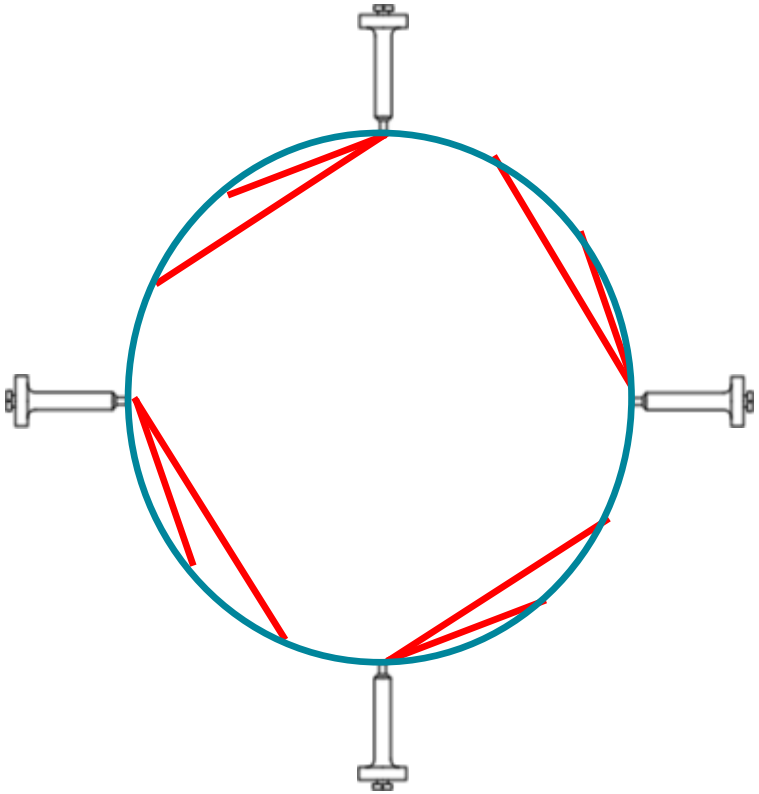
Radial Oil Distribution

Radial oil distribution

Spray holes in the nozzle tip of the injection unit in the lubricating quill determine the radial oil distribution



