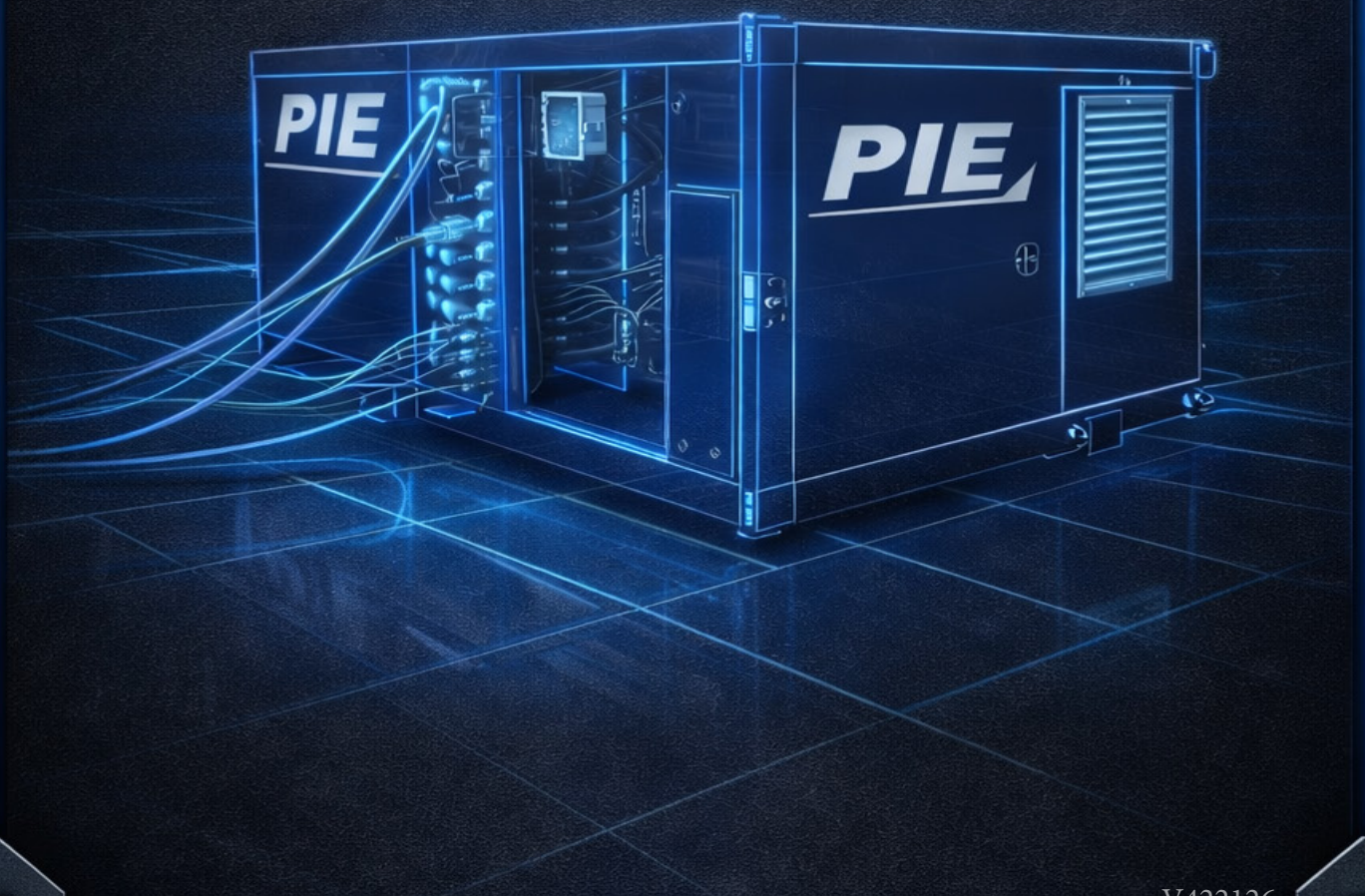
PIE

Model 75 Power Unit Manual



V422126

Table of Contents

Use this guide to quickly find the information you need.
Each section is organized to help you operate and maintain your power unit safely and efficiently.

Quick Common Information:
Filters / Oil Types / Weights / Dimensions

Fuel Filter:	CAT 363-5819
Engine Oil Filter:	CAT 220-1523
Filter Element:	CAT 551-6183
Engine Oil:	CAT EFC-3 or SAE 15W-40
Hydraulic Oil Filter:	Schroeder 2K 18-inch, 10 micron (KZ10)
Engine Coolant:	CAT ELC (Extended Life Coolant)
Hydraulic Oil:	Clarity 46, Clarity 32, or TideGaurd 46
Battery:	12V System
Fuel Capacity:	55 Gallons
Hydraulic Oil Capacity:	115 Gallons
Horse Power:	74
Max Pressure:	3,500 PSI
Max Flow:	50 gpm
Engine Type:	CAT C2.2 Diesel Tier 4 Final (no Def needed)
Color:	Royal Blue
Weight:	5,000 lbs
Dimensions:	53” tall x 107 inches long x 56” wide

Main Specifications:

- Engine: CAT C2.2 74hp Engine Tier 4
- Max Hydraulic Flow: 50gpm
- Max Hydraulic Pressure: 3,500 PSI
- Fuel Capacity: 55 Gallons
- Hydraulic Oil Capacity: 115 Gallons
- Fuel Type: Diesel
- Recommended Oil Type: TideGuard 46 or Clarity 46

Valve Controls:

- Stand 1: 3 levers, 25gpm @ 3,500 PSI
  - Drill forward and reverse
  - Drill winch up/down
  - Hydraulic Trip up/down

Stand 2: 4 levers, 50gpm @ 2,500 PSI
- Spud 1 up and down
- Spud 2 up and down
- Spud 3 up and down
- Spud 4 up and down

Dimensions:

- Height: 52 inches
- Width: 51.5 inches
- Length: 100 inches
- Weight: 5,000 lbs

CAUTION & SAFETY INFORMATION

IMPORTANT SAFETY GUIDELINES

Please read and follow these safety guidelines carefully to prevent personal injury, equipment damage, and ensure safe operation of this power unit. Failure to follow these guidelines may result in serious injury or property damage.

- This equipment is sold “as is” and the user is solely responsible for determining its suitability and safe operation.
- Power units and their components are inherently hazardous if handled or operated improperly. Only trained, qualified personnel should install, operate, or perform maintenance on this equipment.
- High noise levels during operation may require appropriate hearing protection. Review OSHA 29 CFR 1926.52 for additional information on noise level regulations.
- Keep loose clothing, jewelry, and long hair away from rotating parts to avoid entanglement and injury.
- Never disable, bypass, or remove any safety devices, labels, or guards. Always check and maintain these safety components to ensure proper function before use.
- Stay clear of “HOT SURFACE” labels on the equipment. Surfaces may become extremely hot during and after operation.
- Always relieve hydraulic pressure before disconnecting hoses or performing any maintenance. Failure to do so could result in hoses whipping dangerously.
- Adhere to all OSHA (Occupational Safety and Health Administration) regulations and all local safety regulations when operating this power unit.

FAILURE TO FOLLOW THESE SAFETY GUIDELINES MAY RESULT IN SERIOUS INJURY, DEATH, OR PROPERTY DAMAGE.

Power Unit Overview / Front View

Engine
Air Intake

4 Point Pick
D-Rings

Engine Controls

Engine
Radiator Side

Front Air Vent

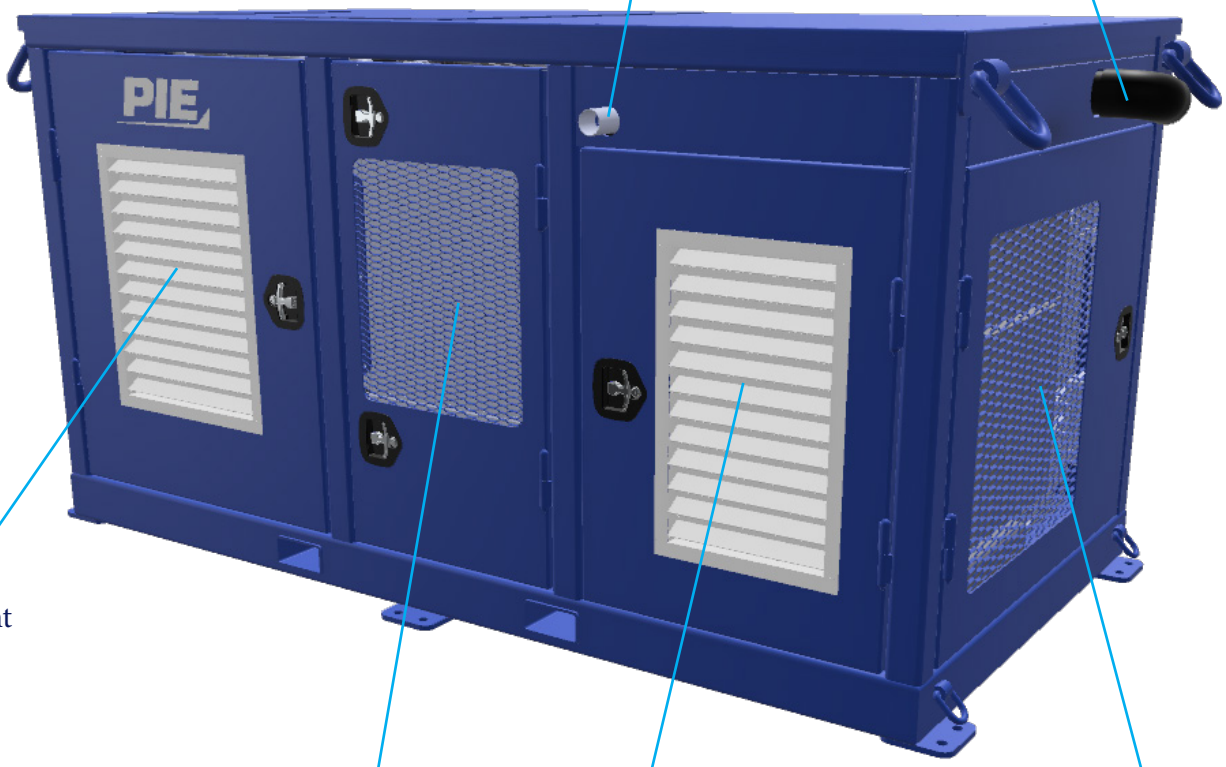
Lash Down
D-Rings

Forklift
Pockets

Main Quick Disconnect
Cluster

Bolt Down
Point

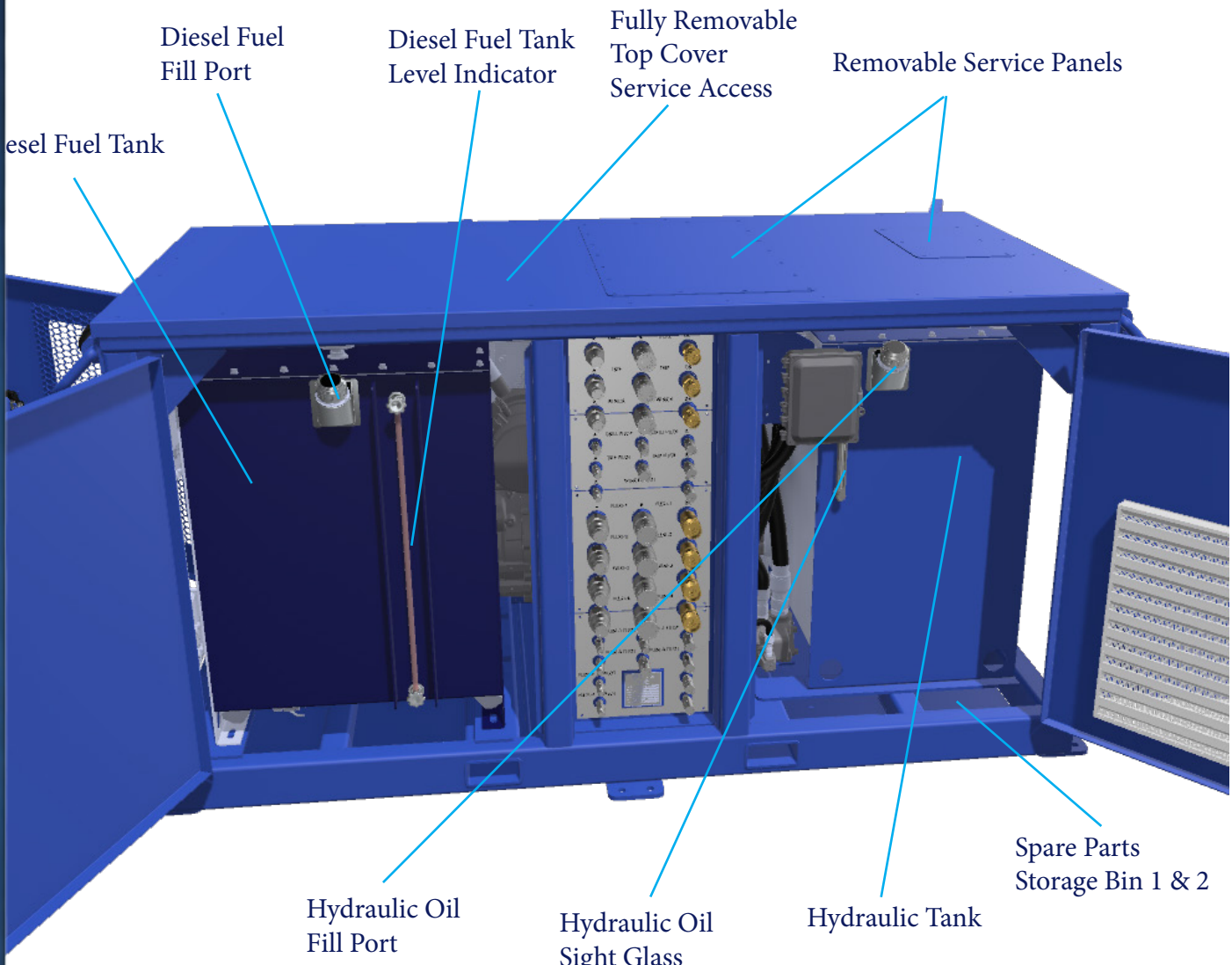
Power Unit Overview / Back View



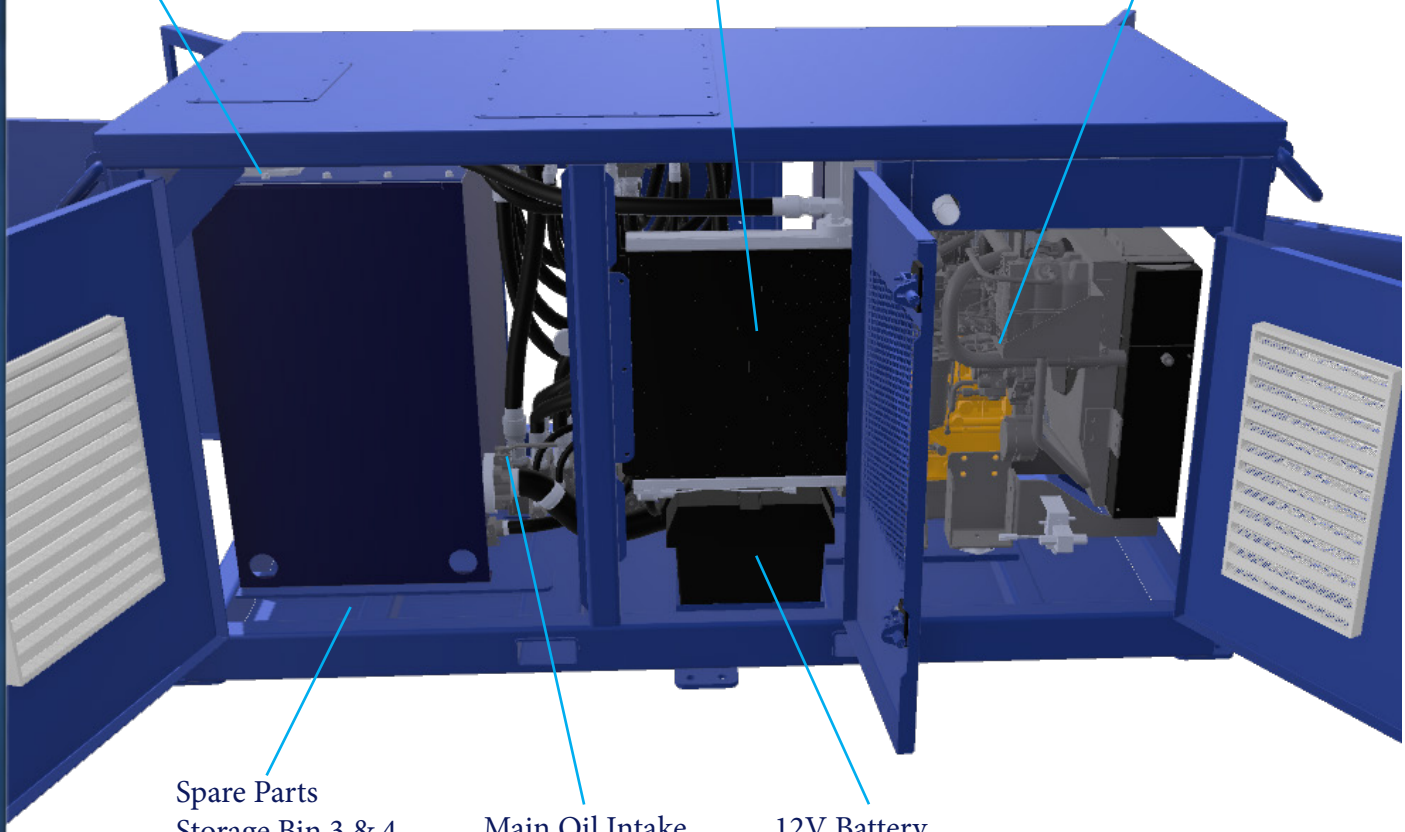
Stand 1
3 Lever System
Trip | Drill | Winch

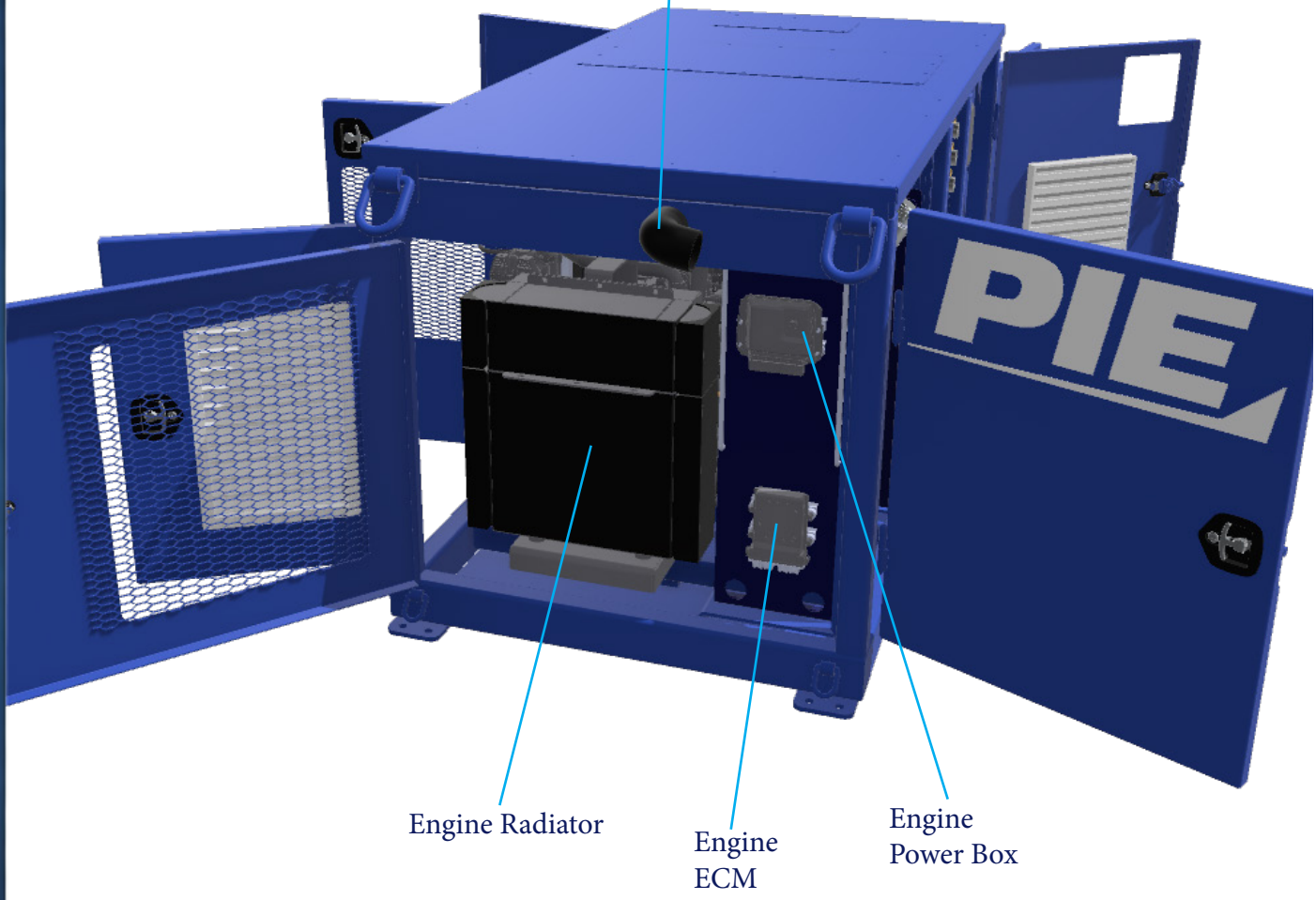
Stand 2
4 Lever System (Flexi)
Spud 1 | Spud 2 | Spud 3 | Spud 4

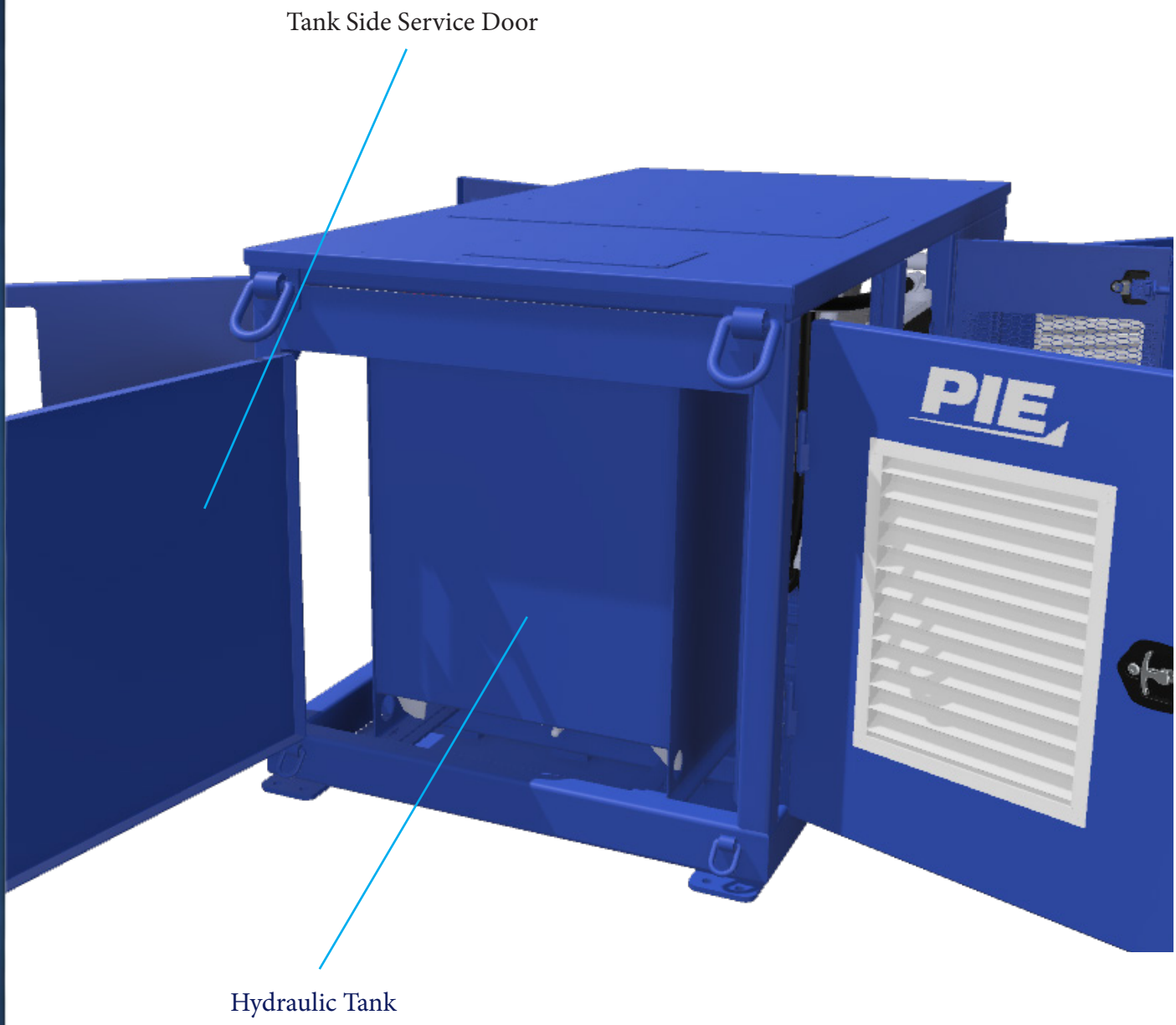
Power Unit Overview / Front Inside View



Power Unit Overview / Back Inside View

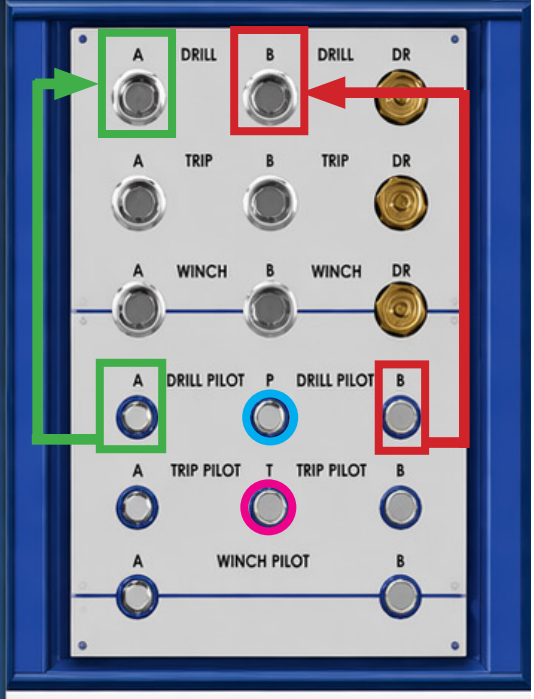



Air intake
PIE
Engine Radiator
Engine
ECM
Engine
Power Box


Tank Side Service Door
PIE
Hydraulic Tank

Understanding the Quick Disconnects

High Pressure Low Flow



Low Pressure High Flow

Summary:
To help understand how the QD controls work lets just take a close look at the Drill Controls.