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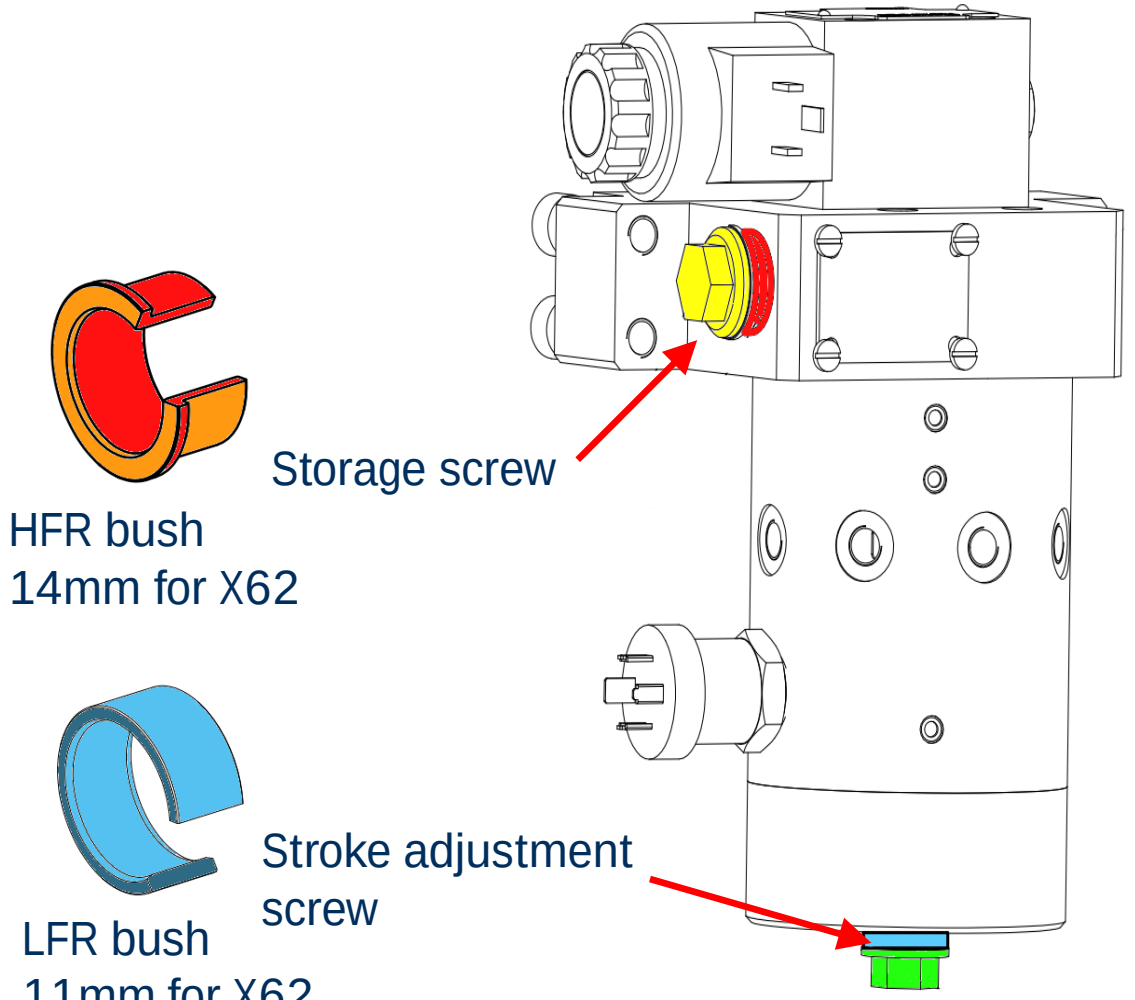
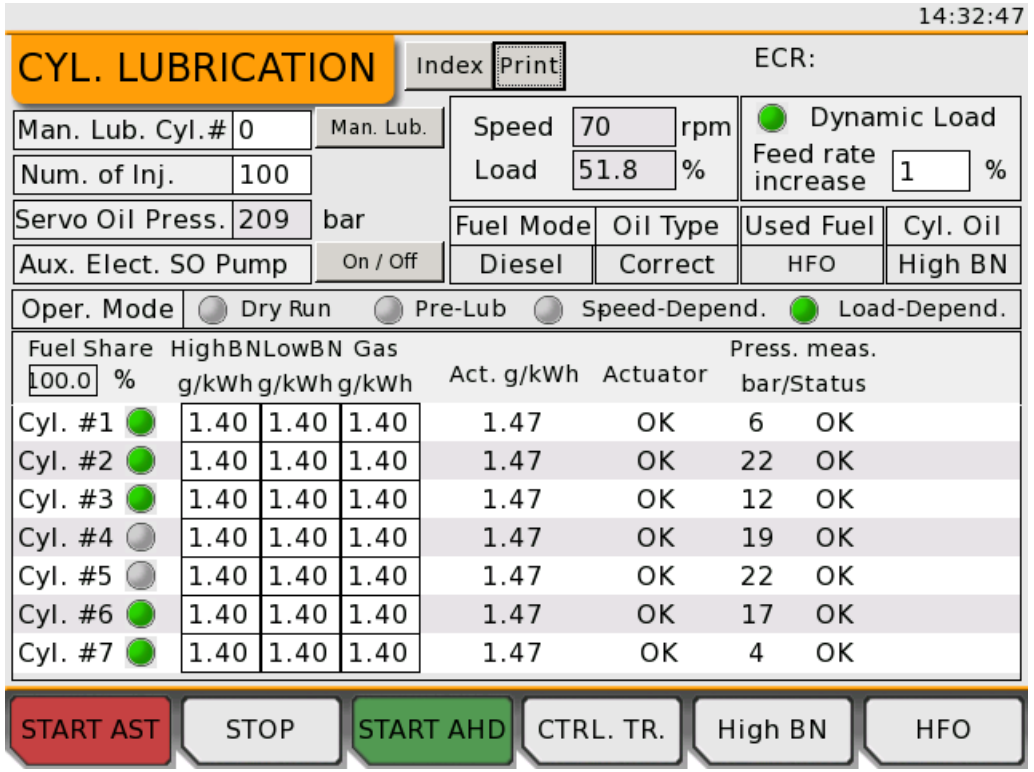
LFR / HFR Bush

- At CMCR and at a feed rate of 1.20g/kWh, every piston stroke is lubricated to avoid dry-running
- To achieve a feed rate of 1.40g/kWh for running-in, the stroke of the flexLube pump has to be lengthened by changing the “feed rate bush”
- The short LFR (low feed rate) bush has to be exchanged with the HFR (high feed rate bush)
- If HFR bush is used, actual pump volume will be increased about 33.6%, therefore, the Pump Vol. must be considered when setting federate on LDU.



Display on LDU

- The feed rate can be adjusted for each cylinder individually
- Manual lubrication to a specific cylinder
- Selecting cyl. #100, manual lubrication applied to all cylinders
- Feed rates can be adjusted between 0.4 and 1.20 g/kWh with LFR bush and higher than 1.4 g/kwh feed rate setting with HFR bush considering increased pump volume.
- Green indication shows the unit currently lubricating



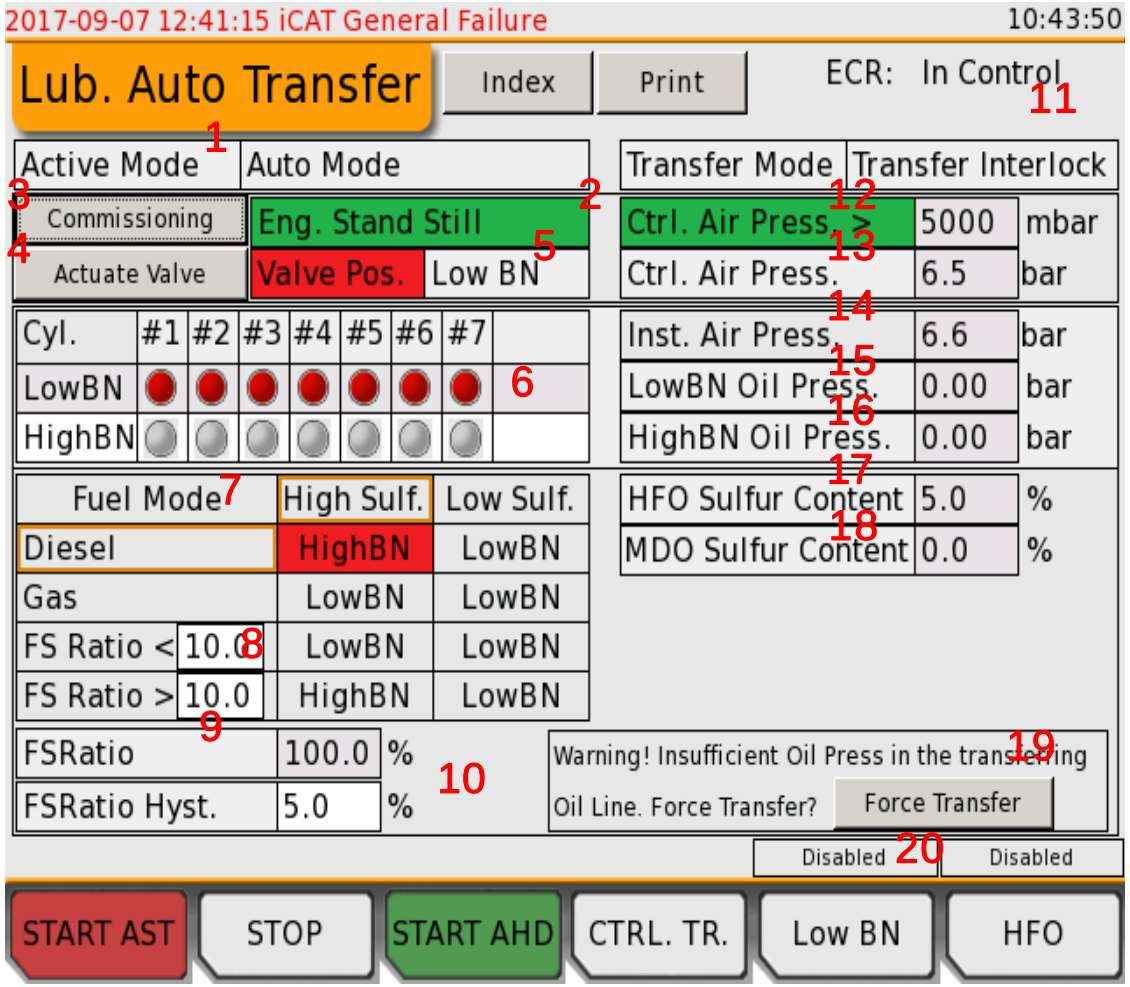
iCAT Page on LDU

1. Current Active Mode
2. Commissioning Activating conditions fulfilment.
- Green = Fulfilled. Grey = Not fulfilled.

3. Commissioning Activating Push button.
4. Actuating Pilot Valve Push button during Commissioning Mode