On the top row you have the main QD's that will connect directly to your drill:

Drill A QD on the top left connects to the Drill Forward hose

Drill B QD on top middle connects to the Drill Reverse hose

Drill DR connects to the case drain line.

To control the drill we use the pilot lines. First the P and T ports must be connected to operate the stand. Once the P and T ports are connected to the stand we can connect the A and B side of one of the levers.

When a lever is pushed it diverts oil pressure from P to A or B.

Shown in Green is the Drill Pilot A port controlling the Drill A port. The Drill Pilot B port controls the Drill B port. P and T are just used the power the stand.

The same logic applies to the Trip and Winch circuits. Trip pilot A controls Trip A, Trip pilot B controls Trip B, ect.. Although the labels say "Trip" and "Winch" theoretically any hydraulic controlled device could be connected, log splitter, cylinder, rat control cylinders, motors, ect..

ALL functions on the top "high pressure low flow" QD's are set at 3,500 PSI and 25gpm. The top QD's are a totally different circuit than the lower "Low Pressure High Flow" QD's which are set at 2,500 PSI and 50gpm.

Understanding the Quick Disconnects

When first looking at the quick disconnect panel, it can seem complex.
In reality, each row follows the same simple pattern.

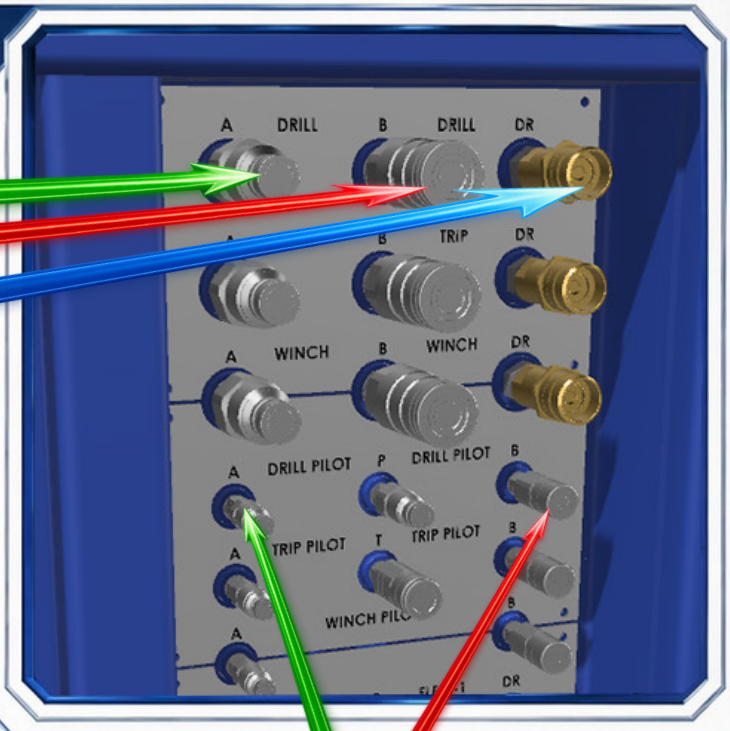
Top Row Example (Drill Circuit)

Each function uses three hoses:

- **A** = Forward
- **B** = Reverse
- **DR** = Drain (case return)

Connection:

- Connect Forward hose → **A**
- Connect Reverse hose → **B**
- Connect Drain hose → **DR**



How the Drill is Controlled

For the Drill forward and reverse use the middle lever:

- Lever up → Drill **A** Port
- Lever down → Drill **B** Port
- Middle lever will not spring to center

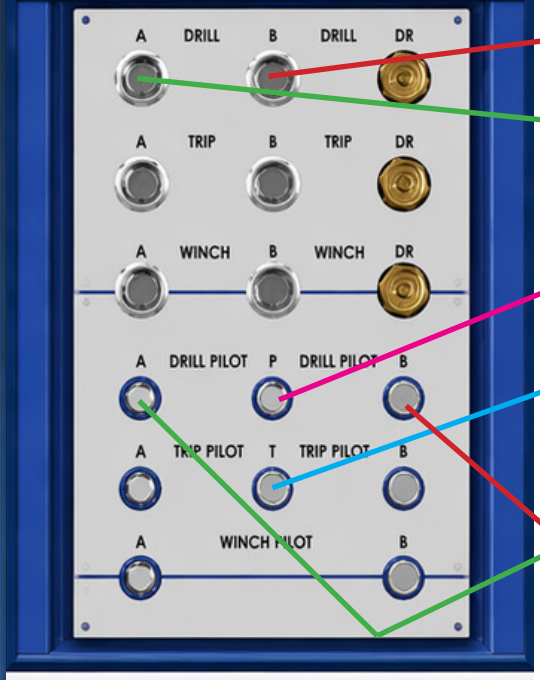
Pilot Lines (Control Signal)

P & T pilot lines pump oil to the levers:

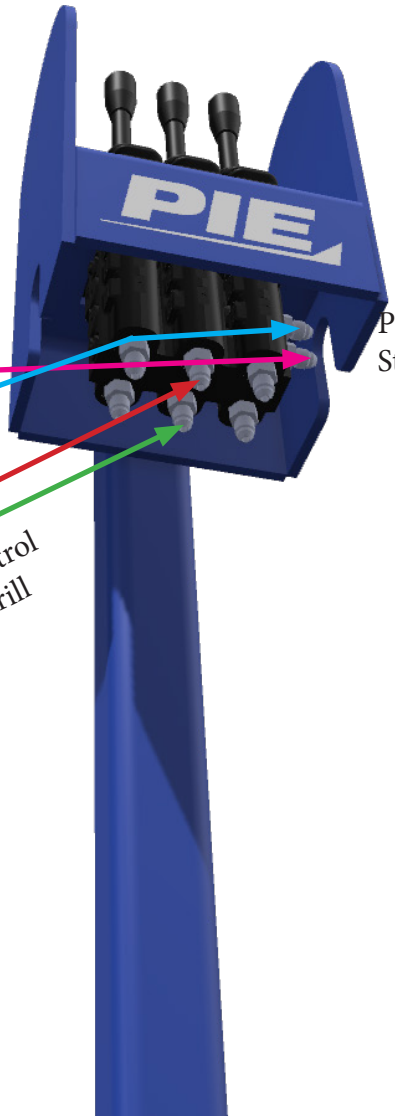
- **P** = Pressure to main valve on stand ↑
- **T** = Tank/Return from main valve on stand ↓
- **A** = Controls main **A** (Forward) on drill
- **B** = Controls main **B** (Reverse) on drill

Understanding the Quick Disconnects

High Pressure Low Flow



Low Pressure High Flow



Drill: Reverse

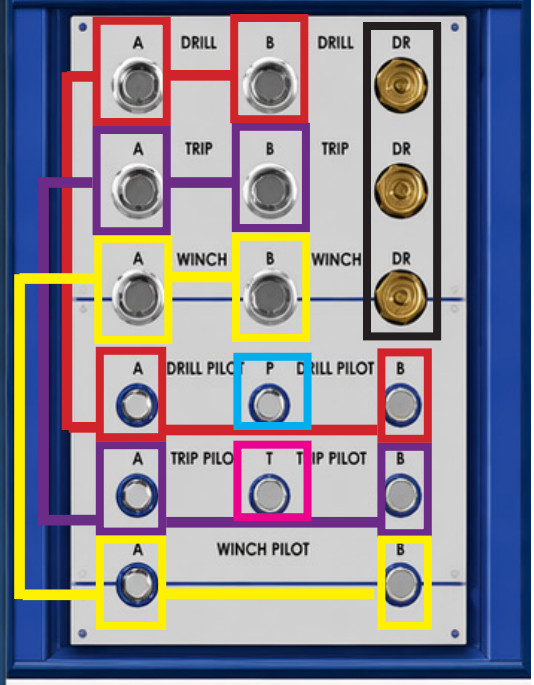
Drill: Forward

P/T ports for Stand.

Lever Control for the Drill

Understanding the Quick Disconnects

High Pressure Low Flow

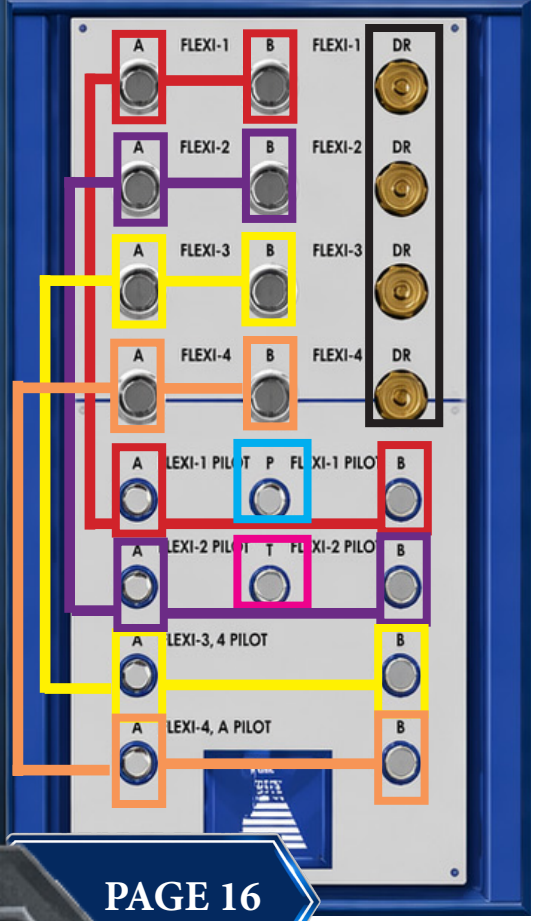


Stand 1: 3 levers (2x spring centers, 1x detented)

Example: Red Controls Red, Purple Controls Purple...

- Drill A&B are controlled by Drill Pilot A&B
- Trip A&B are controlled by Trip Pilot A&B
- Winch A&B are controlled by Winch Pilot A&B
- DR = Case Drains, they all return to tank
- P goes to Stand 1 "P" port or "Pressure port"
- T goes to Stand 1 "T" port or "Tank port"

Low Pressure High Flow



Stand 2: 4 levers (4x spring centers)

High Pressure Circuit is not connected to the Low Pressure Circuit. Same color examples but different valves and levers.

- Flexi Spud 1: Up/Down
- Flexi Spud 2: Up/Down
- Flexi Spud 3: Up/Down
- Flexi Spud 4: Up/Down
- DR = all case drains, all return to tank
- P goes to Stand 2 "P" port or "Pressure port"
- T goes to Stand 2 "T" port or "Tank port"

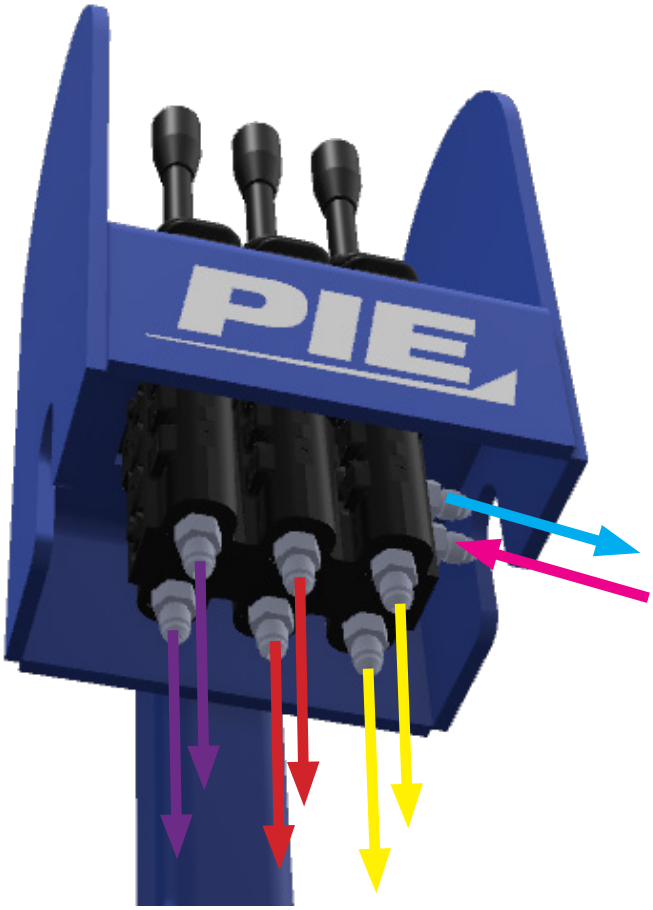
Pink = P line
Blue = T line
Red = Flexi 1 Pilot A/B (up/down)
Purple = Flexi 2 Pilot A/B (up/down)
Yellow = Flexi 3 Pilot A/B (up/down)
Orange = Flexi 4 Pilot A/B (up/down)

Note: P and T QD size is slightly larger than the Flexi QD lines, it should not be possible to accidentally connect the P and T lines incorrectly.

Pilot lines have an Female and Male, however you could accidentally plug the Flexi 1 A/B into the Flexi 2 A/B for example. In that case the lever 2 would control Spud 1. This can be easily troubleshooted.

Stand Diagrams

(Stand 1) Low Flow @ 2,500 PSI
Max PSI = 3,500

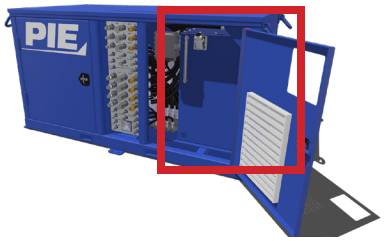


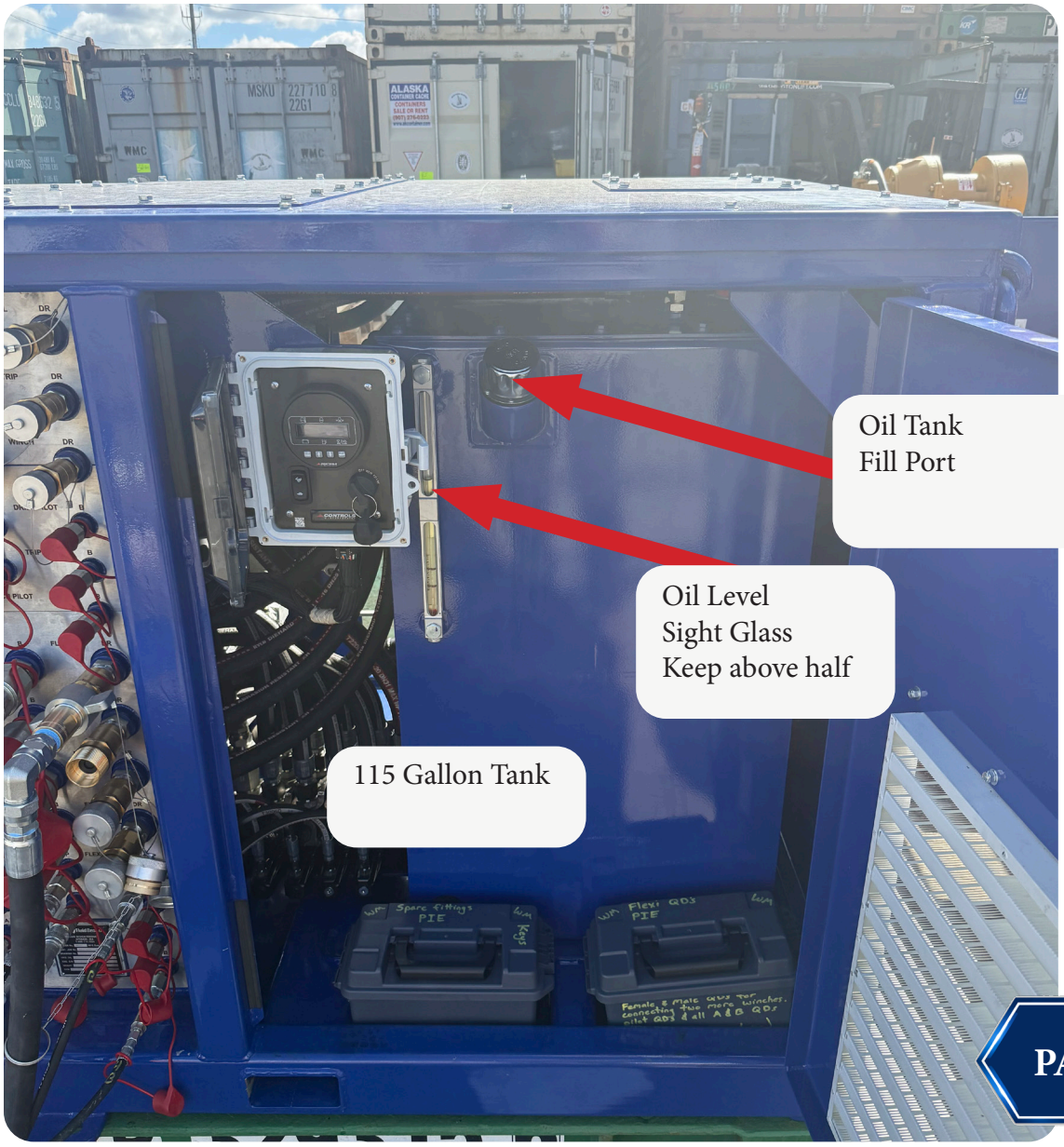
Pink = P line
Blue = T line
Red = Drill Pilot A/B (Forward / Reverse)
Purple = Trip Pilot A/B (up / down)
Yellow = Winch Pilot A/B (Drill up/down)

Note: P and T QD size is slightly larger than the Drill/ Trip/Winch QD lines, it should not be possible to accidentally connect the P and T lines incorrectly.

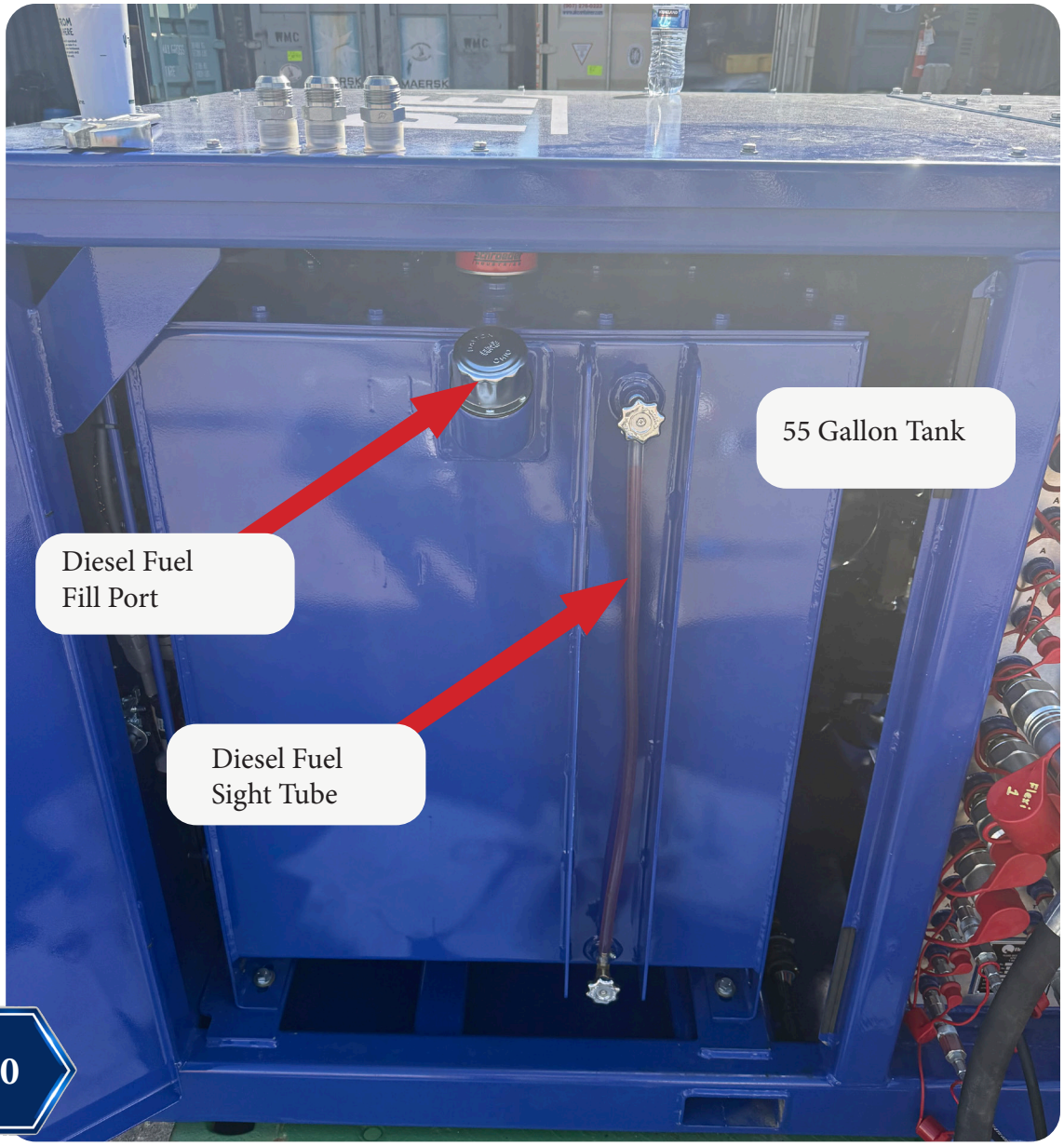
Pilot lines have an Female and Male, however you could accidentally plug the Drill A/B into the Trip A/B for example. In that case the trip lever would control the drill forward and reverse. It's important to plug each A and B into the correct place.