5. Current Cyl. Lub. Oil BN Change Vlv Position. – CV7147C
- Red = Position disagrees with Cylinder Positions and Control Air Pressure After Pilot Changeover Valve value.
6. Position sensors status(LowBN/HighBN).– ZS320-2XC
- Green + Grey = Sensors in the correct position. Green means active position.
- Red + Grey = Sensors in the wrong position. Red means active position
- Double red = Sensors contradicting.

7. Table of Fuel Mode, Fuel Share Ratio and correct lubrication Oil type
- Green = Correct Lubrication Oil in use.
- Red = Wrong Lubrication Oil in use.

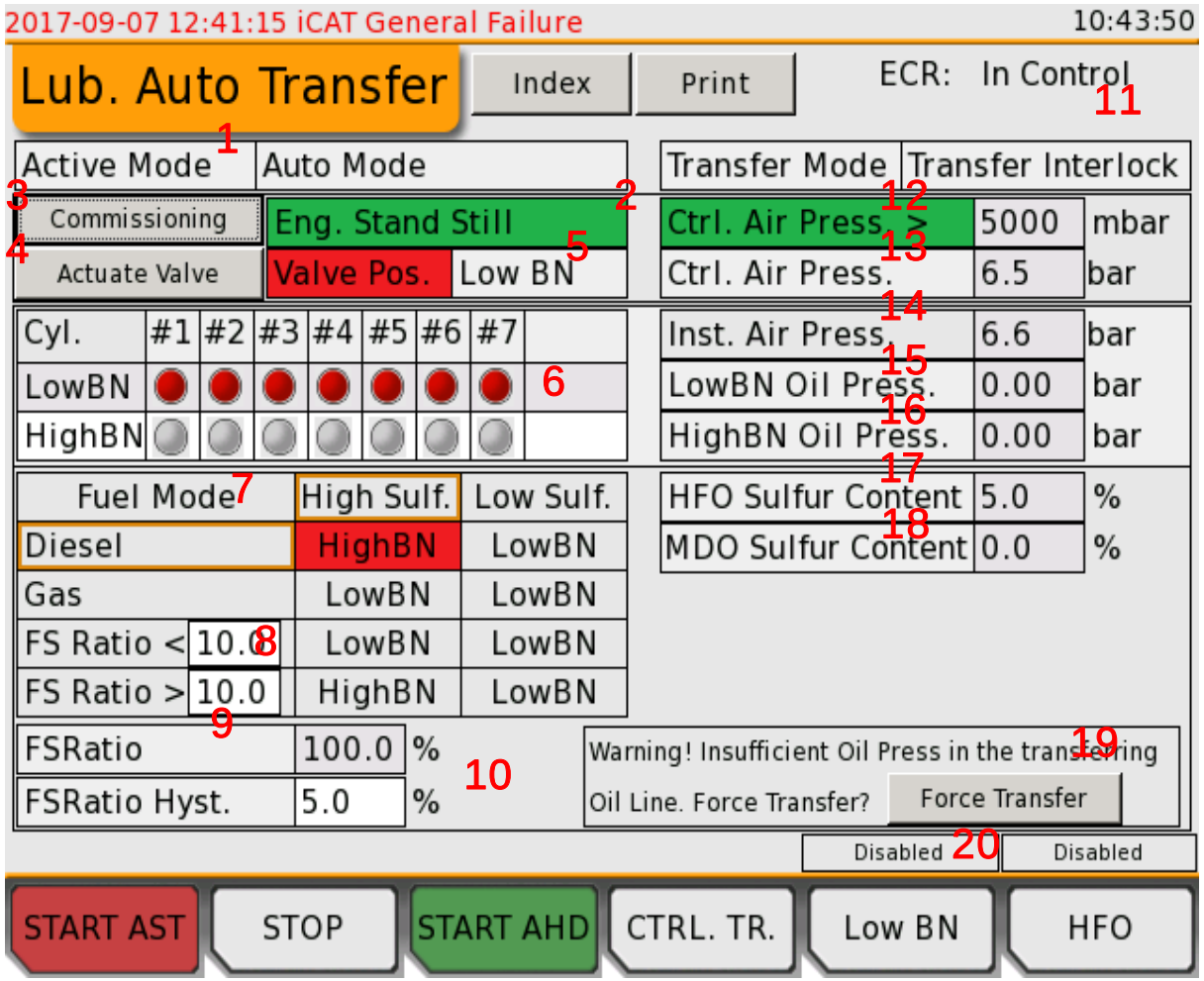
8. Current Fuel Share Ratio Threshold
9. Current Fuel Share Ratio
10. Current Fuel Share Ratio Threshold hysteresis.