Step 1) Check Hydraulic Oil Level
Use Clarity 32 or 46 or TideGaurd

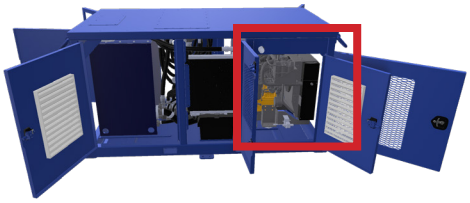


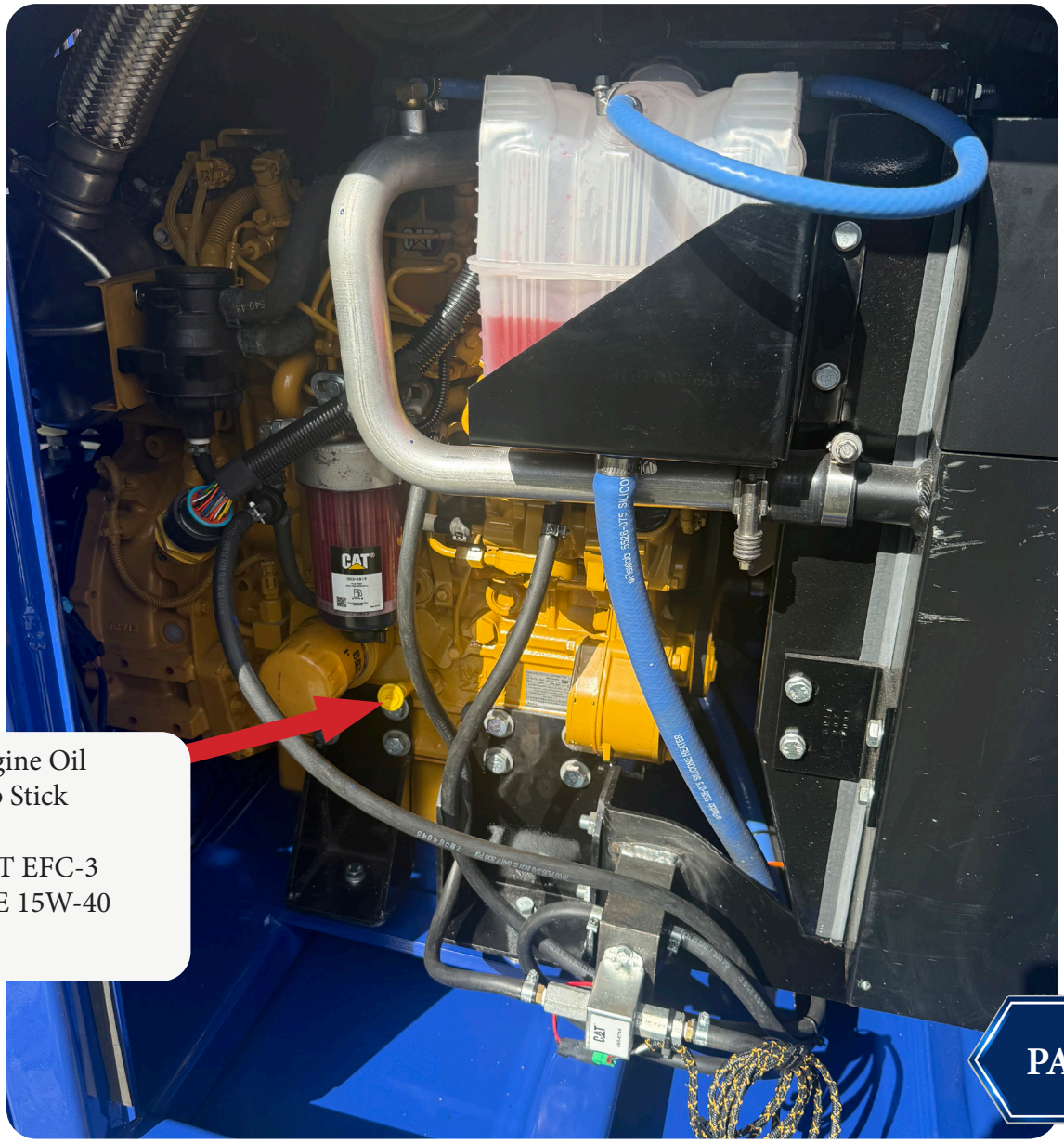


Step 2) Check Diesel Fuel Level



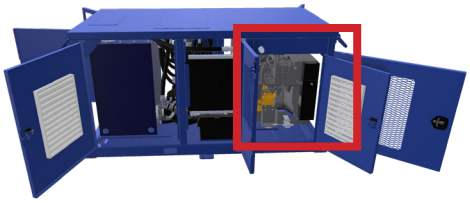
Step 3) Check Engine Oil



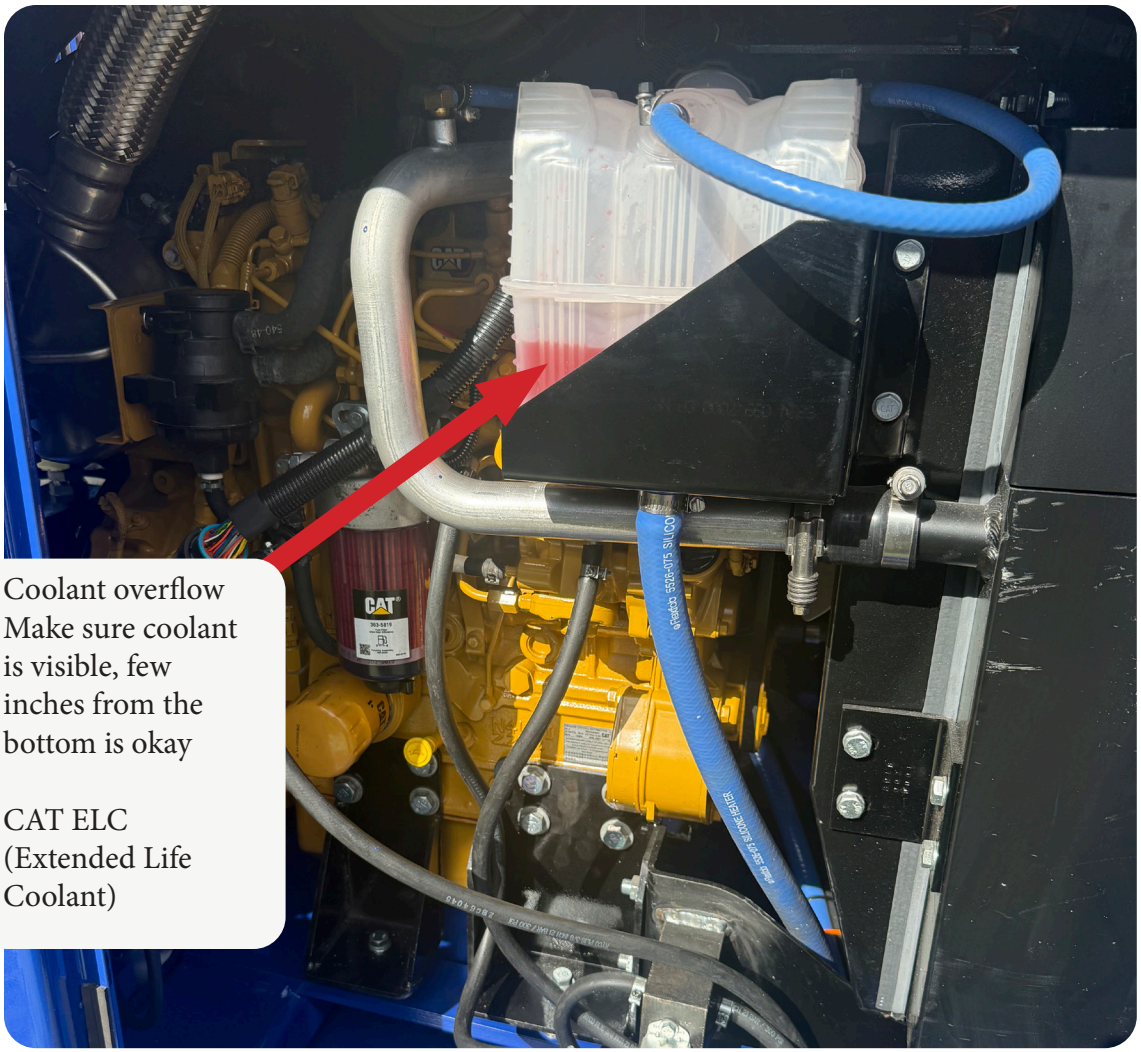


Engine Oil
Dip Stick

CAT EFC-3
SAE 15W-40



Step 4) Check Coolant Level



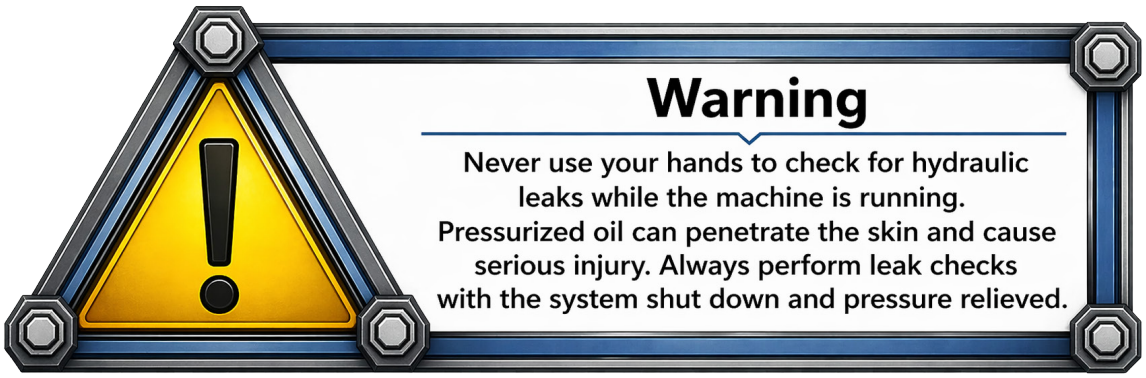
Coolant overflow
Make sure coolant is visible, few inches from the bottom is okay

CAT ELC (Extended Life Coolant)

Step 5) Internal Hydraulic Oil Leak Check

On mobile equipment, fittings can loosen and seals can wear over time. Before operating, ensure all components are clean and free of oil. Starting with a clean system makes it much easier to identify new leaks during inspection.

If the unit is already covered in oil, locating the source of a fresh leak can be difficult.



Key Inspection Areas
Regularly inspect the following locations:

* Top and bottom of the main pump
* Around the main hydraulic valves
* Front and back of quick disconnects (QD's)

Engine Start Information

After the Pre-Check is complete insert key, switch system to Run for a brief moment, then switch to Start. Once the engine is running release switch and it will spring to the run position.

Use the **Tortoise** and **Hare** symbol for Governor up or down.

RPM Up / Down

Off / Run / Start

Make sure to warn up engine for at least 5 to 10 minutes prior to using any of the hydraulic functions.

Also, let engine cool down for 5-10 minutes after usage.

The pumps are fixed displacement pumps; therefore the faster the RPM the faster the pumps will pump. For the Flexi-Float Spuds most likely the RPM will need to be close to max.

ALL levers and hydraulics are connected, therefore **you CAN push all levers at the same time**; however this will bog the engine down very quickly. All oil will be split to all levers so the flow will be greatly reduced. For example if you have four spuds connected and you push down on all four levers the 50gpm of flow would be split between all spuds and flow will be very slow to each spud. There is a max 74 horse power of usable power, once the engine is pushed beyond it's limit it will likely die; it will be up to the user to get a feel for what tool or tools can be used simultaneously.

Know that the quick disconnects chosen was to help prevent accidentally connecting the wrong hose to the wrong QD on the power unit. All High Pressure lines are slightly smaller than the lower pressure lines. The P and T port QD's are slightly larger than the A and B port QD's; this will prevent accidentally plugging the main pilot flow into a lever. Although much design consideration was taken to prevent accidently connecting QD's the wrong tool there are some possible user errors that can happen:

Make sure to plug each lever / pilot A/B into the correct function. Make sure the main tools are connected to the correct A and B ports. Failure to do so will result in either a lever controlling the wrong tool or a tool behaving strangely. It's best to take the time to label each hose and make sure the next person knows exactly where each hose needs to connect.

Please take some time to familiarize yourself with how the system works in the below documents; a brief understanding of the valve can go a long way to prevent accidents.

The levers are variable, the further you push the more flow will happen, if the RPM is too low the biggest concern is running out of horse power and killing the engine. Best to listen to the engine and hear how it's doing to gauge what RPM should be used for a certain tool.

LEVER MOTION

Each lever controls hydraulic function by moving forward or backward.

PUSH FORWARD

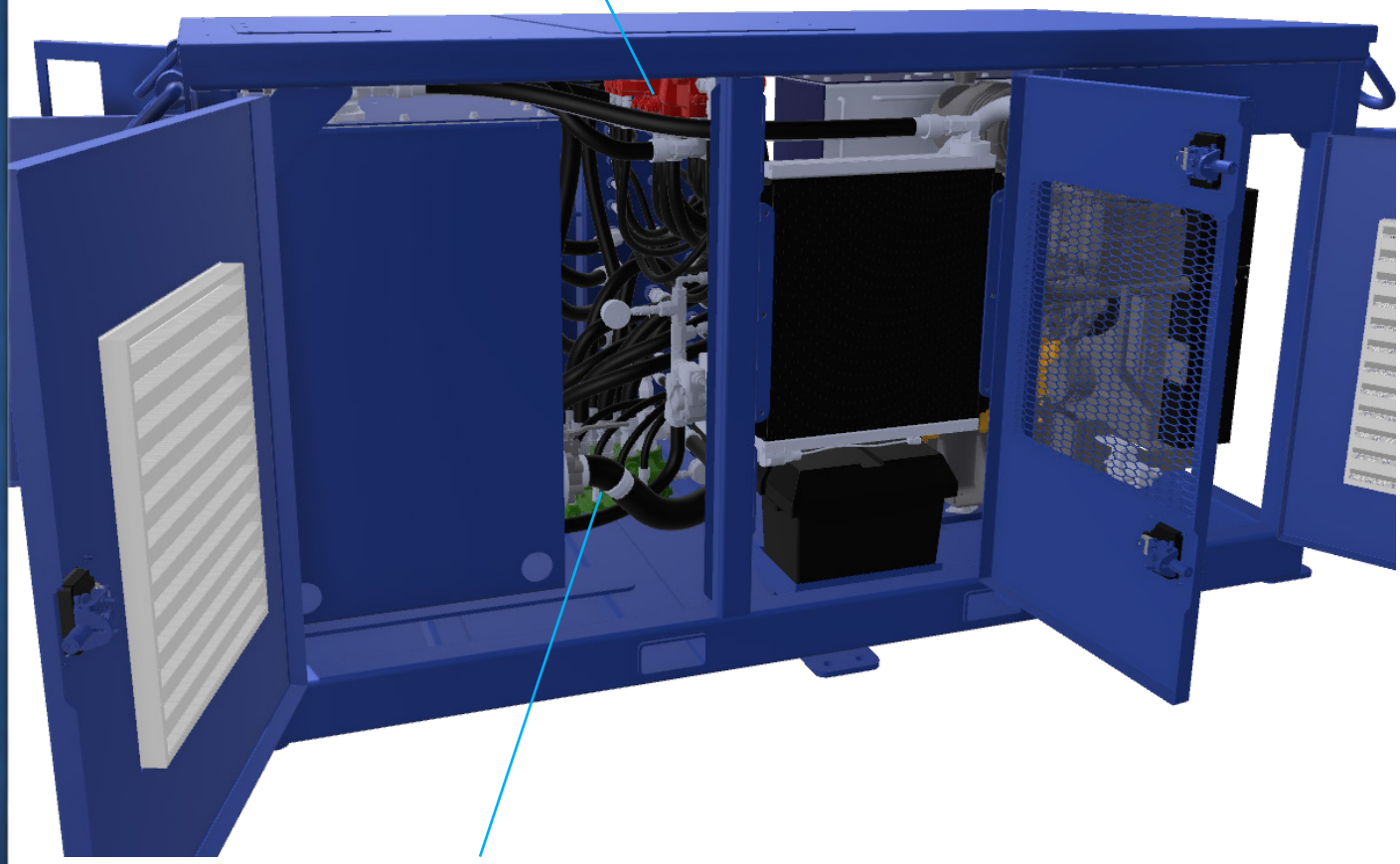
Push the lever forward (away from you) to activate the function.

PULL BACK

Pull the lever back (toward you) to activate the function.

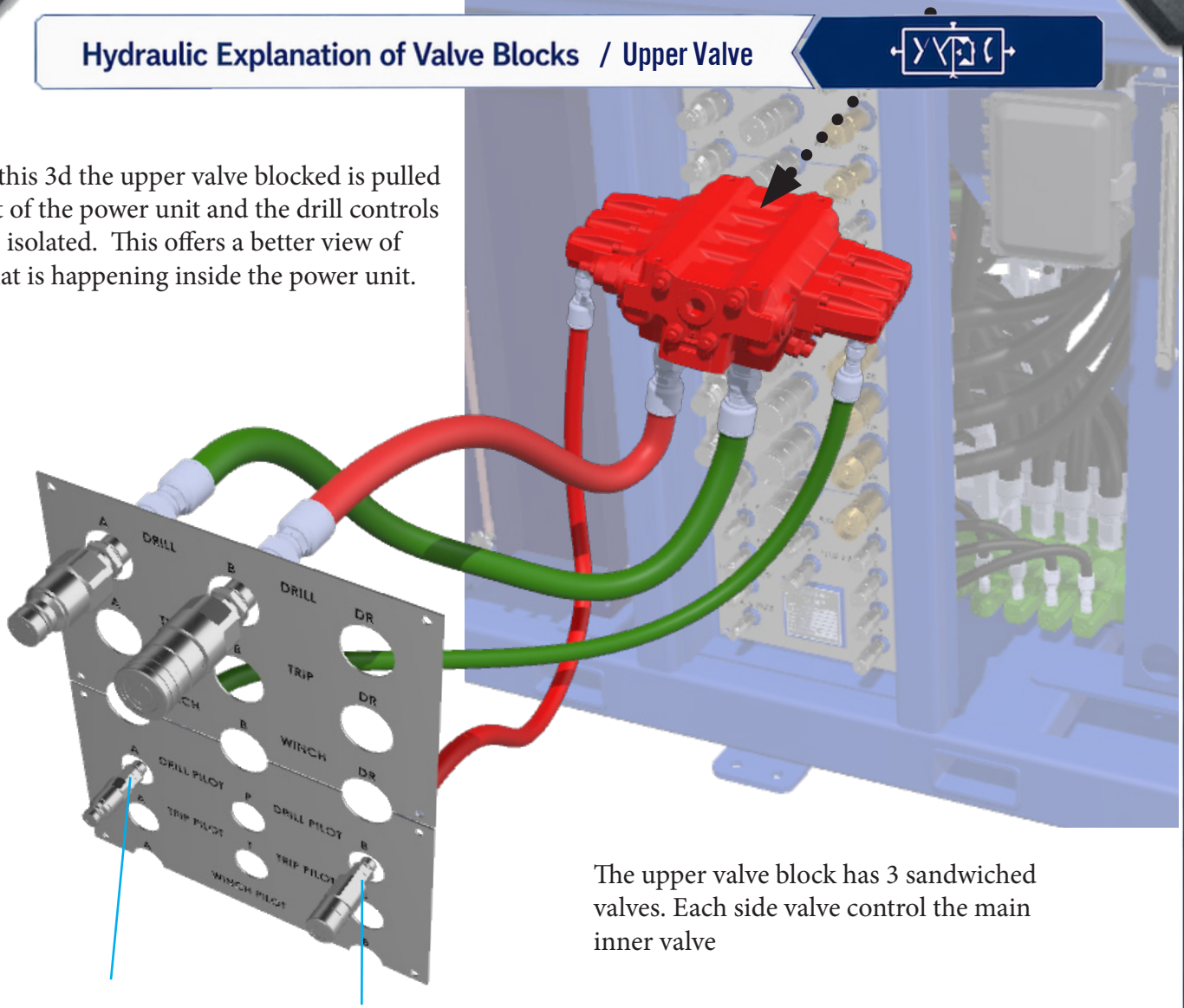
NOTE:
Release the lever (return to neutral) to stop the function.

High Pressure low flow - **Upper Valve Block**
Trip, Drill, Winch Controls



Low Pressure High Flow - **Lower Valve Block**
Flexi-float Spud Controls

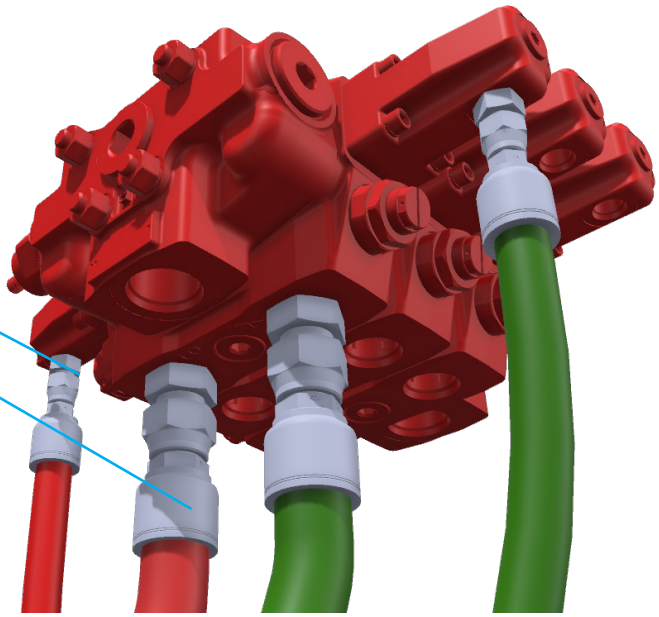
In this 3d the upper valve blocked is pulled out of the power unit and the drill controls are isolated. This offers a better view of what is happening inside the power unit.



Drill Pilot A port

Drill Pilot B port

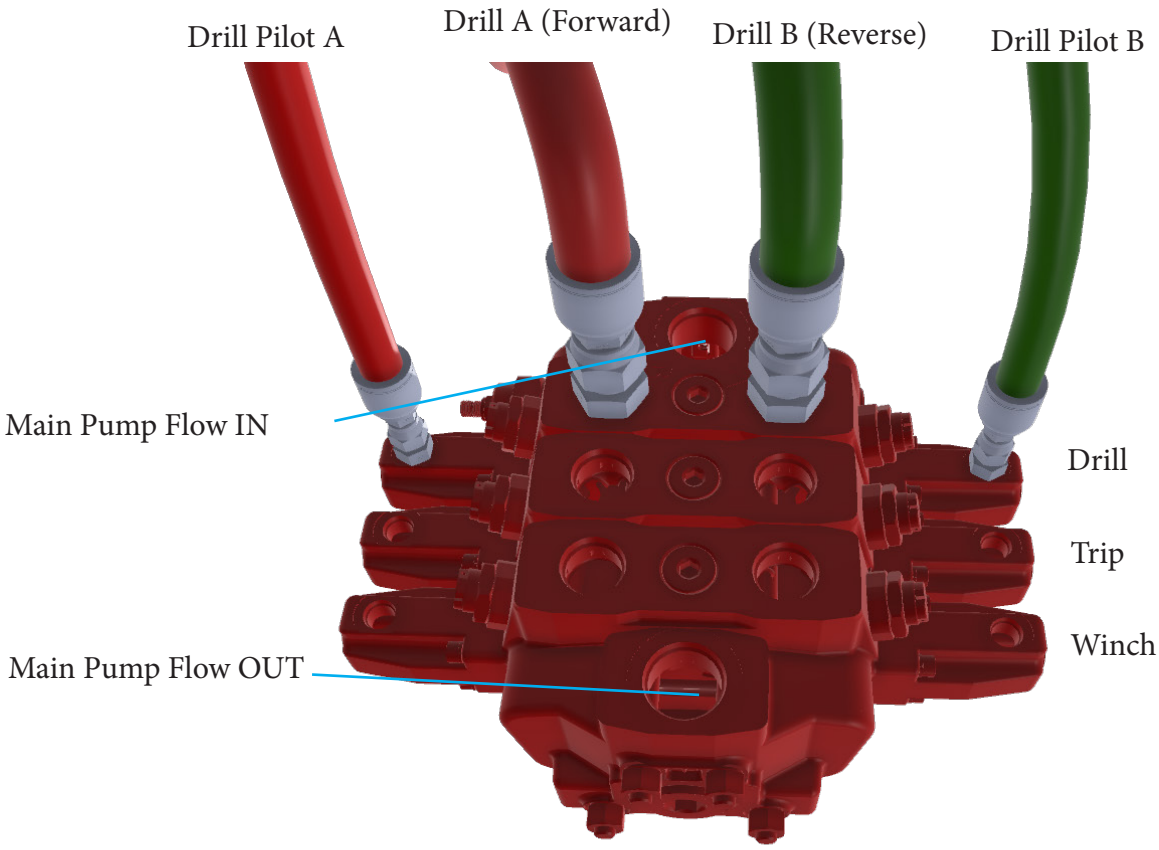
The upper valve block has 3 sandwiched valves. Each side valve control the main inner valve

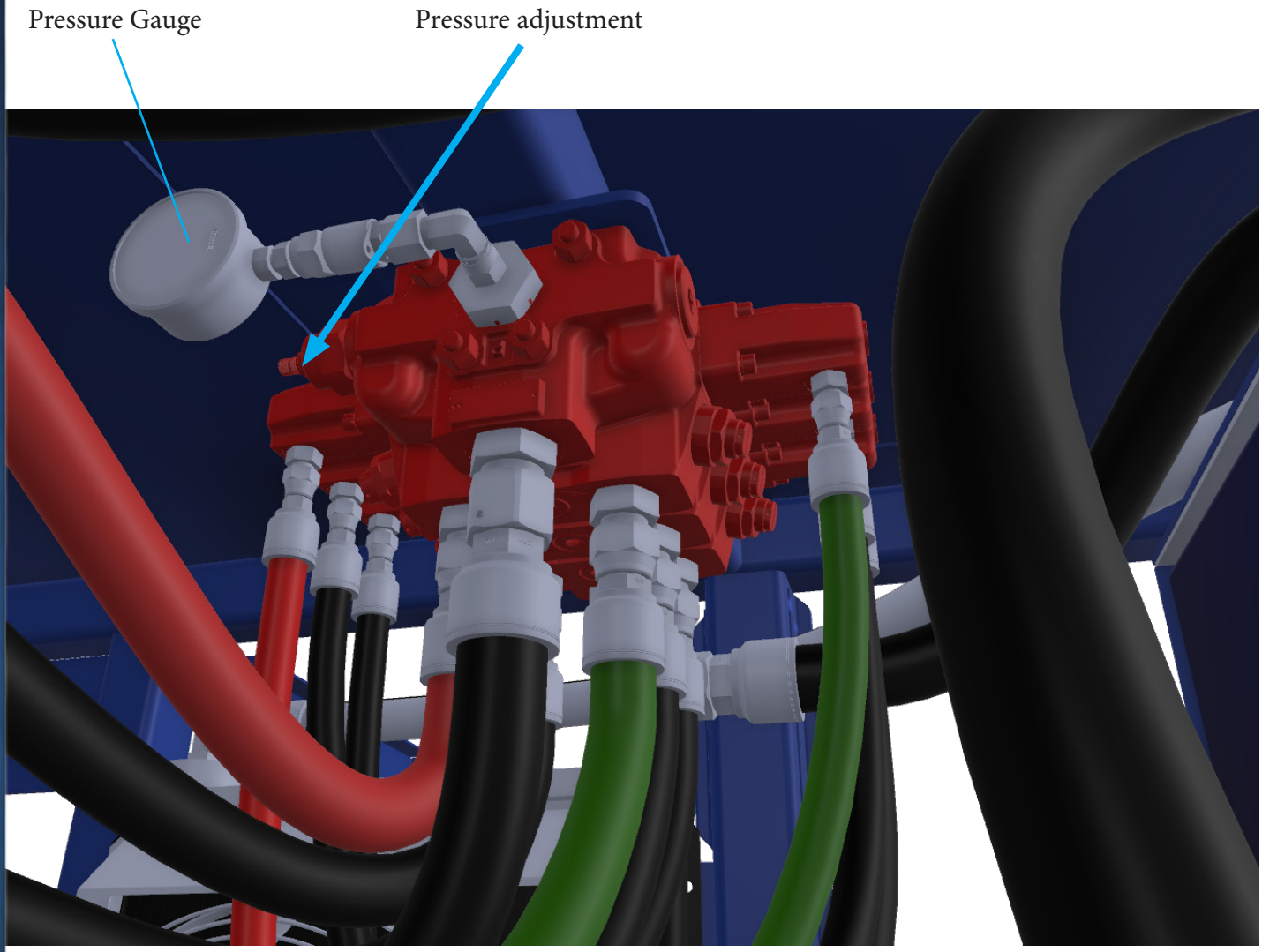


Drill Pilot A port

Drill Port A (Forward)

Shown below the upper valve block shown upside down; in this angle you can clearly see that this valve body has 3 total controls: Drill, Trip, Winch. Each “valve block” has two pilot lines that control the main lines





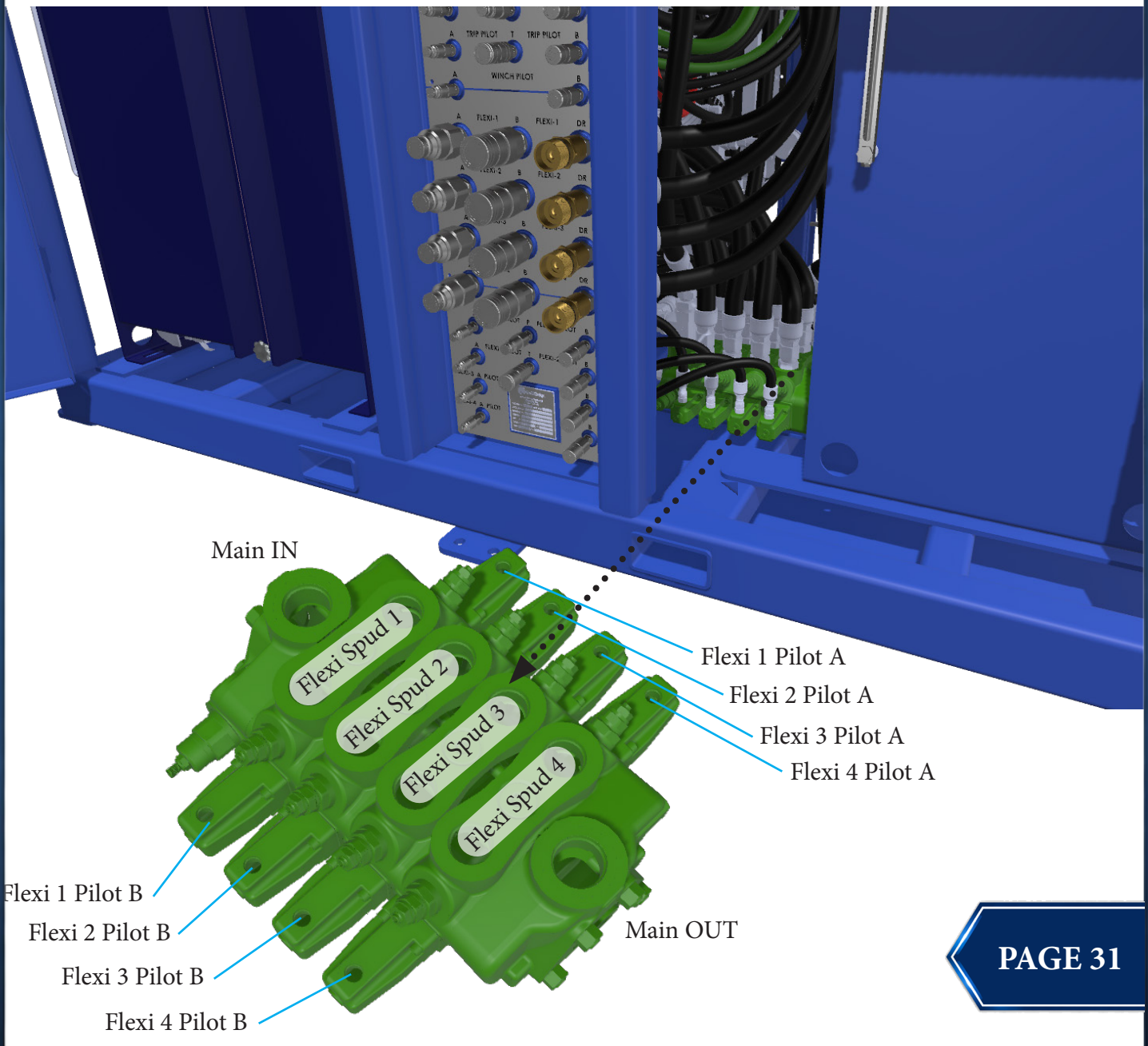
How to adjust the pressure:

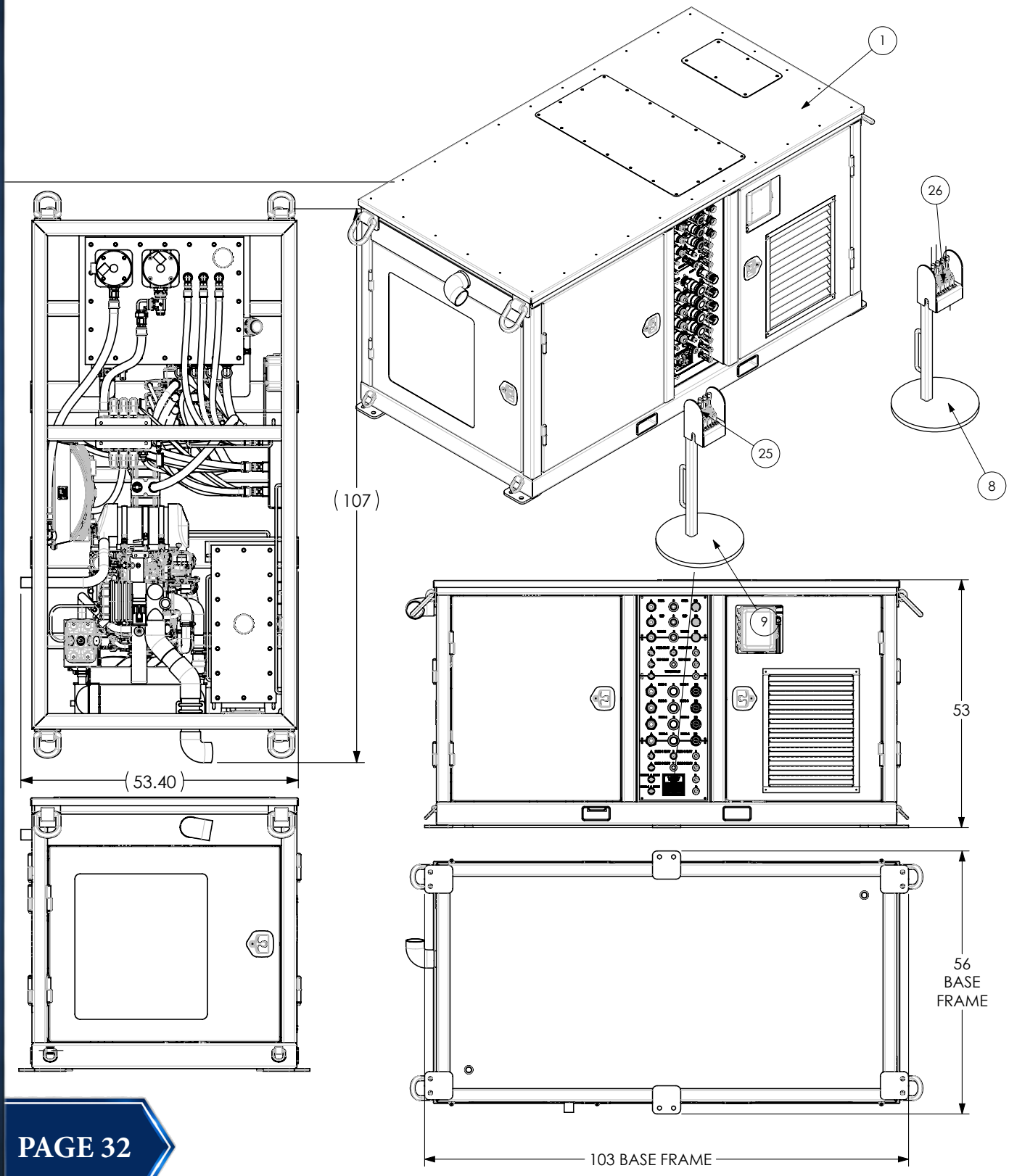
Note: The pressure affects the entire block, if you change the pressure it will affect the Drill, Trip, and Winch circuit or anything connected to this valve.

To adjust pressure, like most relief valves, connect the pilot lines but do not connect the main lines to one of the tools. For example, connect the drill pilot lines but not the drill QD's. Push the lever and it will try to force oil through the QD and "dead head" the oil, the oil pressure will rise to max and the gauge will show what that max pressure is. To lower it loosen the set screw, use an Allen wrench to loosen the nut. Push the lever again and re-test the pressure is at the desired level. MAX pressure is 3,500 PSI.

Hydraulic Explanation of Valve Blocks

The lower block works exactly the same as the upper block, the only difference is that the lower block has 4 valves instead of 3. The valve bodies are expandable to 12 total valves if ever in the future there was a desire to add more functions. Currently however with 7 valves total the QD space is limited to add more valves in a clean way, but it can be done.

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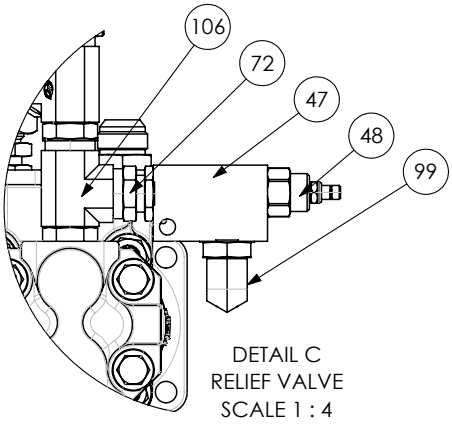
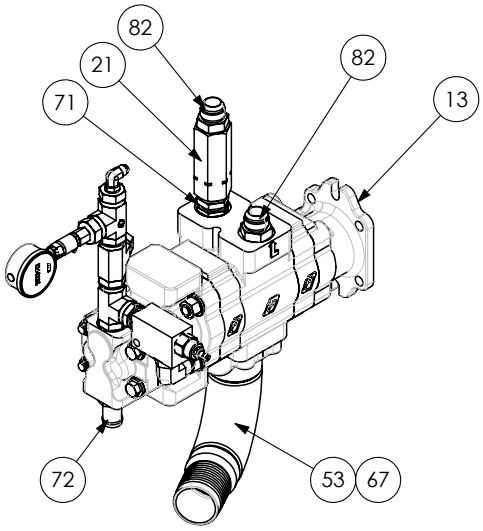
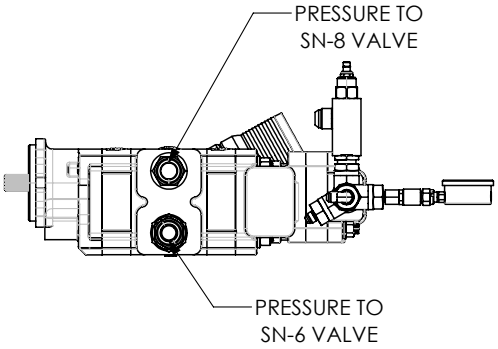
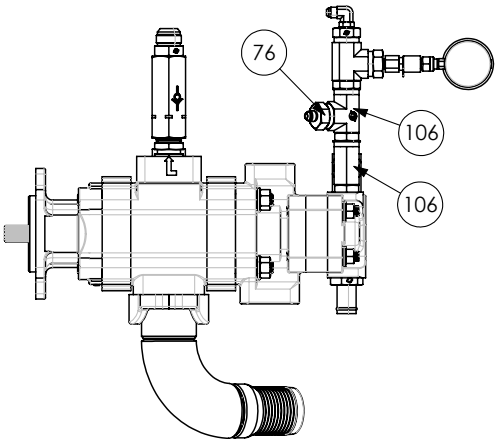
26
25
8
9
(107)
(53.40)
53
56
BASE
FRAME
103 BASE FRAME

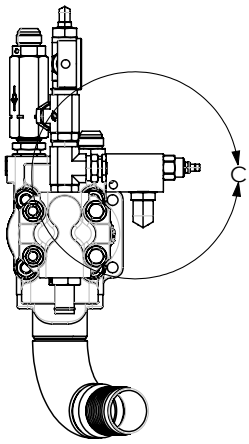


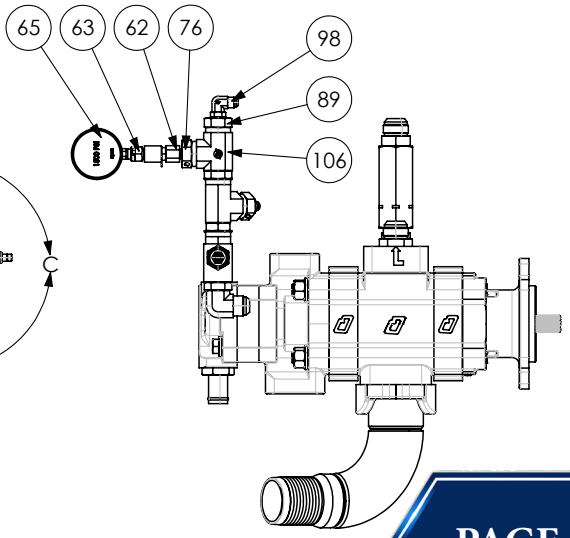
DETAIL C
RELIEF VALVE
SCALE 1 : 4

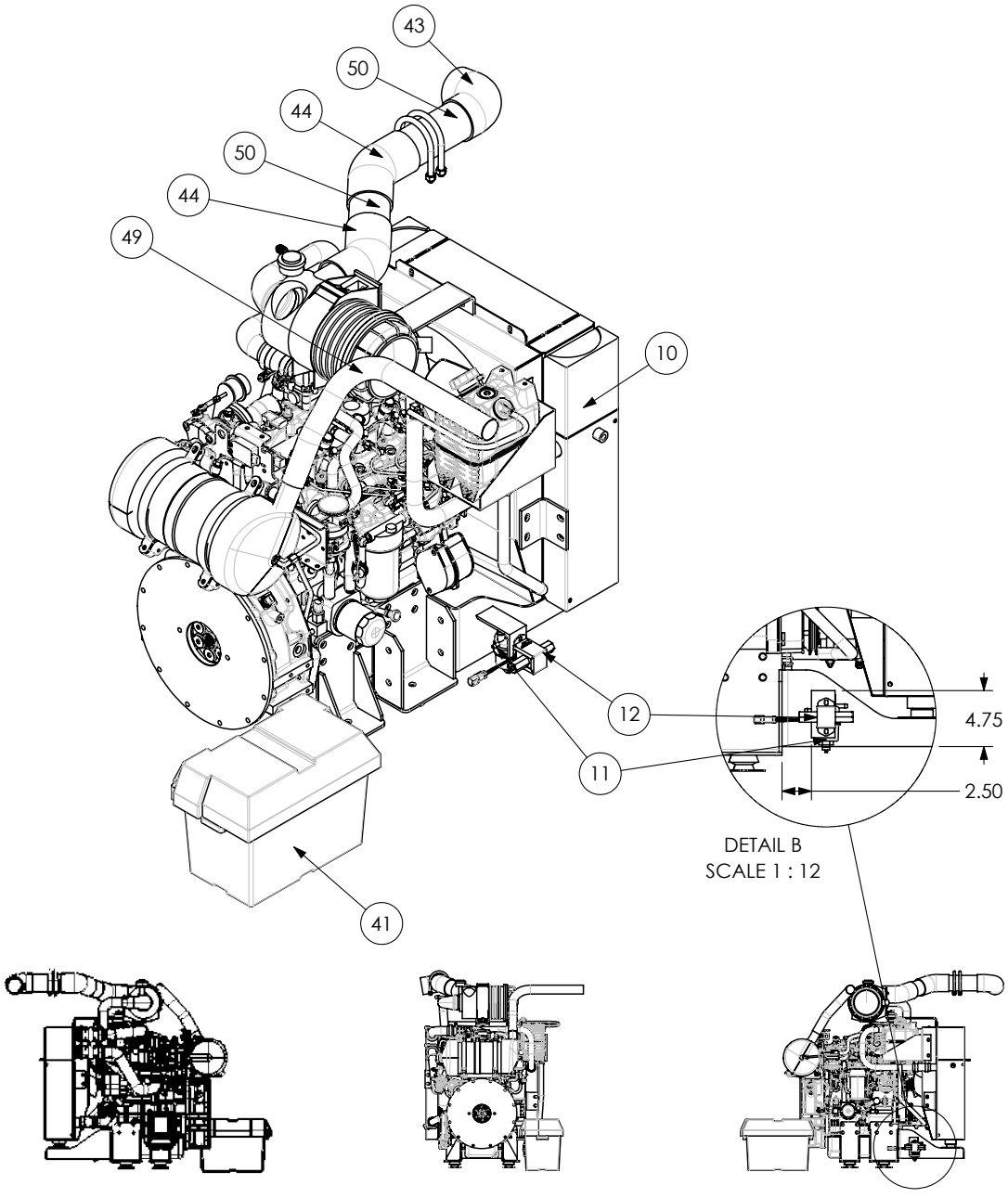











43
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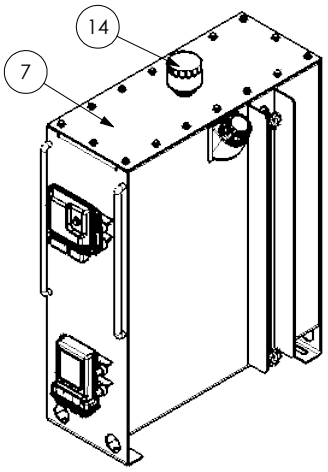
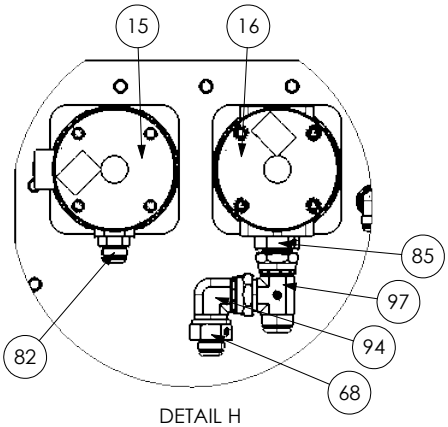
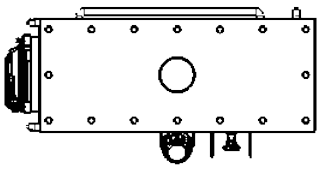
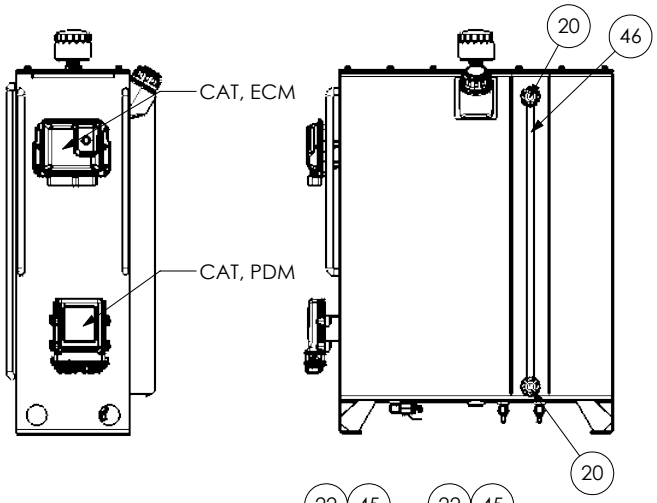
4.75
2.50
DETAIL B
SCALE 1 : 12