iCAT Page on LDU

11. Transfer Mode
    High BN, Low BN, Transferring, Transfer Interlocked.
12. Control Air minimum pressure value for commissioning
13. Control Air Pressure
14. Control Air Pressure After Changeover Valve – PT4413C
    Red = Sensor value disagree with Cylinder Positions and Pilot Valve Position.
15. Cyl. Lub. Oil Press. Low BN – PT3145C
16. Cyl. Lub. Oil Press. High BN – PT3146C
17. HFO Sulfur content
18. MDO Sulfur content
19. Force Transfer button (Only visible when Transfer is Interlocked).

20. LDU buttons Status
    Enable / Disable



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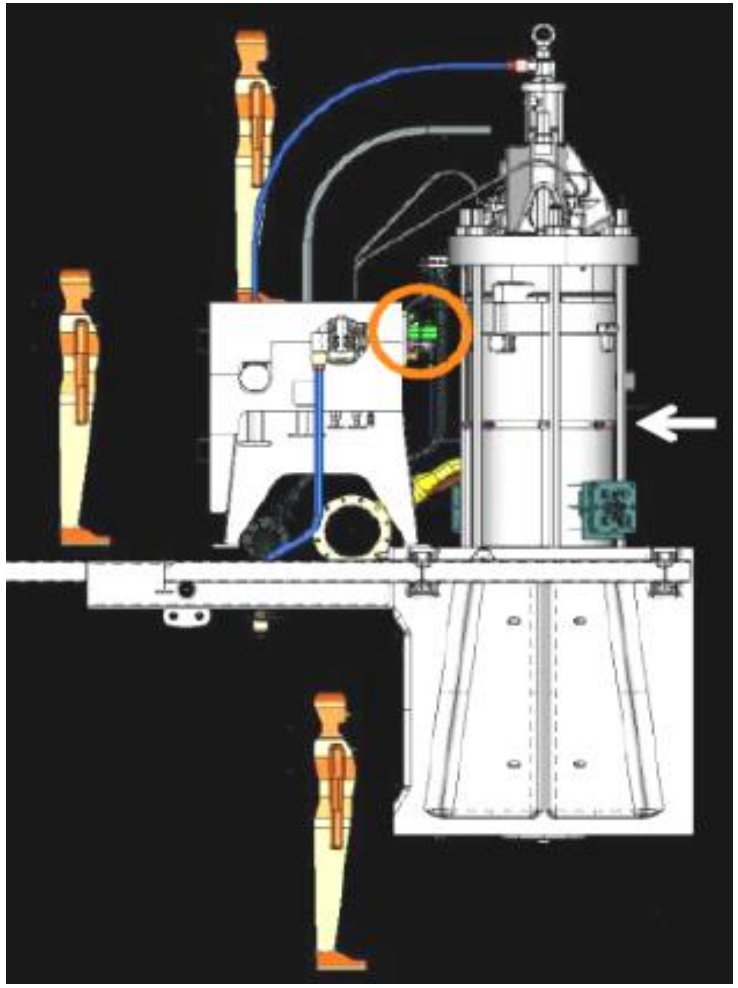
Maintenance and Spare Parts

- Visual inspection of the pumps and piping
- Possible failures:
  - Air inside the system
  - Broken NRV inside the pump or inside the quill
- Spare parts:
  - complete pump
  - solenoid valve
  - pressure sensor
  - O-rings
  - Lubricating quills



Maintenance and Spare Parts

- The flexLube system is generally maintenance free
- Filters have to be replaced if corresponding alarm appears at Δp >0.5bar
  Note: The filters are switched over manually using change-over lever, whereby **the filter below the handle is always out of operation**
- Venting screw at the top of the pump
- Venting of quills by manual lubrication or using a ø3.5mm pin on the solenoid valve
- Cable for emergency lubrication in case one CCM-20 being switched off