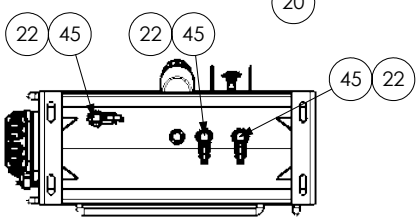


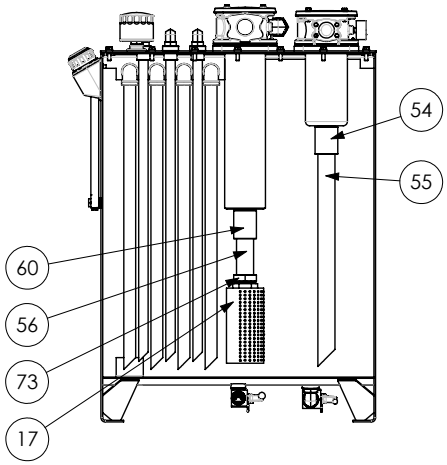


DETAIL H
SCALE 1 : 8

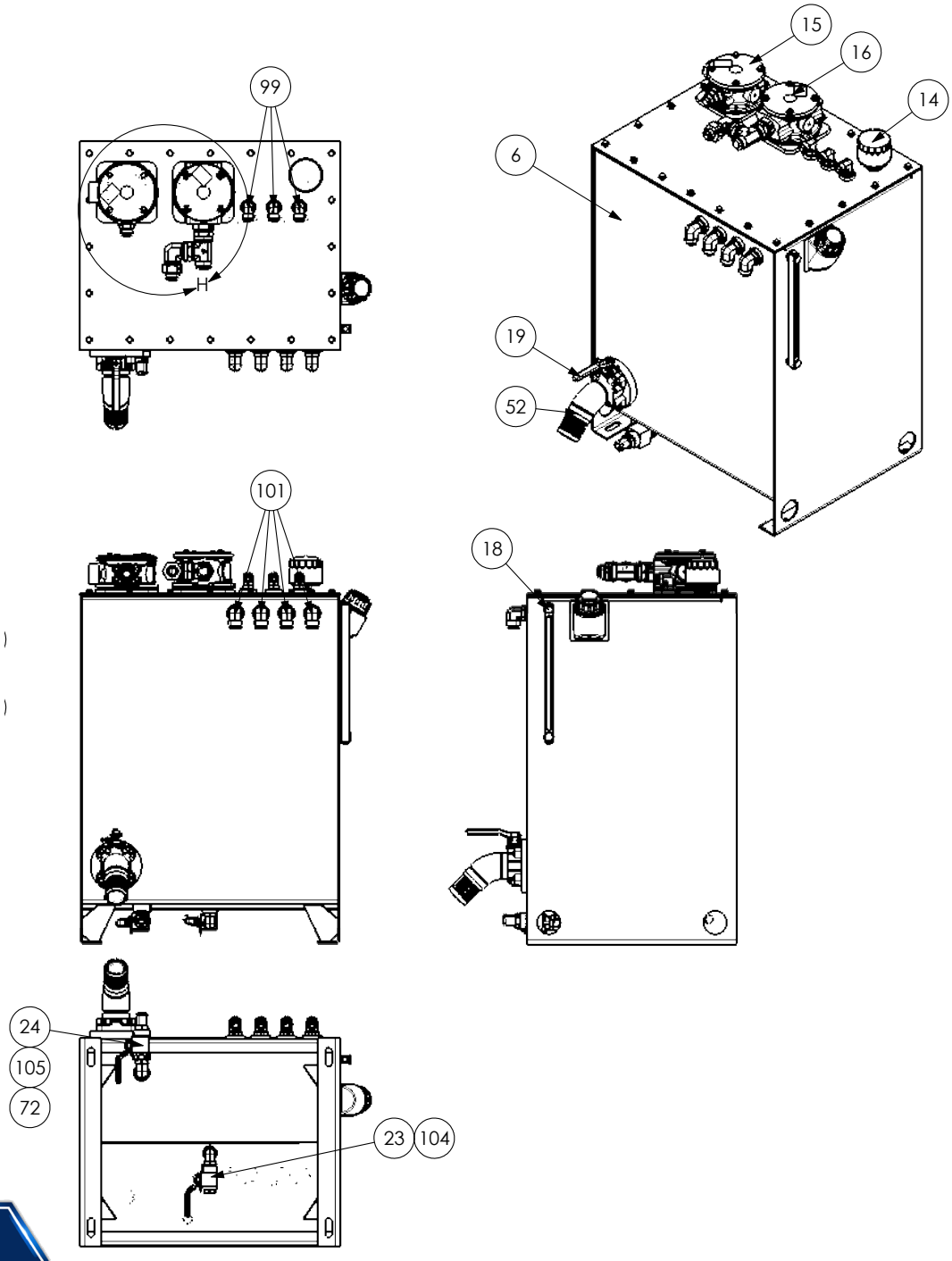








REAR
BELLY REMOVED
FROM VIEW


99
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15
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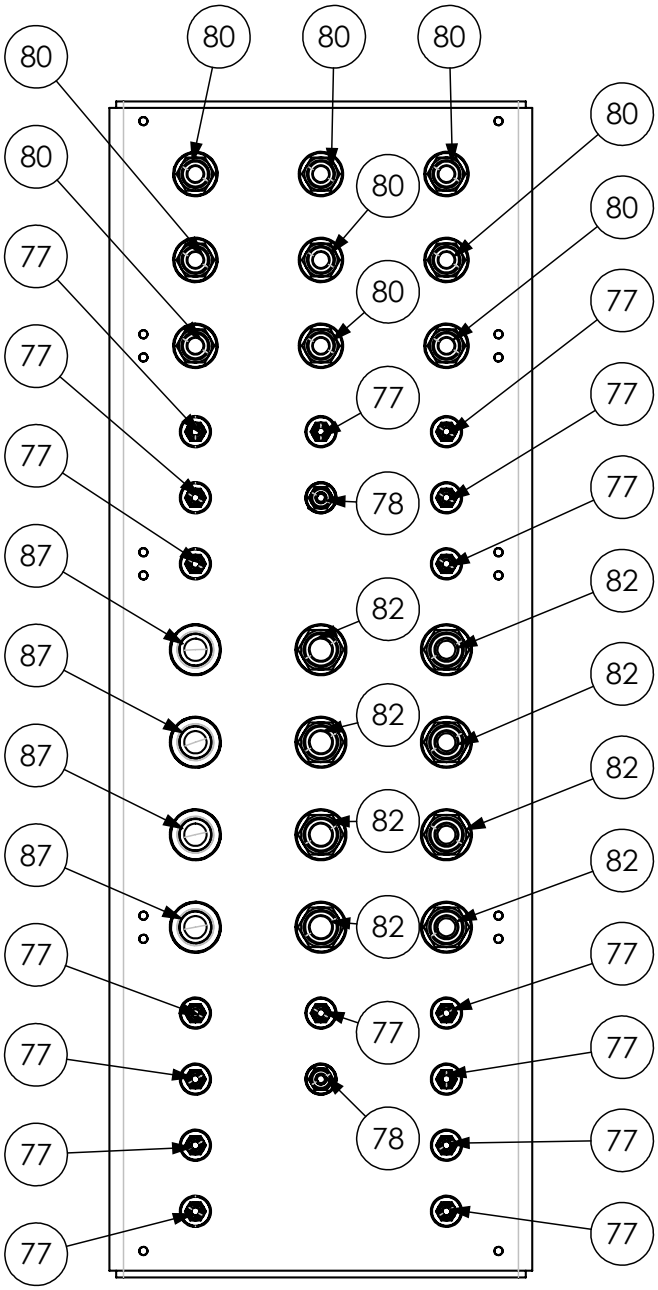
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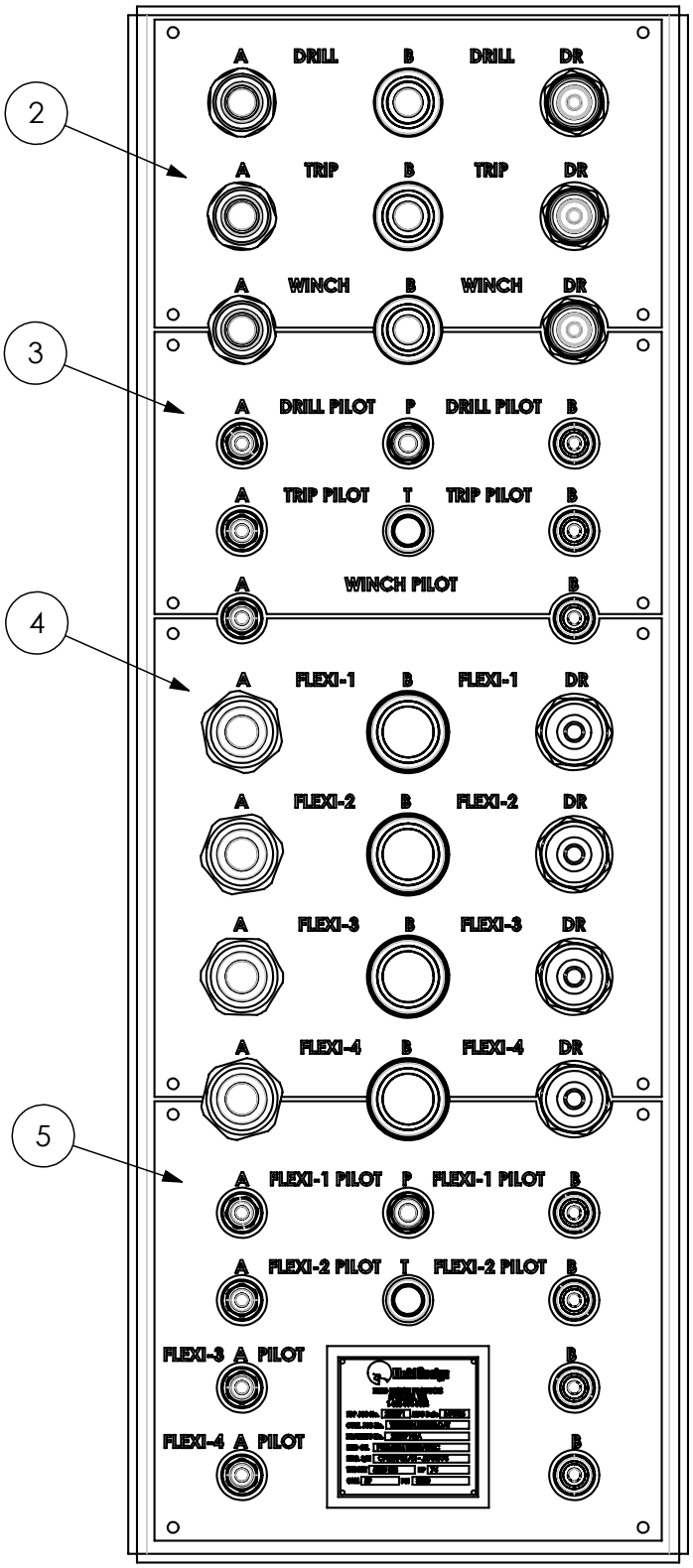
REAR


2
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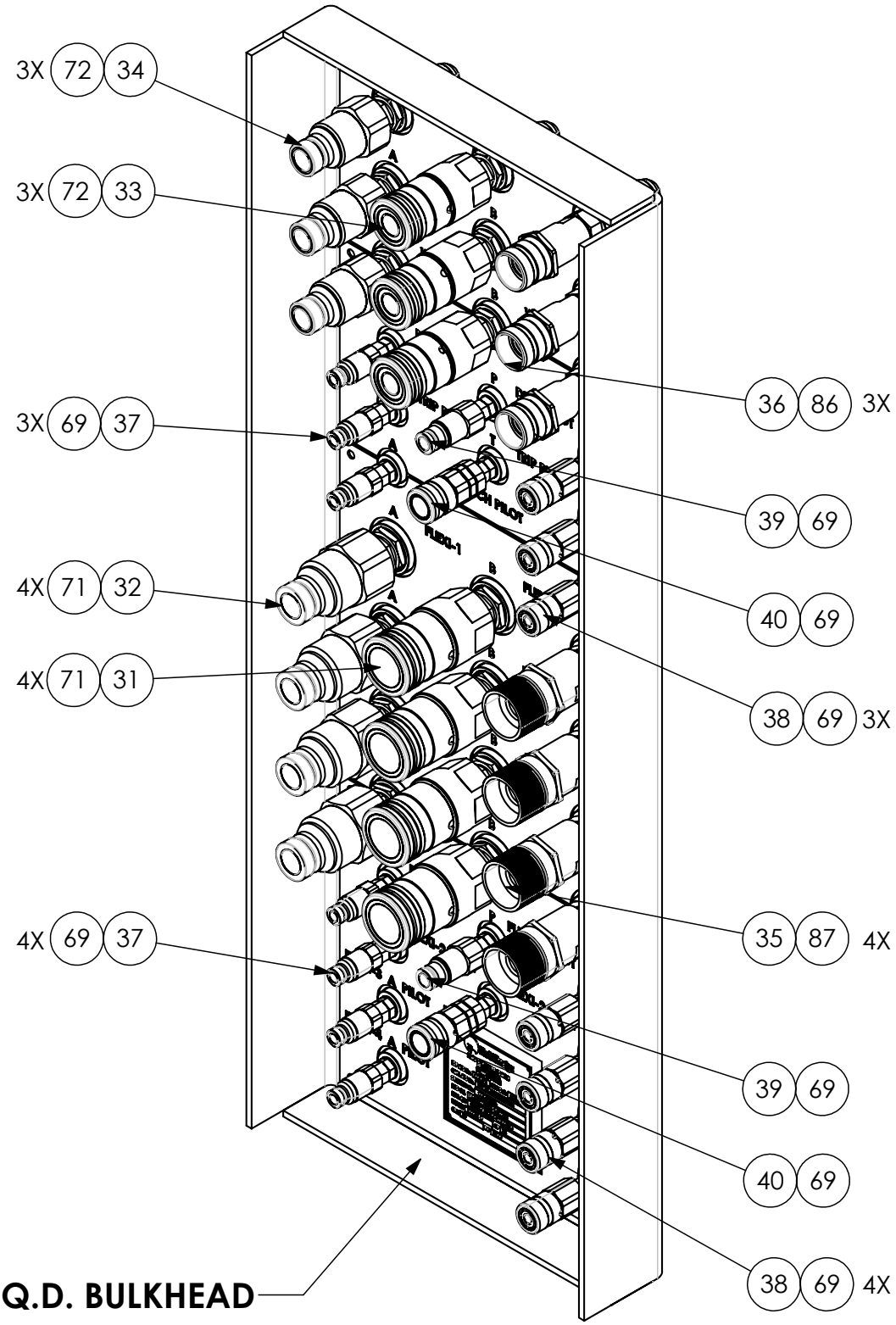
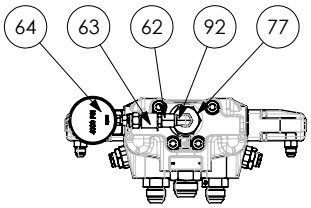
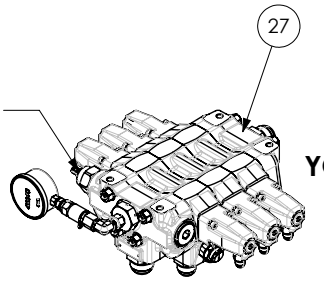
4
5
A DRILL B DRILL DR
A TRIP B TRIP DR
A WINCH B WINCH DR
A DRILL PILOT P DRILL PILOT B
A TRIP PILOT T TRIP PILOT B
A WINCH PILOT B
A FLEXI-1 B FLEXI-1 DR
A FLEXI-2 B FLEXI-2 DR
A FLEXI-3 B FLEXI-3 DR
A FLEXI-4 B FLEXI-4 DR
A FLEXI-1 PILOT P FLEXI-1 PILOT B
A FLEXI-2 PILOT T FLEXI-2 PILOT B
FLEXI-3 A PILOT
FLEXI-4 A PILOT
B
B

FRONT

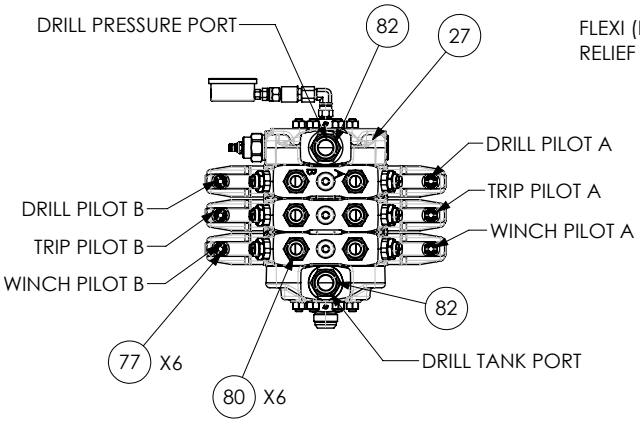

3X 72 34
3X 72 33
3X 69 37
4X 71 32
4X 71 31
4X 69 37
36 86 3X
39 69
40 69
38 69 3X
35 87 4X
39 69
40 69
38 69 4X
Q.D. BULKHEAD



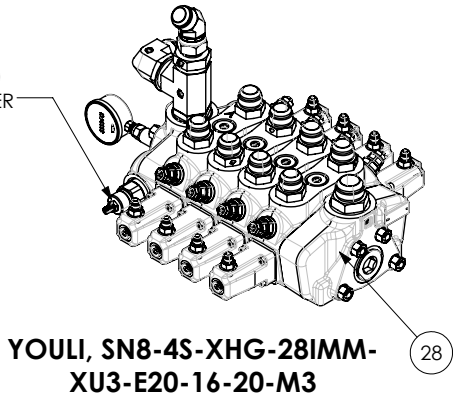
DRILL (HIGH PSI)
RELIEF ADJUSTER



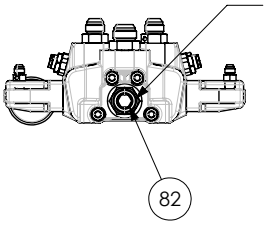
YOULI, SN6-3S-XFG-28IMM-U3-E16-12-16-M3

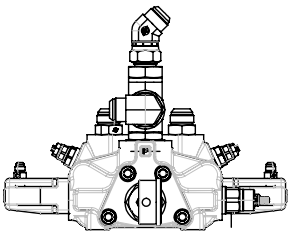


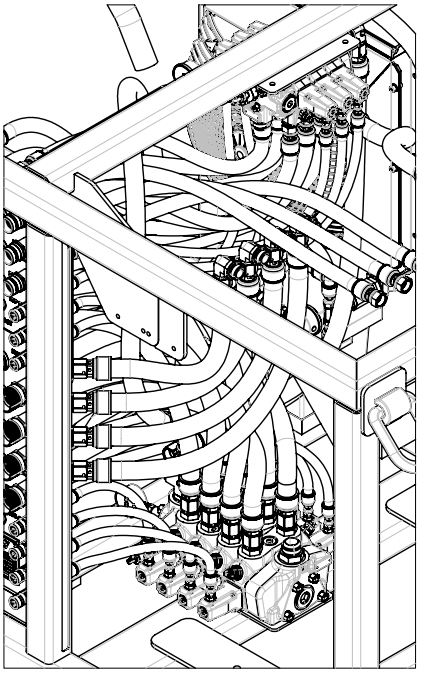
FLEXI (LOW PSI)
RELIEF ADJUSTER

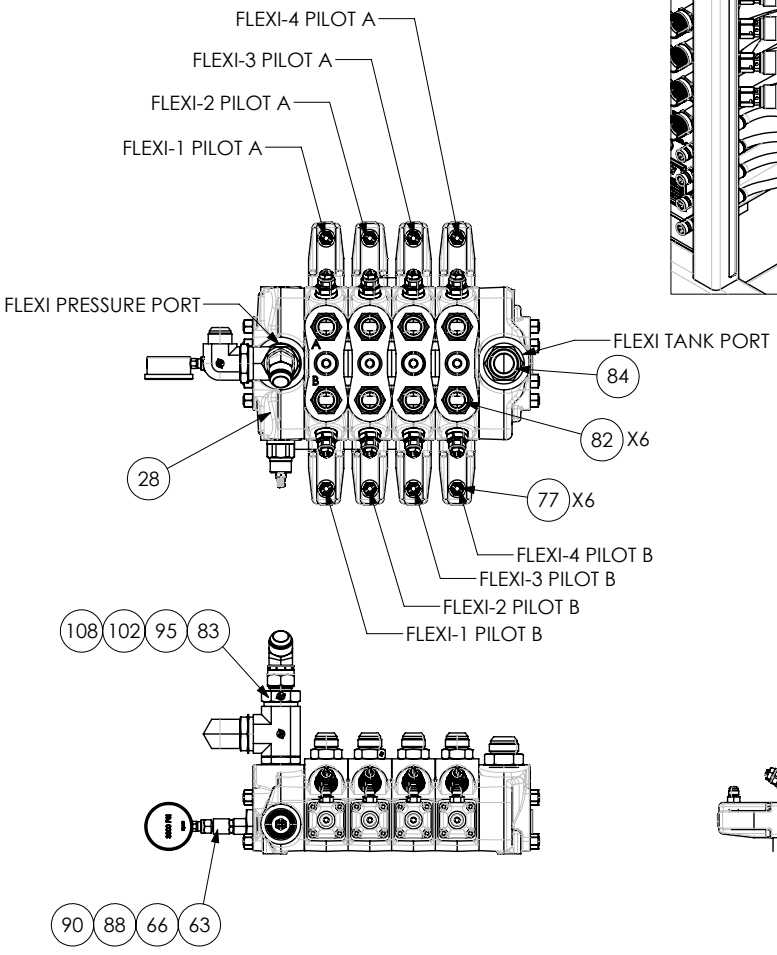


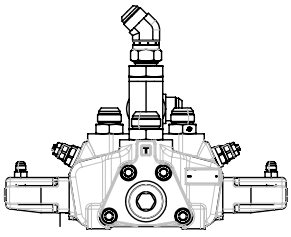
YOULI, SN8-4S-XHG-28IMM-XU3-E20-16-20-M3

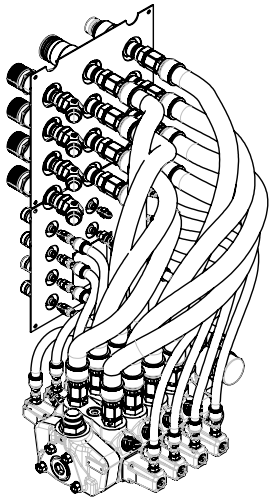


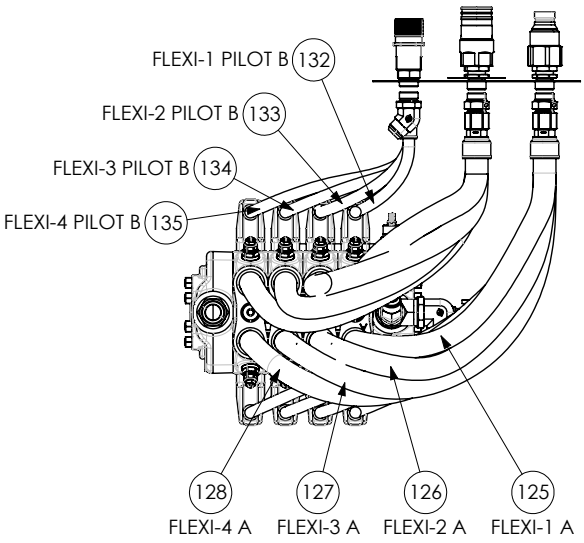


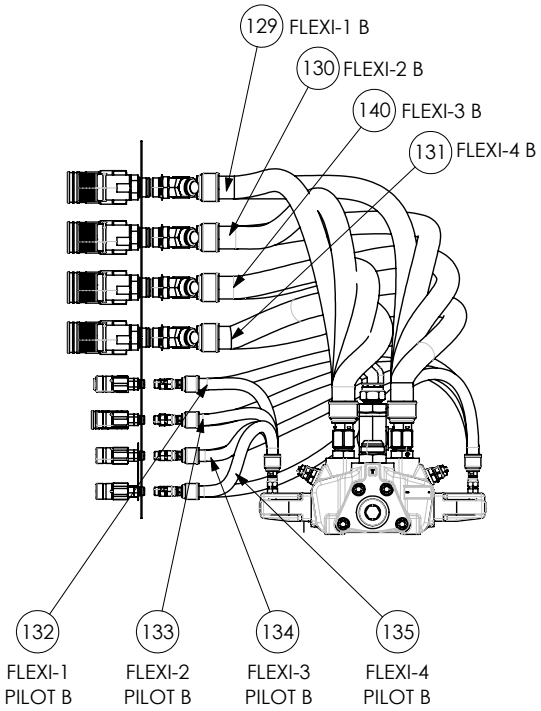


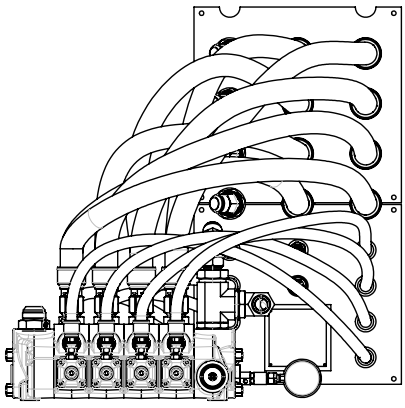

FLEXI-4 PILOT A
FLEXI-3 PILOT A
FLEXI-2 PILOT A
FLEXI-1 PILOT A
FLEXI PRESSURE PORT
FLEXI TANK PORT
84
82 X6
28
77 X6
FLEXI-4 PILOT B
FLEXI-3 PILOT B
FLEXI-2 PILOT B
FLEXI-1 PILOT B
108 102 95 83
90 88 66 63

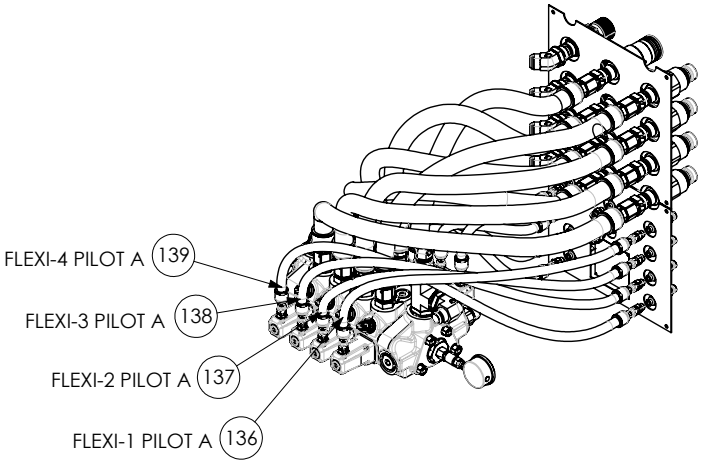


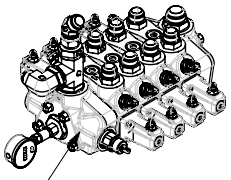



FLEXI-1 PILOT B 132
FLEXI-2 PILOT B 133
FLEXI-3 PILOT B 134
FLEXI-4 PILOT B 135
128 FLEXI-4 A
127 FLEXI-3 A
126 FLEXI-2 A
125 FLEXI-1 A

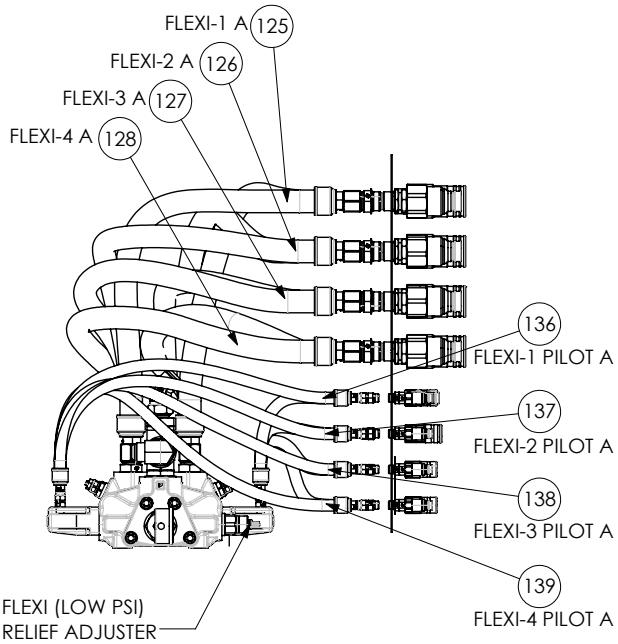

129 FLEXI-1 B
130 FLEXI-2 B
140 FLEXI-3 B
131 FLEXI-4 B
132 FLEXI-1 PILOT B
133 FLEXI-2 PILOT B
134 FLEXI-3 PILOT B
135 FLEXI-4 PILOT B

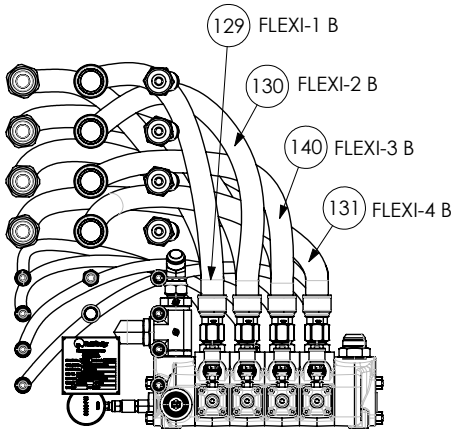




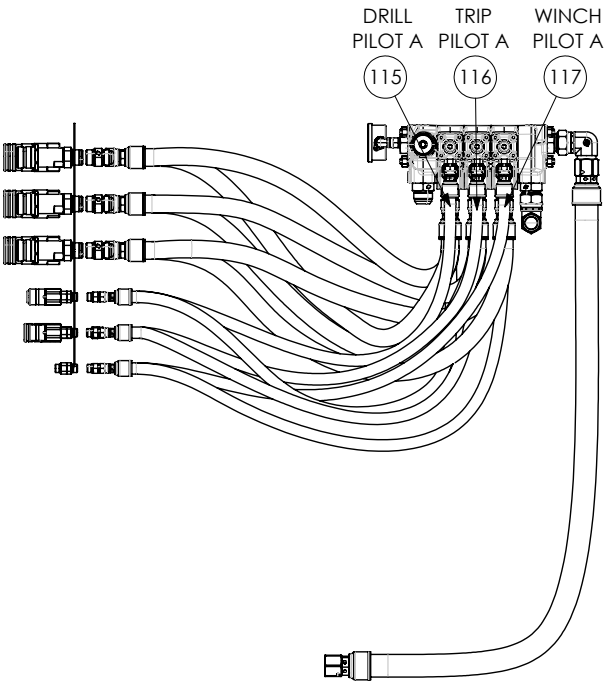


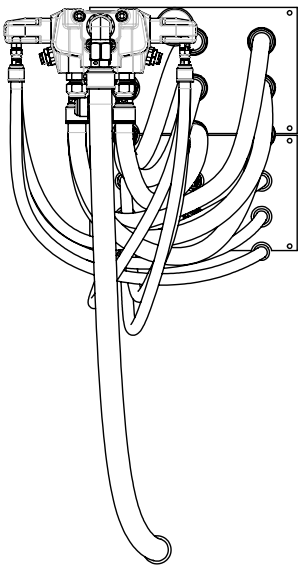
28 **YOULI, SN8-4S FLEXI VALVE**

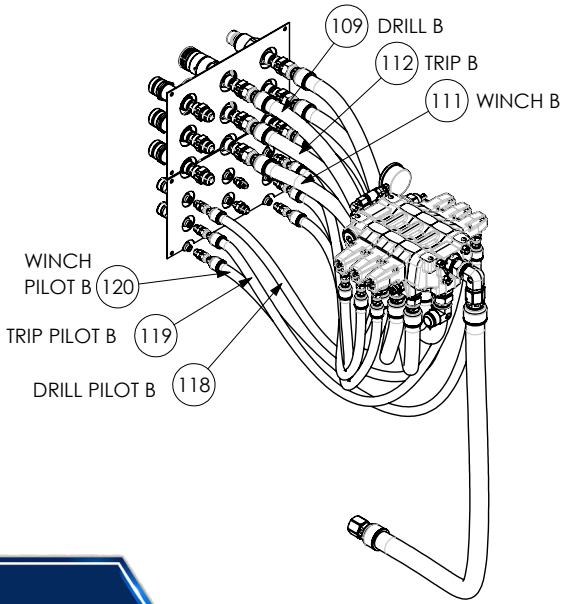


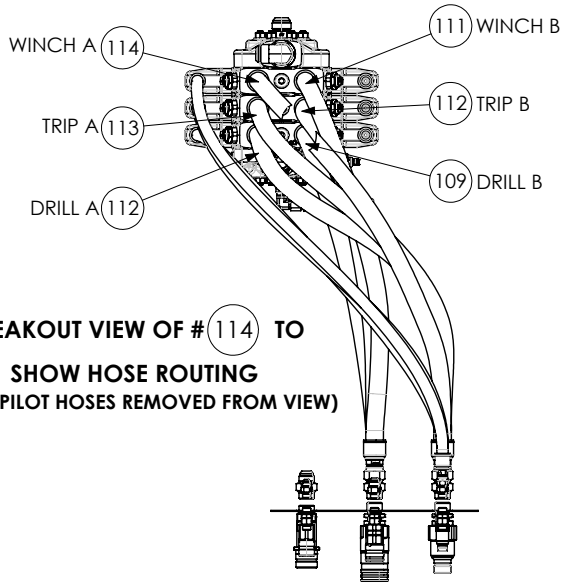


BULKHEAD PANEL REMOVED TO SEE HOSE ROUTING

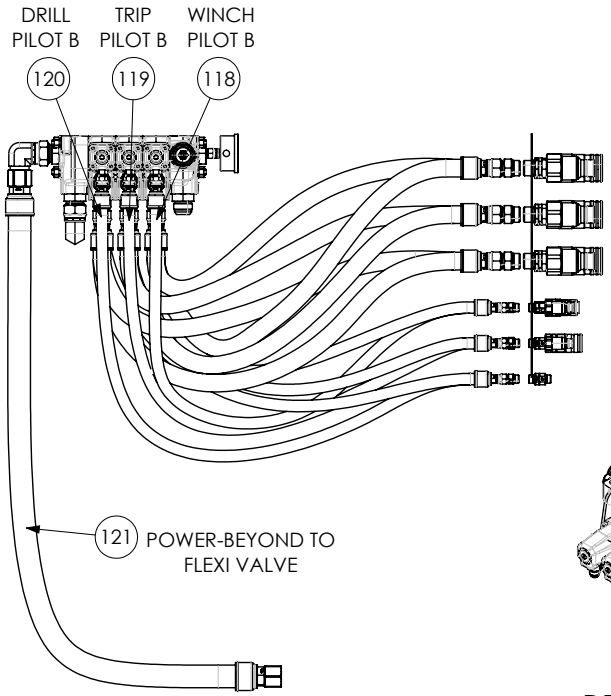


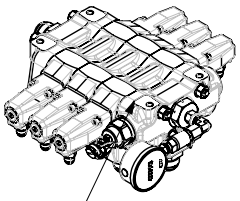




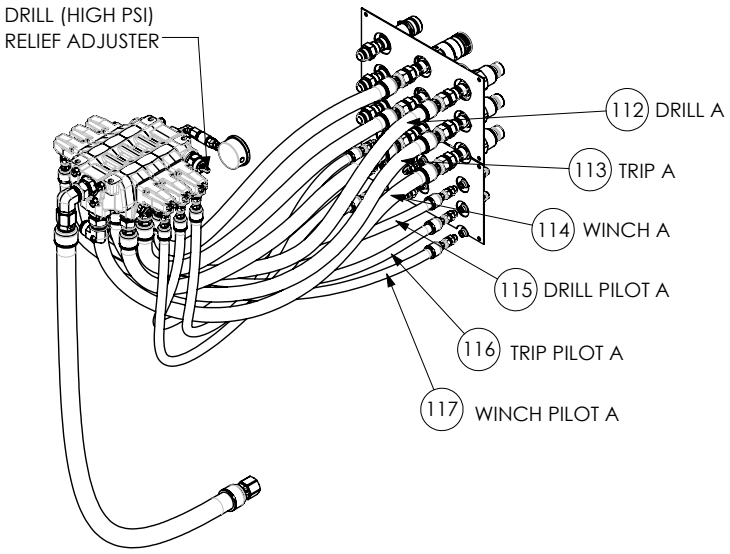


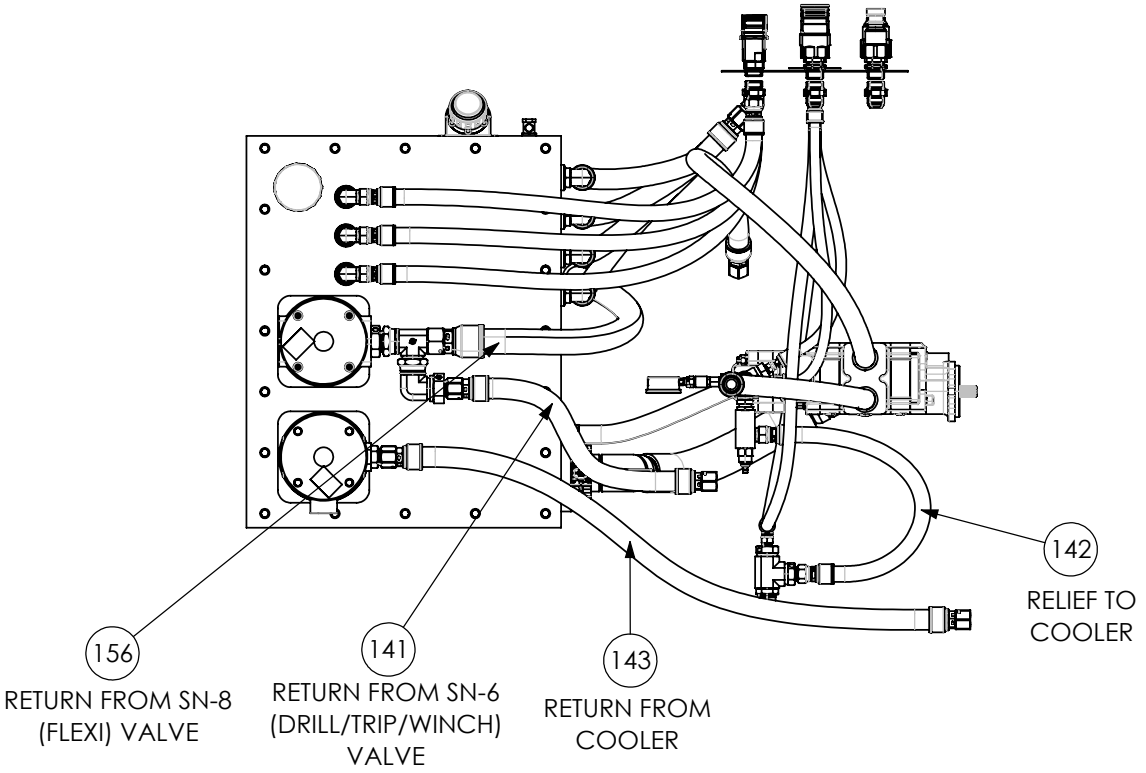
BREAKOUT VIEW OF # 114 TO SHOW HOSE ROUTING
(SOME PILOT HOSES REMOVED FROM VIEW)

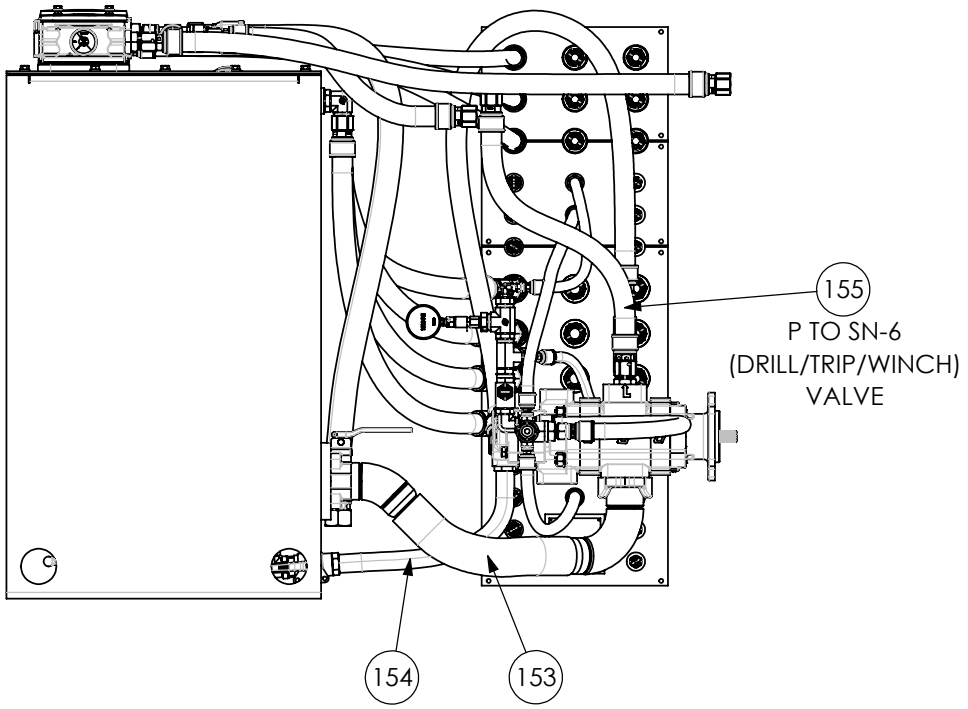


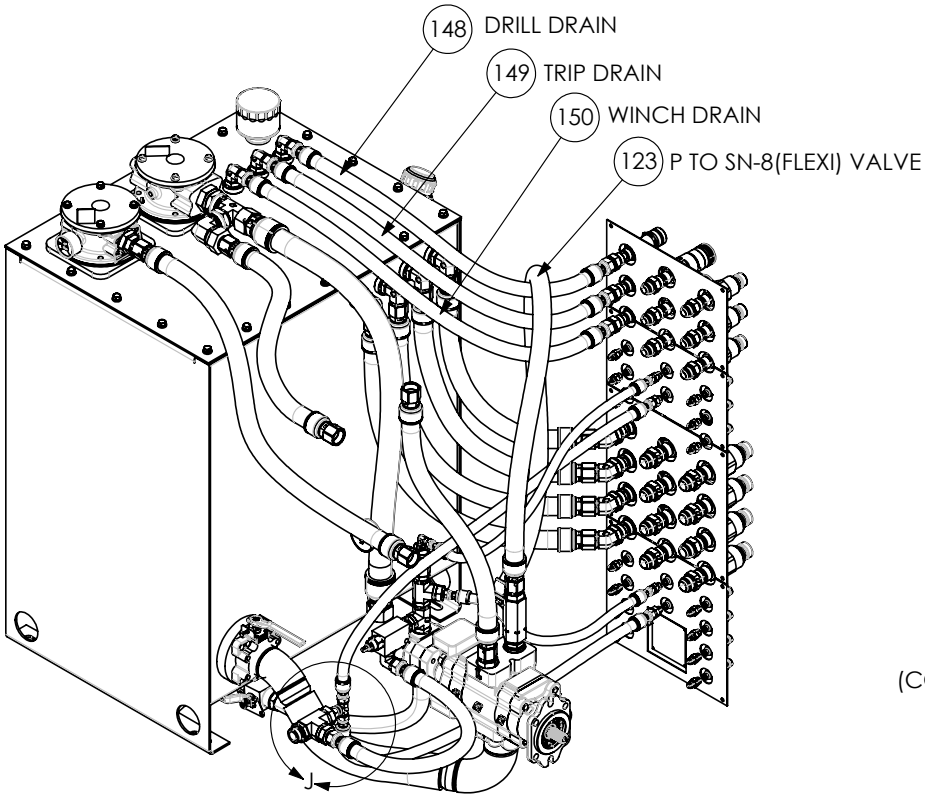


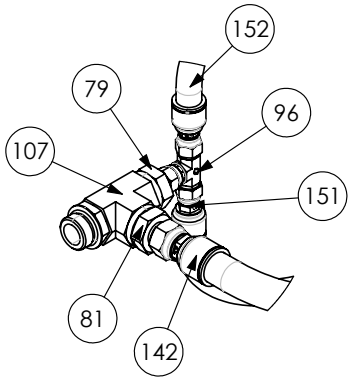
27 **YOULI, SN6**
DRILL, TRIP & WINCH VALVE



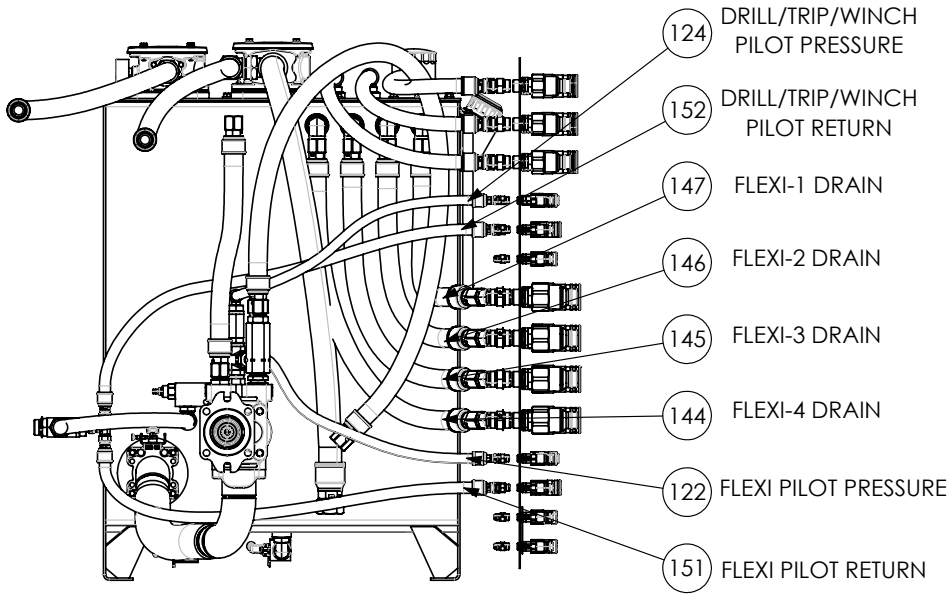

156
RETURN FROM SN-8 (FLEXI) VALVE
141
RETURN FROM SN-6 (DRILL/TRIP/WINCH) VALVE
143
RETURN FROM COOLER
142
RELIEF TO COOLER


155
P TO SN-6 (DRILL/TRIP/WINCH) VALVE
154
153





DETAIL J
RETURN TO COOLER FITTINGS
(COOLER REMOVED FROM VIEWS)
SCALE 1 : 6



Detailed Parts List

ITEM	DESCRIPTION	PART NUMBER	QTY
1	Skid Assembly	225071-1	1
2	Nameplate, Drill Main	225071-31	1
3	Nameplate, Drill Pilot	225071-32	1
4	Nameplate, Flexi Main	225071-33	1
5	Nameplate, Flexi Pilot	225071-34	1
6	Reservoir, Carbon Steel, 100 Gallon	225071-2	1
7	Filter Assembly, 50 Gallon	225071-3	1
8	Pilot Valve Stand	225071-4	1
9	Pilot Valve Stand	225071-5	1
10	Diesel Engine, 274HP, 2800 RPM	CAT C2.2 74HP	1
11	Filter, GP-Fuel	CAT 276-1804	1
12	Water Separator, Fuel Pump	CAT 495-0714	1
13	Pump, Gear, Triple (2x 2.6 CID, 1x 0.9 CID)	PERMCO PB25VB390SPLZA10-14YKCZA101-P1241EVAZ07	1
14	Breather, 3 Micron, 3/4" NPT	SCHROEDER ABF3-10-MP12	2
15	Filter Assy (1), Element 10µ, 24 ORB Inlet, 25 PSI Bypass	SCHROEDER RT1K210S24S24NY2	1
16	Filter Assy (2), Element 10µ, 24 ORB Inlet, 25 PSI Bypass	SCHROEDER RT2K210S24S24NY2	1
17	NPT Tank Diffuser (TD-127)	BEHRINGER TD-127	1
18	Sight Gauge, 15"	LDI G-605-15-A-1	1
19	Thermometer	ASA SDA0063	1
20	Truck Valve, Brass, 3/8" NPT x 3/8" HB	MIDLAND 4650	2
21	Check Valve, Brass, PSI Cracking	DNP CV16-SAE-7	2
22	Ball Valve, Brass, 3/8" NPT x 3/8" HB	MIDLAND 46988	3
23	Ball Valve, Aluminum, 1/2" ORB Locking Handle	DMIC BVAL-0750S-4321-AZZN	1
25	Ball Valve, Aluminum, #16 ORB Locking Handle	DMIC BVAL-1000S-4321-AZZN	1
25	Remote Control / Joystick Control Valve (3 Bank)	YOULI JHP-1-3S-E4-B-A03B-9-1-A03B	1
26	Directional Valve, 4 Section, JHP-1, 4W/3P Open Center, Spring Centered, SAE Ports	YOULI JHP-1 / 4S-E4 / 8-A03B / 8-A03B / 8-A03B / 8-A03B	1
27	Directional Control Valve, 3 Section, Float Center, 37 GPM, 4600 PSI	YOULI JN6-3S-XFG-28IMM-U3-E16-12-16-M3	1
28	Directional Control Valve, SN8, 360-4600 PSI Relief, 4 Section, 4W/3P Open Center, HVI Pilot Operated, SAE Ports	YOULI SN-8 / 4S-XHG / 28IMM/XU3 / 28IMM/XU3 / 28IMM/XU3 / 28IMM/XU3 / E16-E20 / M3	1
29	Anti-Vibration Mount, 1/4-20 Stud, 3/4" High, 50LBS	MCMASTER 9376K29	4
30	Anti-Vibration Rubber Mount (DM 0)	AV Products DM 0	4
31	Quick Disconnect Coupler, F, A21, 1" x SAE	STUCCHI 801304038	4
32	Quick Disconnect Nipple, M, A21, 1" x SAE	STUCCHI 801304039	4
33	Quick Disconnect Coupler, F, A17D, 3/4" x 3/4 SAE	STUCCHI 801304028	3
34	Quick Disconnect Nipple, M, A17, 3/4" x 3/4 SAE	STUCCHI 801304029	3
35	Quick Disconnect Nipple, N51WS-16-16NPT	STUCCHI 10061016	4
36	Quick Disconnect Nipple, N51WS-12-12NPT	STUCCHI 10061012	3
37	Quick Disconnect Nipple, M, A7, 1/4" x 3/8 SAE	STUCCHI 801304017	7
38	Quick Disconnect Coupler, F, A7, 1/4" x 3/8 SAE	STUCCHI 801304004	7
39	Quick Disconnect Nipple, M, A7, 3/8" x 3/8 SAE	STUCCHI 801304005	2
40	Quick Disconnect Coupler, F, A7, 3/8" x 3/8 SAE	STUCCHI 801304006	2
41	Battery Box, NOCO, HM327	NOCO HM327BK	1
42	U-Bolt, 3in Pipe, Steel, Zinc Coating, 1/2-13	MCMASTER 3043740	2
43	Intake Elbow, Silicone, Black, 3.5in X 90 Degree	SILICONE INTAKE, SIL000416	1
44	Intake Elbow, Silicone, Black, 3.5in X 45 Degree	SILICONE INTAKE, SIL000408	2
45	3/8" Brass Street Elbow 90°	MIDLAND 28158	3

Detailed Parts List

ITEM	DESCRIPTION	PART NUMBER	QTY
46	3/8" Vinyl Flex Vacuum Tubing	—	1
47	Inline 90° Valve Body, Aluminum, T-3A Cavity, -12 SAE Ports	SUN	1
48	Valve, Cartridge, Relief, 50 GPM, 5000 PSI, T-3A Cavity	SUN RPGC-LAN	1
49	2" Exhaust Pipe Section	225071-Exhaust Pipe	1
50	3/8" OD Polyurethane Air Tube	224071-Intake Air	2
51	#16 SAE Asst Adapter	—	2
52	#40 Flare x 2-1/2" HB 45°	—	1
53	#40 Flare x 2-1/2" HB 90°	—	1
54	1-1/2" NPT x SW 3000# Coupling	—	1
55	1-1/2" SCH40 x 24" Pipe x 45°	—	1
56	1-1/2" SCH40 Pipe x 6" TBE	—	1
57	Oil/Air Cooler, 24V DC, 26 Bar, Aluminum	ASA ASATT25RD02	1
58	ASA Rail Connector, UN 15/16", G-1/2 90° Port	ASA LLZSET5U1600	1
59	Temperature Switch, 50°C / 122°F, Deutsch DT06-2S Connector	ASA LLZTH4767	1
60	1-1/2" NPT 3000# Coupling	—	1
61	Test Coupling, Type E, 9/16-18 UNF	STAUFF SMK20-9/16VEC6F	2
62	Test Fitting, M16 Male x 06J	STAUFF SMK20-JIC3/8VK-C6F	1
63	Test Fitting, M16 Female x 04FB (SMD20-7/16UNF-PC6F)	STAUFF SMD20-7/16UNF-PC6F	3
64	Gauge, Pressure, 2.5in, 0-4000 PSI, 1/4" M ORB	STAUFF SPG-063-04000-5-S-N04	1
65	Gauge, Pressure, 1.5in, 0-300 PSI, 1/4" ORB Male	STAUFF SPG-063-01500-5-S-U04	1
66	Gauge, 3000 PSI, -40 ORB Male, PSI/Bar, Stem Mount	STAUFF SPG-063-03000-5-S-U04	1
67	Fitting, Split Flange Kit, -40 Code 61 (Flange), 20–15mm Straight Reducer	FDEL SF40-K61	1
68	15mm Straight Reducer (IPC/RIGID)	BRENNAN 2406-20-16	1

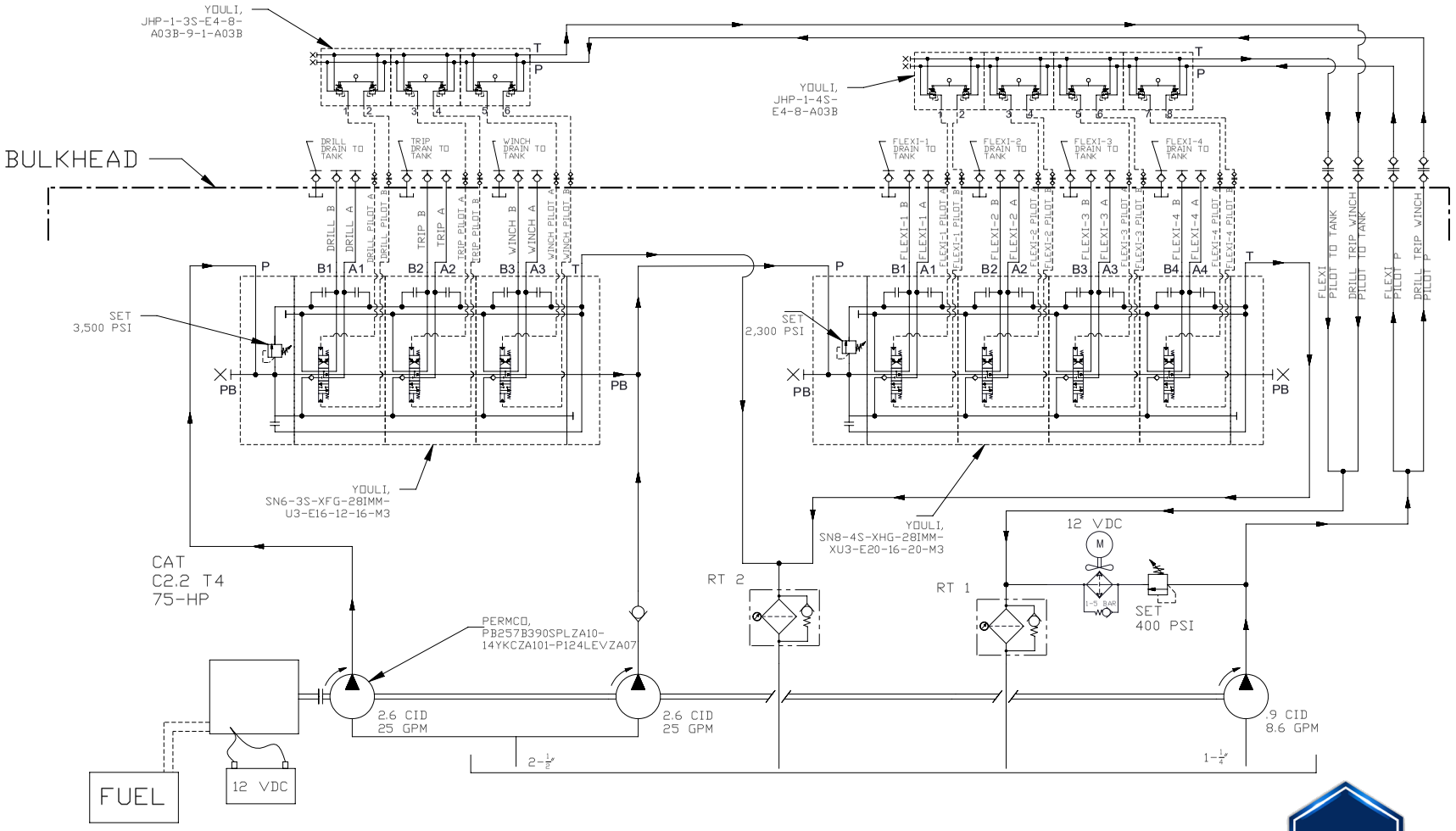
Detailed Parts List

ITEM	DESCRIPTION	PART NUMBER	QTY
69	Fitting, -6ORBMX-6ORBMB	BRENNAN, 3474-06-06-NWO	18
70	Fitting, -12ORBMX-12ORBM	BRENNAN, 3474-12-12-NWO	7
71	Fitting, 16 MORB x 16 MORB	BRENNAN, 3474-16-16-NWO	9
72	Fitting, -16 BARBX-16 ORBM	BRENNAN, 4604-16-16	2
73	Fitting, Reducer, 32MP x 24FP	BRENNAN, 6400-32-24	1
74	Fitting, 04 MJIC x 04 MORB	BRENNAN, 6400-04-04	18
75	Fitting, -6MJ x -6MB	BRENNAN, 6400-06-06-O	30
76	Fitting, -06MJIC x -12MORB	BRENNAN, 6400-06-12-O	7
77	Fitting, -06MJ-16MORB Straight	BRENNAN, 6400-06-16-O	1
78	Fitting, 08MJ x 06MAORB Straight	BRENNAN, 6400-08-06-O	2
79	Fitting, 08MJ-16MORB Straight	BRENNAN, 6400-08-16-O	1
80	Fitting, Straight -12MB-12MJ	BRENNAN, 6400-12-12-O	15
81	Fitting, 16MB x 12 MORB Straight	BRENNAN, 6400-12-16-O	6
82	Fitting, -16MORB x -16MJIC	BRENNAN, 6400-16-16-O	22
83	Fitting, -16 JICM x -20 ORBM	BRENNAN, 6400-16-20	1
84	Fitting, Straight, 20MB x 20MJ (6400-20-20)	BRENNAN, 6400-20-20-O	27
86	Fitting, -20MJ x 24MB	BRENNAN, 6400-20-24	1
86	Fitting, -12 NPTM x -12 ORBM	BRENNAN, 6401-12-12-O	3
87	Fitting, 16MB x 16MP	BRENNAN, 6401-16-16-O	4
88	Fitting, Blanking -8 MORB x -6 FORB	BRENNAN, 6410-08-06-O	1
89	Fitting, -12MORB-06FORB Straight Reducer	BRENNAN, 6410-12-06-O	1
90	Fitting, Bushing, 20MB x 08FB (6410-20-08-FG)	BRENNAN, 6410-20-08	1
91	Fitting, Reducer, 24MB x 16FB	BRENNAN, 6410-24-16-O	1
92	Fitting, Elbow, -6JICx-6JICx 90	BRENNAN, 6500-06-06-FG	1
93	Fitting, Elbow, -16MJ x -16Jx 90	BRENNAN, 6500-16-16-FG	2
94	Fitting, Elbow, -20MJIC x -20FJICX (6500-20-20-FG)	BRENNAN, 6500-20-20-FG	1
95	Fitting, Elbow, 16MJ x 16FJX 45	BRENNAN, 6502-16-16-FG	1
96	Fitting, 08MJ-08MJ 45 DEG	BRENNAN, 6502-08-08-FG	1
97	Fitting, 20MJ-20FJ 45	BRENNAN, 6502-20-20-FG	1
98	Fitting, Elbow, -6MORB x -6MJIC, 90 (6801-06-06)	BRENNAN, 6801-06-06-NWO-FG	1
99	Fitting, Elbow, -12ORBM x -12JICM, 90	BRENNAN, 6801-12-12-NWO-FG	4
100	Fitting, Elbow, -16ORBM x -12JICM, 90	BRENNAN, 6801-12-16-NWO-FG	1
101	Fitting, Elbow, -16MJIC x -16 MORB (6801-16-16)	BRENNAN, 6801-16-16-NWO-FG	5
102	Fitting, Elbow, 16MJ x 20MB, 90	BRENNAN, 6801-16-20	1
103	Fitting, Elbow, -16ORBM x -16JICM, 45	BRENNAN, 6802-16-16-NWO-FG	4
104	Fitting, Elbow 12 ORBM x 12 ORBM, 90	BRENNAN, 6807-12-12-NWO-FG	1
105	Fitting, Elbow 16MB x 16MB 90 (6807-16-16)	BRENNAN, 6807-16-16	1
106	Fitting, Tee, 12MB x 12FB x 12FB (6835-12-12-12)	BRENNAN, 6835-12-12-12-NWO-FG	3
107	Fitting, Tee, 16 MBIRUN x 16 FB x 16 FB	BRENNAN, 6835-16-16-16	1
108	Fitting, Tee, 20MB-20FB-MB on Run (6835-20-20-20-NWO-FG)	BRENNAN, 6835-20-20-20-NWO-FG	1
109	RYCO® T4012D™ 32IN CL™ T2040-1217* T2040-1217	225071-13	1
112	RYCO® T4012D™ 32IN CL™ T2040-1217* T2040-1217	225071-15	1
111	RYCO® T4012D™ 32IN CL™ T2040-1217* T2040-1217	225071-17	1
112	RYCO® T4012D™ 37IN CL™ T2040-1217* T2040-1217	225071-12	1
113	RYCO® T4012D™ 39IN CL™ T2040-1217* T2040-1217	225071-14	1
114	RYCO® T4012D™ 41IN CL™ T2040-1217* T2040-1217	225071-16	1
115	RYCO® T3006D™ 45IN CL™ T2040-0609* T2040-0609	225071-6	1
116	RYCO® T3006D™ 46IN CL™ T2040-0609* T2040-0609	225071-8	1
117	RYCO® T3006D™ 47IN CL™ T2040-0609* T2040-0609	225071-10	1
118	RYCO® T3006D™ 42IN CL™ T2040-0609* T2040-0609	225071-7	1
119	RYCO® T3006D™ 43IN CL™ T2040-0609* T2040-0609	225071-9	1
120	RYCO® T3006D™ 47IN CL™ T2040-0609* T2040-0609	225071-11	1
121	RYCO® T3016D™ 44IN CL™ T2040-1621* T2040-1621	225071-18	1
122	RYCO® T3006D™ 25IN CL™ T2040-0609* T2040-0609	225071-19	1
123	RYCO® T4016D™ 66IN CL™ T2040-1621* T2040-1621	225071-38	1
124	RYCO® T3006D™ 29IN CL™ T2040-0609* T2040-0609	225071-39	1

Detailed Parts List

ITEM	DESCRIPTION	PART NUMBER	QTY
125	RYCO® T3016D* 35IN CL* T2040-1621* T2040-1621	225071-30	1
126	RYCO® T3016D* 29IN CL* T2040-1621* T2040-1621	225071-32	1
127	RYCO® T3016D* 35IN CL* T2040-1621* T2040-1621	225071-34	1
128	RYCO® T3016D* 35IN CL* T2040-1621* T2040-1621	225071-36	1
129	RYCO® T3016D* 29IN CL* T2040-1621* T2040-1621	225071-31	1
130	RYCO® T3016D* 29IN CL* T2040-1621* T2040-1621	225071-33	1
131	RYCO® T3016D* 29IN CL* T2040-1621* T2040-1621	225071-37	1
132	RYCO® T3006D* 13IN CL* T2040-0609* T2040-0609	225071-23	1
133	RYCO® T3006D* 14IN CL* T2040-0609* T2040-0609	225071-25	1
134	RYCO® T3006D* 16IN CL* T2040-0609* T2040-0609	225071-27	1
135	RYCO® T3006D* 19IN CL* T2040-0609* T2040-0609	225071-29	1
136	RYCO® T3006D* 32IN CL* T2040-0609* T2040-0609	225071-22	1
137	RYCO® T3006D* 35IN CL* T2040-0609* T2040-0609	225071-24	1
138	RYCO® T3006D* 35IN CL* T2040-0609* T2040-0609	225071-26	1
139	RYCO® T3006D* 37IN CL* T2040-0609* T2040-0609	225071-28	1
140	RYCO® T3016D* 29IN CL* T2040-1621* T2040-1621	225071-35	1
141	RYCO® T1216D* 23IN CL* T2040-1621* T2040-1621	225071-52	1
142	RYCO® T3012D* 25IN CL* T2040-1217* T2040-1217	225071-44	1
143	RYCO® T1216D* 45IN CL* T2040-1621* T2040-1621	225071-47	1
144	RYCO® T1216D* 33IN CL* T2040-1621* T2040-1621	225071-51	1
145	RYCO® T1216D* 28IN CL* T2040-1621* T2040-1621	225071-50	1
146	RYCO® T1216D* 23IN CL* T2040-1621* T2040-1621	225071-49	1
147	RYCO® T1216D* 19IN CL* T2040-1621* T2040-1621	225071-48	1
148	RYCO® T1212D* 34IN CL* T2040-1217* T2040-1217	225071-43	1
149	RYCO® T1212D* 36IN CL* T2040-1217* T2040-1217	225071-45	1
150	RYCO® T1212D* 38IN CL* T2040-1217* T2040-1217	225071-46	1
151	RYCO® T3008D* 36IN CL* T2040-0812* T2040-0812	225071-42	1
152	RYCO® T3008D* 42IN CL* T2040-0812* T2040-0812	225071-41	1
153	SRX-40* 15IN CL* TBC-213 X 4	225071-21	1
154	SRX-16* 18.5IN CL* TBC-150 X 4	225071-20	1
155	RYCO® T4016D* 23IN CL* T2040-1621* T2040-1621	225071-40	1
156	RYCO® T220D* 44IN CL* T7040-2026* T7040-2026	225071-53	1

Hydraulic Schematic



Product Manual

Engine Display and Control
J1939 Engines

Part Number: MVP-62303
Revision: 3.0

P.O. Box 368 • Sharon Center, OH 44274
Phone 330.239.4345 • Fax 330.239.2845 • www.controlsinc.com

TABLE OF CONTENTS

Prior to starting the engine, select the proper throttle control mode and parameters required for application.

CAN Bus Configuration

This module communicates to the engine ECU via the J1939 CAN Bus network. This is a three wire connection to the engine ECU. Engine information and alarm codes are broadcast over the CAN bus from the engine ECU to the controller display. And, the controller communicates throttle commands to the engine ECU over the CAN bus.

To assure proper communications between the engine ECU and the controller, the correct **SOURCE ADDRESS** and **TSC1 ADDRESS** need to be selected in the controller for the particular engine make and model. These settings are available in the **CAN CONFIGURATION MENU**.

Throttle Settings

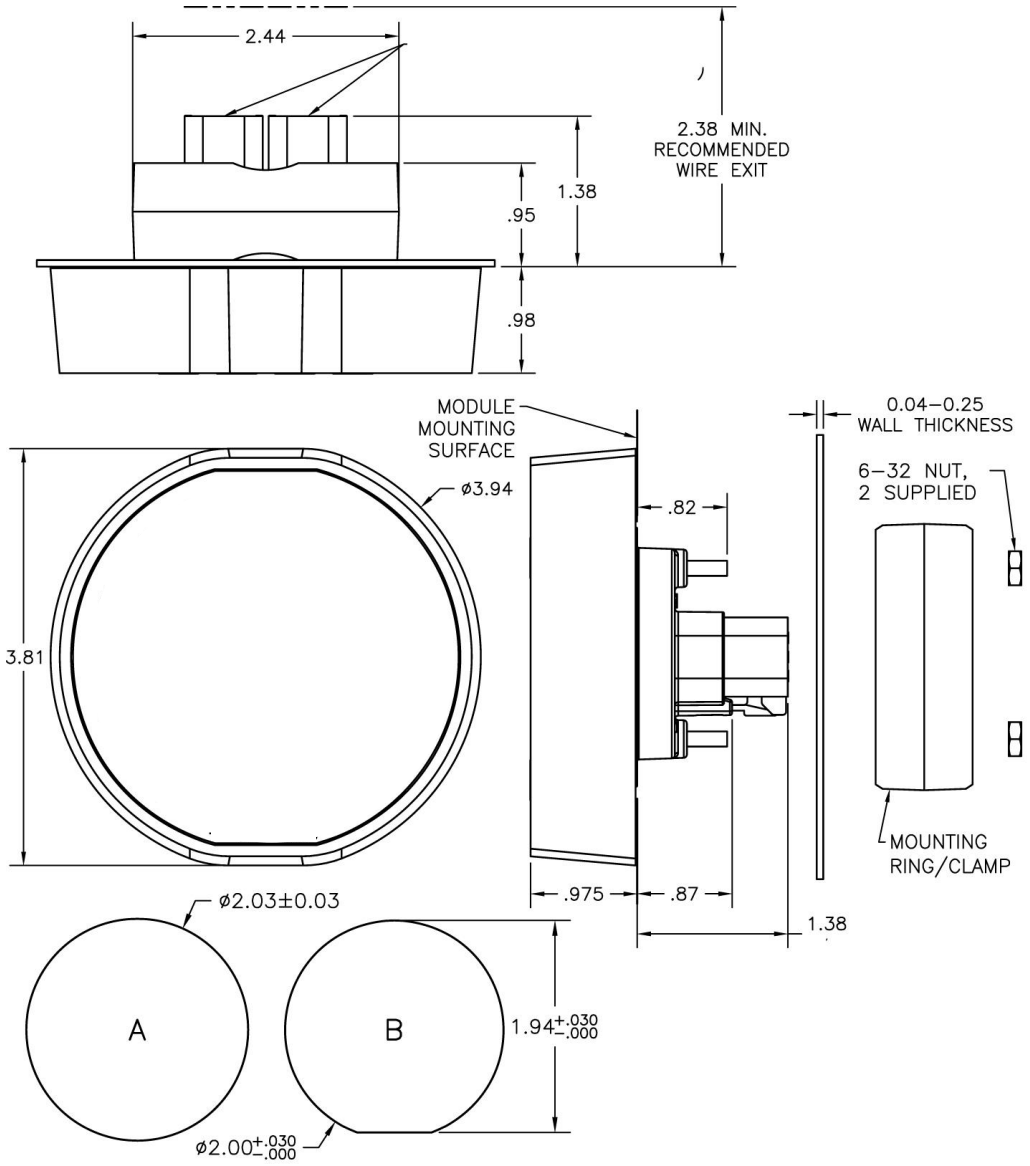
The following **bolded** settings are required for manual (and automatic) operation in the Throttle Configuration menu.

Throttle Configuration	Throttle Type Selection (Default = TSC Multistate)
	E-Throttle Mode (Default = Remote Accelerator Pedal Position)
	Cooperative TSC (Default = Off)
	TSC Minimum Speed
	TSC Maximum Speed
	TSC Ramp Rate
	Throttle Curve Selection
	TSC Multistate Speeds 1-4

Manual Throttle Options

1) **Vernier Throttle**
   Vernier throttle is standard up and down throttle between the minimum and maximum selections. The ramp rate is the rate of acceleration in rpm's per second. The control panel uses J1939 throttle, also called "torque speed control" or TSC1.
2) **Multistate Throttle**
   Multistate throttle provides for one, two, three or four specific operating speeds. Pressing the up and down buttons adjusts engine speed between the selected multistate speed selections.
3) **High/Low**
   Engine accelerates to the Max speed setting with the UP button is pressed. When the UP button is released, the engine goes back to idle speed.

INSTALLATION INFORMATION



MOUNTING HOLE REQUIREMENTS (A OR B)

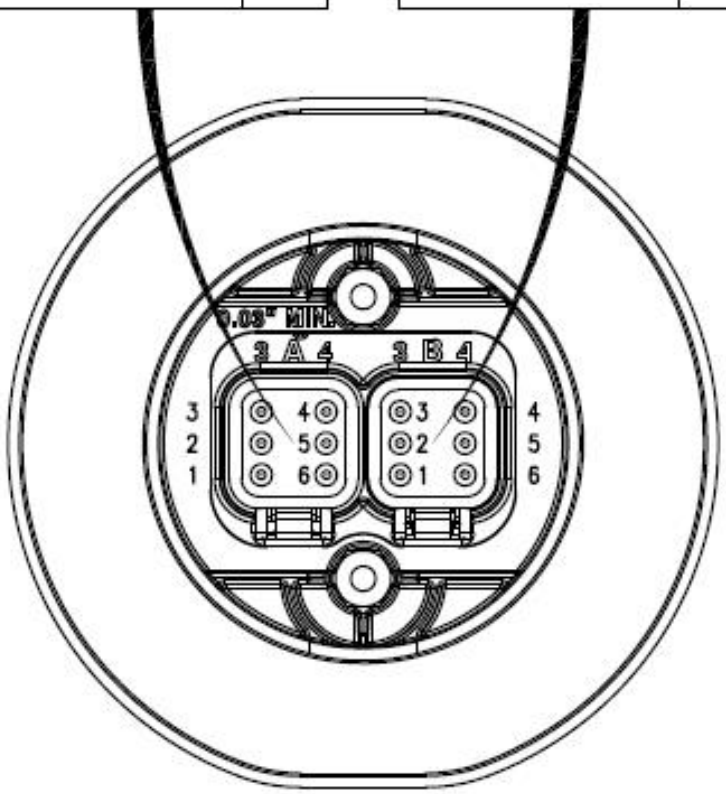
CONNECTOR INFORMATION

CONNECTOR A

FUNCTION	PIN
BATTERY +	1
CAN HIGH	2
CAN LOW	3
N/A	4
FUEL LEVEL INPUT	5
BATTERY -	6

CONNECTOR B

FUNCTION	PIN
EXTERNAL SD	1
FUEL/RUN	2
THROTTLE UP	3
THROTTLE DOWN	4
OUTPUT #2	5
OUTPUT #3	6



PANEL CONNECTOR INFORMATION

21 Pin Connector

Pin	Function
B	Battery Positive
E	Battery Negative
G	Key On Power
D	Crank Signal
V	J1939 High
U	J1939 Low
J	Alternator Excite

4 Pin Connector

Pin	Function
1	External Shutdown
2	Fuel Level Input
3	Output #2
4	Output #3

ENGINE ALARMS, CODES AND MESSAGES

Engine ECU Alarm/De-Rate/Shut Downs

It is important to understand panel operation with respect to engine safety protections, alarms, and fault codes. The panel operates with J1939 engines. These engines have an ECU (engine control unit) which is essentially a computer that runs the engine. When engine parameters are out of normal operating ranges, the ECU takes specific actions which can include the following:

1) Broadcast a trouble code
2) Broadcast a red or yellow lamp
3) De-rate the engine
4) Shut down the engine
5) Turn on alarm horn

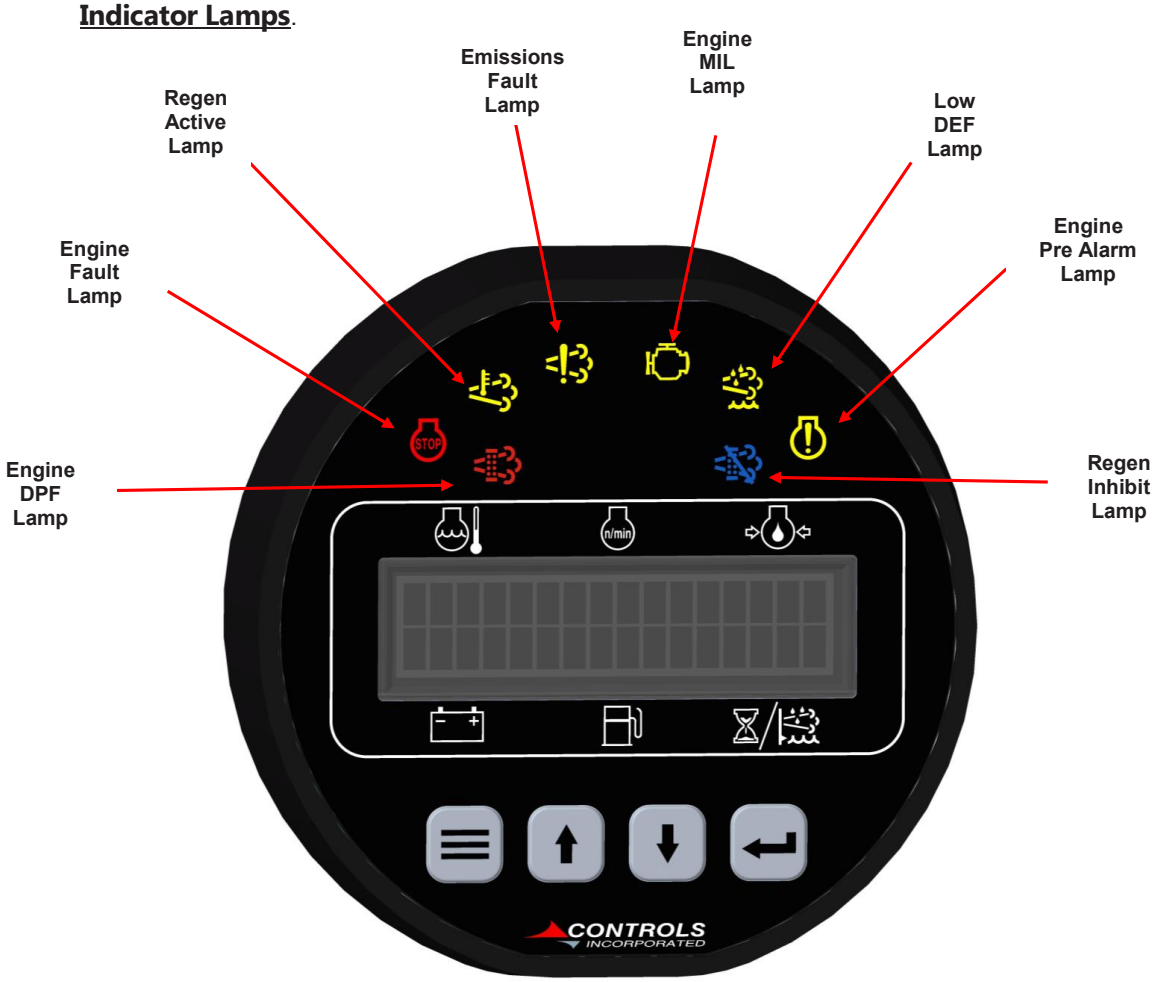
It is the engine ECU that de-rates or shuts down the engine when it is not operating within normal parameters. This includes more common shut downs like high engine temperature and low oil pressure but can encompass a large range of parameters depending on the ECU.

Alarm Annunciation and Code Reader

This panel is configured to operate with standard J1939 engines where engine de-rate and shutdowns are managed by the engine ECU. The panel communicates with the engine ECU and serves as a trouble code reader. When the engine ECU broadcasts a trouble code (called an SPN.FMI code) the panel does the following:

1) Illuminate the appropriate LED indicator lamp
    a. Yellow Lamp = Alarm
    b. Red Lamp = Engine Shut Down
2) Displays the trouble code (standard SPN.FMI code)
3) Displays a code description on the LCD screen
4) Displays the occurrence count of the code

Indicator Lamps.



Active and Stored Engine ECU Codes

The panel also provides the ability to check the engine ECU for all ACTIVE and STORED engine ECU codes. These codes can be viewed via the Active Codes and Stored Codes menus.

CONTROL PANEL ANALOG AND DIGITAL INPUTS

The panel has one digital inputs and three analog inputs available to monitor other components, senders or signals. The analog input is preset to fuel level and cannot be configured. The digital inputs can be used for a number of purposes including alarms and shut downs.

Input	Heading	Default	Options	Connector	Pin
Digital 1	Normally	Open	Open / Closed	B	1
	Function	Alarm			
	Message	External Shutdown			
	Check	Always	Off / Always / Run		
Analog 2	Function	Throttle Up	Always	B	3
Analog 3	Function	Throttle Down	Always	B	4

Digital Function

1) Pre Alarm – Warning message will be displayed along with a yellow lamp when active.
2) Throttle Up – Mimics the front panel key press for speed control.
3) Throttle Down - Mimics the front panel key press for speed control.

Digital Function Activation

1) Off / Always / Run – Describes when the parameter will be monitored for alarm conditions. Run refers to when the engine is running. Off disables the alarm conditions. Always enables the alarm constantly regardless of engine state.
2) Alarm Delay – The time period, after Sender Check Bypass, that the parameter must be on the alarm condition before the alarm becomes latched.

CONTROL PANEL OUTPUTS

The panel has three outputs available to signal other devices based on predefined events. These Outputs can be used for a number of purposes including engine operation or driving an audible alarm.

Input	Heading	Default	Connector	Pin
Output 1			B	2
	Function	Fuel Run		
	Polarity	Positive		
	Initial State	On		
Input	**Heading**	**Default**	**Connector**	**Pin**
Output 2			B	5
	Function	None		
	Polarity	Positive		
	Initial State	Off		
Input	**Heading**	**Default**	**Connector**	**Pin**
Output 3			B	6
	Function	None		
	Polarity	Positive		
	Initial State	Off		

MENU SYSTEM

To Enter Menu System

Hold MENU button and press ENTER button.

Menu Navigation

Press MENU button to scroll menu options.

Press UP arrow button to enter menu.

Press DOWN arrow button to reverse.

Exit Menu System

Hold MENU button and press ENTER button.

To Change a Setting

Press ENTER button to bring up brackets [ ].

Press UP arrow button and DOWN arrow button to change setting.

Press ENTER button to make selection, brackets disappear.

Recycle key to the OFF position after changing a setting.

Main Menus

Main Menus	Sub Menus		
Active Engine Fault Codes	View/Scroll Active Fault Codes		**Viewing Menus**
Stored Engine Fault Codes	View/Scroll Stored Fault Codes		
Engine Parameters	View ECU Engine Information (% Load, Torque, Oil Temp, etc.)		
Emissions Parameters	Regen Options (Auto, Inhibit, Request)		
	DEF Level		
	Regen Active/Not Active View		
	Regen Inhibited/Not Inhibited View		
	DPF Out Gas Temperature View		
	DPF Differential Pressure View		
Engine Identification	Engine Model # View		
	Engine Serial # View		
Module Information	Control Unit Part# View		
	Control Unit Software Version View		
Controller Setup (PASSWORD PROTECTED)	Quick Setup	(1)	**Configuration Menus**
	Engine Parameter Configuration	(2)	
	Input Configuration	(3)	
	Output Configuration	(4)	
	Throttle Configuration	(5)	
	Engine Safety Configuration	(6)	
	Module Configuration	(7)	
	Display Configuration	(8)	
	CAN Configuration	(9)	
	Maintenance Configuration	(10)	
	Emissions Configuration	(11)	
	Clutch Configuration	(12)	

To access the controller setup menus, a password is required.

Configuration Menus

(1)	**Quick Setup**	Engine Manufacturer
		TSC Minimum Speed
		TSC Maximum Speed
		Performance Display Off/On
(2)	**Eng. Parameter Configuration**	Parameter Selection (Speed, Coolant Temp., Oil Pressure, Fuel Level, Voltage, Hour Meter)
		Parameter Setup (Varies based on parameter)
(3)	**Input Configuration**	Configure Selection (Channels/Message)
		Digital 1-3 Function
(4)	**Output Configuration**	Configure Selection (Channels/Message)
		Relay 1 Function (Default to Fuel/Run)
		Relay 2 Function (Default to Preheat)
		Relay 3 Function
(5)	**Throttle Configuration**	Throttle Type
		E-Throttle Mode
		Cooperative TSC Mode
		TSC Minimum Speed
		TSC Maximum Speed
		TSC Bump Speed
		TSC Ramp Rate
		Throttle Curve
		Multi State Speeds 1-4
(6)	**Engine Safety Configuration**	Sender Check By-Pass (Default = 0:10)
		Parameter Selection (Fuel Level, Oil Pressure, Temperature, Battery, Overspeed, Speed Limit, Derate to Shutdown)
		Parameter Settings (vary based on selection)
(7)	**Module Configuration**	Pre Alarms Displayed
		Clear Number of Starts
		Engine Run Criteria Speed
		Engine Stop Criteria Speed
(8)	**Display Configuration**	English/Metric Selection
		Performance Display Off/On

(9)	**CAN Configuration**	Engine Manufacturer (Default = Cummins)
		TSC1 Address (Default = 3) Others available
		Source Address (Default = 3) Others available
		Engine Address (Default = 0) Others available
		Speed Transmit On/Off
		Temperature Transmit On/Off
		Oil Pressure Transmit On/Off
		Fuel Level Transmit On/Off
		Voltage Transmit On/Off
		Hours Transmit On/Off
		Faults Transmit
(10)	**Maintenance Configuration**	Service Messages (Default = No)
		Schedule Selection
		Schedule Reset Yes/No
		Schedule Interval Setting
		Schedule Warning Setting
		Schedule Trip Setting
		Schedule Message
(11)	**Emissions Configuration**	DEF Level Check (Default = Off)
		Low DEF Pre Alarm (Default = 16%)
		Low DEF Alarm (Default = 0%)
		DEF Alarm Delay
		Allow Service Regeneration Yes/No (Deere Only)
		Regeneration Interlock On/Off
		TSC Transmit Yes/No (stop TSC to engine during regeneration)
		DPF Inhibit Lamp Source
(12)	**Clutch Configuration**	Clutch #1 Engage Trip (Default = None)
		Clutch #1 Engage Speed (Default = 800 rpm)
		Clutch #1 Engage Load (Default = 0%)
		Clutch #1 Engage Coolant Temperature (Default = 150°F)
		Clutch #1 Engage Delay (Default = 0:00)
		Clutch #1 Engage Interval (Default = 0:00)
		Clutch #1 Release Trip (Default = None)
		Clutch #1 Release Speed (Default = 800 rpm)
		Clutch #1 Release Load (Default = 0%)
		Clutch #1 Release Coolant Temperature (Default = 150°F)
		Clutch #1 Release Delay (Default = 0:00)
		Clutch #1 Release Interval (Default = 0:00)

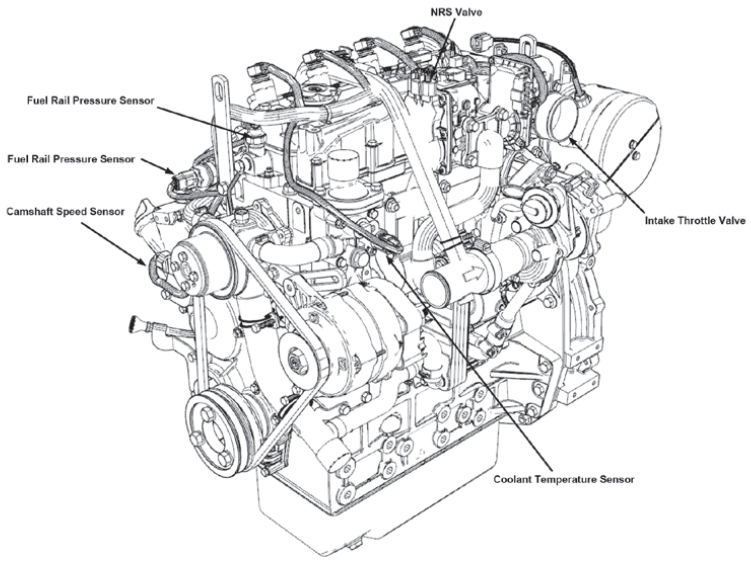


Figure 2.2 – Engine Electronic Components Right-hand Side

2.2 Minimum and Mandatory Installation

This section provides the minimum and mandatory installations for any application. The optional feature installations are in Section 18.

- **Engine ECM Powering:** The Engine ECM must be correctly wired from the battery (Section 4).
- **Engine ECM to EIC Connector Wiring:** The wiring between engine ECM and EIC connector is mandatory to ensure all the sensors are correctly linked to the engine ECM. Specific resistance limit applies to the injector circuit (Section 5).
- **Glow Plugs:** The glow plug relay is mandatory to ensure the full operation of the engine.
- **Engine Starter Motor Control:** To ensure the right operation of the engine the starter needs to be controlled through the ECM. Refer to Section 12.2 for installation details.
- **Speed Control Method:** The engine requires at least one speed control method, between Analog Throttle, Multi Position Switch or J1939 TSC1.

2.3 Electronic Control Unit (ECU)

The engine ECU is an electronic control device that governs engine speed, torque output, and manages the engines performance and emissions via a number of sensors and actuators. The ECU should be mounted off the engine following the guidelines in this document. The device has two connection sockets, one for the engine wiring harness (J2 or A Connector) and the other for the OEM machine wiring harness (J1 or B Connector). The ECU is air-cooled and is limited to a maximum ambient temperature dependent on airflow.

Every engine is shipped with uniquely calibrated controller and it is the responsibility of the OEM to ensure that they are paired on the machine. To ease the matching process, both engine and ECM have serial number labels attached.

Warning: Not respecting the pairing of the engine and ECM will result in emission non-compliance and a potential negative performance impact.

2.4 Fuel System

The engine fuel system is comprised of an electric lift pump, mechanical transfer pump, high-pressure fuel pump, electronically-controlled unit injectors, and a high-pressure fuel rail to feed the injectors. The high-pressure fuel pump provides high-pressure fuel to the fuel rail. The engine ECU via the fuel pump solenoid controls the fuel pump delivery and the resulting rail pressure. The engine ECU controls the fuel pump solenoid based upon the inputs received from the fuel temperature sensor (which enables the control to be tailored to the specific fuel characteristics) and the fuel rail pressure sensor (which measures the actual pressure within the fuel rail).

High-pressure fuel is delivered to each of the electronically controlled unit injectors which when activated by the engine ECU deliver a controlled measure of fuel for combustion. Voltages applied by the ECU to activate the injectors is not more than 50V, the OEM must ensure that any systems sensitive to electromagnetic radiation are not in close proximity to the harness components that lead to the injectors.

It should be noted that in many cases a fault on any of these sensors, solenoids, or switches would cause the engine to derate, or enter a limp home state due to their emissions critical nature.

2.5 Engine Speed

The engine is fitted with two speed sensors. The first is assembled to the engine flywheel housing to measure the crank speed and position. The crankshaft speed sensor is a variable reluctance type sensor, which targets a sixty minus four pattern (60-4). The other sensor is used to measure the fuel pump gear speed, position, and engine cycle. This speed sensor, referenced as the camshaft sensor is a Hall Effect type sensor, which targets five notches on the fuel pump gear. The engine uses the crank speed signal during normal engine operation, as this signal is more accurate at higher speeds.

2.6 Core Engine System

There are a number of core engine operation sensors that are used to determine how the engine control system should respond to various conditions. These components include the coolant temperature sensor and the oil pressure switch.

The coolant temperature sensor measurement is used as an input to the cold start strategy. The sensor reading is also used to determine fuel limits and injection timing at various temperatures to control engine emissions.

The oil pressure switch detects engine oil pressure. The oil pressure switch is used for engine protection whereby if insufficient oil pressure were measured during engine operation, an event for low oil pressure would be raised.

The engine oil pressure switch is operated when a pressure of between 0.5-0.8 bar is detected.

2.7 NRS (NOx Reduction System)

The NOx reduction system is made up of the following components:

- NRS metering valve (with position sensor)

This part of the engine control system is emissions critical and for this reason the engine may apply a derate if the component has a fault condition.

2.10 Electrical System Component Key Elements Overview T/TA DOC

2.10.1 C2.2 Overview

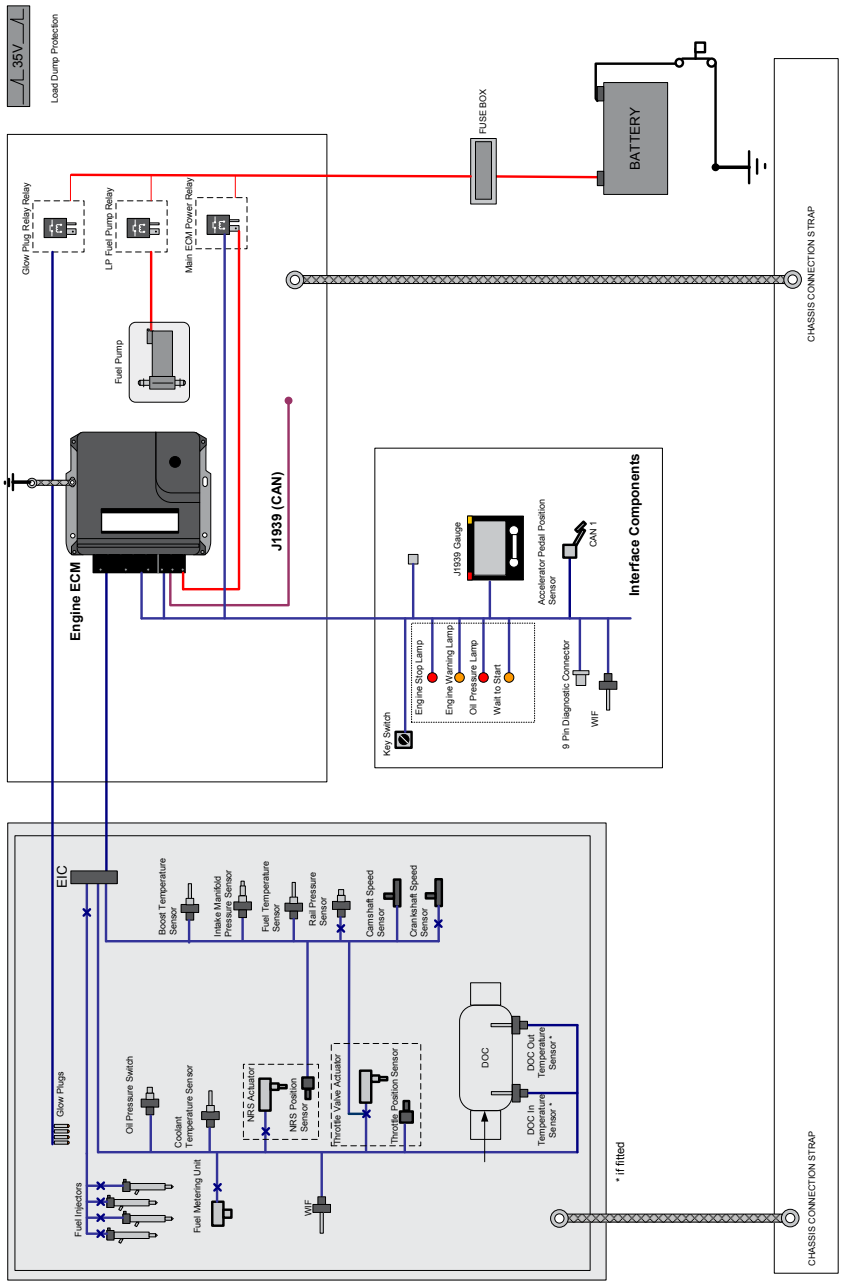


Figure 2.4 – Four-cylinder System Layout Diagram

4.0 Engine System Power and Grounding

The power and grounding of the electrical system must comply with diagram detailed below to avoid an unreliable electrical system. Voltage drop seen during situations where battery demand is high or when battery charge is low may risk components falling below minimum operating voltage thresholds. As an example engine cranking requires a high battery demand, potentially reducing the overall system voltage. The effects can be worse in cold conditions where starter motor load may increase and battery performance decreases. To reduce the effects of voltage drop, circuit design must minimize circuit resistance; the diagram below provides good practice wiring. Components in the circuit must be properly assessed for their resistive properties. Consider the number of connections in the circuit; minimizing this number will improve overall system performance. Over-sizing conductors or reducing their length should be considered as a method of reducing total circuit resistance. Junction blocks, situated close to the battery serve as a reliable supply and ground return point for components susceptible to voltage drop, this practice avoids sharing terminals with components that add to effects of voltage drop, such as starter motor circuits during cranking. Ground paths must be assessed and conductive paths need to be known, if there is any doubt or design requirements can't be met, a direct copper connection must be used. It is recommended that the disconnect switch have only one connection either side of the switch, preventing the switch being bypassed if incorrectly wired. Circuit design must consider specific component design requirements; components may have a maximum circuit resistance or minimum operating voltage. After system design, circuit resistance should be tested to ensure the results fall below 1.7 mOhms.

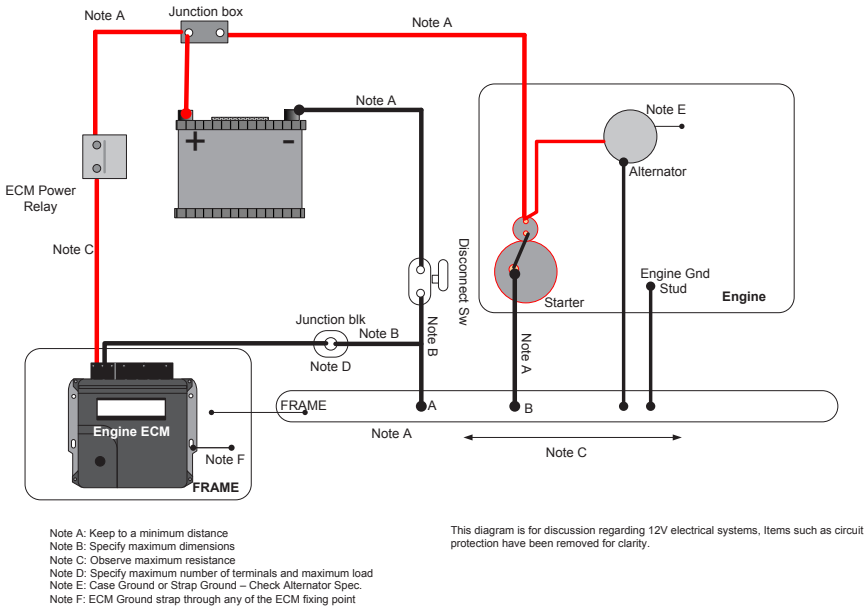


Figure 4.1 – System Supply and Grounding

4.1 Engine ECU Location – Wiring Constraints

The circuit resistance of the injector supply cables and the engine ECU power supply cable limits the distance of the engine ECU from the engine interface connector. The resistance of both circuits must to be considered together to ensure correct operation of the Injectors and ECU.

5.0 System Resistance and Wiring Requirements

5.1 Injector Circuit Resistance

The recommended machine end of life total Injector circuit resistance is 70 mOhms. Caterpillar advises a target resistance of 60 mOhms.

5.2 ECU Power Supply Resistance

The recommended machine end of life total ECM power supply circuit resistance is 50 mOhms. Caterpillar advises a target resistance of 40 mOhms. To ensure the correct ECM functionality, the ECM power supply circuit resistance can't be higher than 50 mOhms.

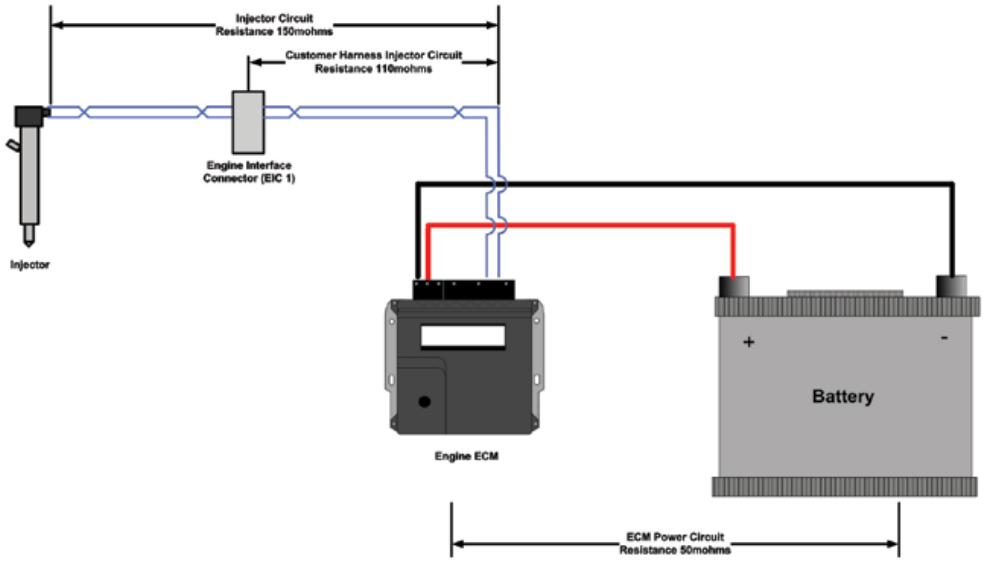


Figure 5.1 – Total Circuit Resistance

5.3 Injector Cables

The required cable cross section for Injector harness wiring is 1.5 mm², shielded twisted pairs. The minimum dielectric strength of the cable insulation for the power supply and fuel system circuits, including Injectors and fuel metering valve is 60V. The injector cables must be twisted shielded pairs with a maximum twist length of 25 mm.

The Injector cables should be separated from other signal circuits to avoid electrical disturbance, the analog signals are especially vulnerable to interference and must be clearly separated from the Injector circuit.

Separate analog and speed signal circuits from injector circuits. Bundle circuits supplying inductive loads separately to signals. If possible use separate conduit paths.

5.3.1 Four-cylinder Injector Wiring

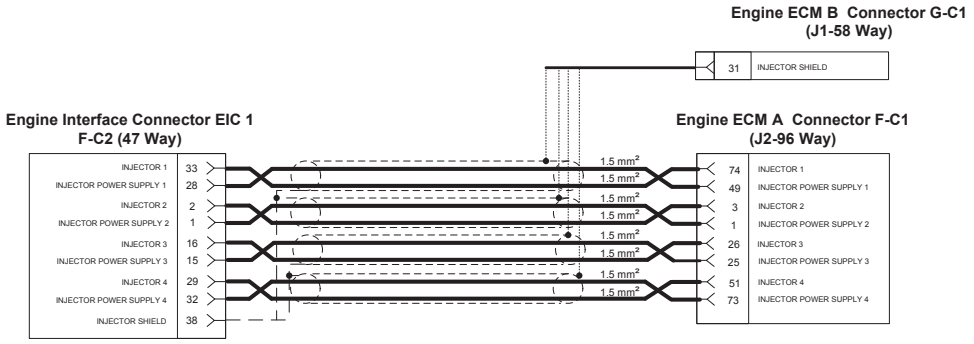


Figure 5.2 – Four-cylinder Injector Wiring

5.3.2 Three-cylinder Injector Wiring

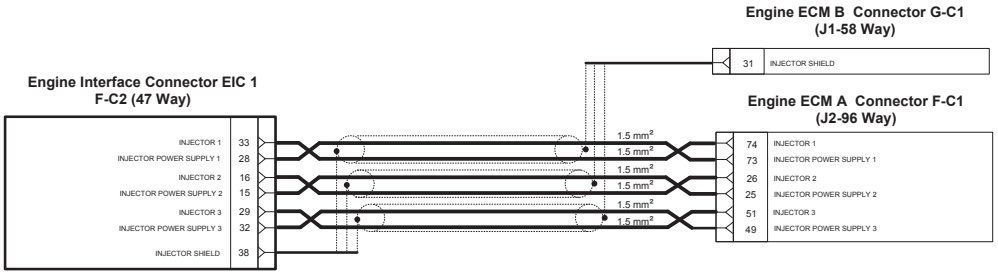


Figure 5.3 – Three-cylinder Injector Wiring

5.4 Fuel Metering Unit Cables

The required cable cross section for fuel metering unit wiring is 0.75 mm², twisted pair. The minimum dielectric strength of the cable insulation for the power supply and fuel system circuits, including injectors and fuel metering valve is 60V. The fuel metering cables must be twisted pairs with a maximum twist length of 25 mm.

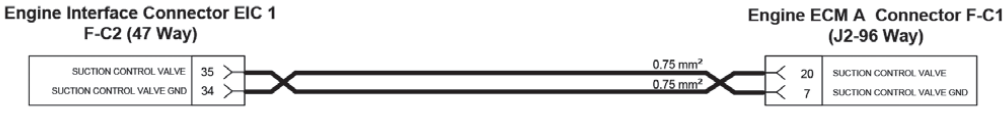


Figure 5.4 – Fuel Metering Valve Cabling

5.5 Engine Solenoids and Actuators

Caterpillar recommends that injector cables along with solenoid and actuators cables be separated from signal cables. As a minimum, the power related cables supplying the following components should be bundled separately to engine and Aftertreatment sensor cables. Where possible, signal/sensor wires should use separate conduit channels.

5.6 Twisting and Shielding

The wiring to the following components need either twisting and shielding, or twisting.

Component Wiring Description	Wire Type
Injectors 1 to 4 Control	Twisted Shielded Pairs
Crankshaft Speed Sensor	Twisted Shielded Pair
Camshaft Speed Sensor	Twisted Shielded Pair
NRS Valve Motor	Twisted Pair
Throttle Valve Motor	Twisted Pair
Fuel Pump Suction Valve	Twisted Pair
Fuel Rail Pressure Sensor	Twisted Shielded Pairs
CAN	Twisted

Table 5.1 – Twisted and Shielded Wires

5.7 Voltage Suppression Requirement

The engine ECU must be protected against high voltage spikes, also known as load dump. The factory fitted alternators are fitted with load dump protection as standard to protect the engine ECU. Load dump protection protects against high transient voltages sometimes seen when switching inductive components in the system circuit. The factory fitted alternators protect for voltages higher than 25V-30V depending on the alternator selected.

If an alternator is not used or a non-standard alternator is selected, the engine electrical system must be designed to provide load dump protection for the engine ECU. The maximum permissible transient voltage measured at the ECU is 40Vdc. It is recommended that the electrical system be designed to protect against voltages higher than 35Vdc measured at the engine ECU.

7.0 Engine and ECU Connector and Wiring Information

400F E Connector Requirements	Part Number	Suggested Quantity	Manufacturer
J1 Connector 58 Pin (G-C1)			
J1 58 Pin Connector Plug Assembly	9-1563172-9	1	Tyco
MCON 1.2mm Terminal Socket (Tin Plated) 0.5 to 0.75	1-394897-1	30	Tyco
MCP 2.8mm Terminal Socket (Tin Plated) 0.35 to 2.5	1-968857-1	6	Tyco
MCP Wire Seal 2.2 to 3.0	0-828905-1	6	Tyco
1.2mm Terminal Position Assurance	0-1452409-2	1	Tyco
2.8mm Terminal Position Assurance	0-1452408-2	1	Tyco
Cavity Plug	1-1452424-1	40	Tyco
Dress Cover Option 1 90 Degree Exit	0-1452421-1	1	Tyco
Dress Cover Option 2 180 Degree Exit	0-1452416-1	1	Tyco
J2 Connector 96 Pin (F-C1)			
J2 96 Pin Connector Plug Assembly	9-1563173-9	1	Tyco
MCON 1.2mm Terminal Socket (Tin Plated) 1.0 to 1.5	0-1452503-1	10	Tyco
MCON 1.2mm Terminal Socket (Tin Plated) 0.5 to 0.75	1-394897-1	40	Tyco
Cavity Plug	1-1452424-1	65	Tyco
1.2mm Terminal Position Assurance	0-1452388-2	1	Tyco
Dress Cover Option 1 90 Degree Exit	0-1452389-1	1	Tyco
Dress Cover Option 2 180 Degree Exit	0-1452862-1	1	Tyco
EIC Interface Connector 47 Pin (F-C2)			
EIC Connector 47 Pin Connector Plug Assembly	HDP24 24-47SE	1	Deutsch
EIC Connector Nut	2411-001-2405	1	Deutsch
EIC Washer	2414-001-2486	1	Deutsch
Socket 16 AWG (Tin Plated) Stamped and Formed	1062-16-0677	5	Deutsch
Option - Socket 16 AWG (Tin Plated) Solid	0462-201-16141	0	Deutsch
Socket 20 AWG (Tin Plated) Stamped and Formed	1062-20-0177	40	Deutsch
Option - Socket 20 AWG (Tin Plated) Solid	0462-201-20141	0	Deutsch
Cavity Seal 20 AWG	0413-204-2005	10	Deutsch
Cavity Seal 16 AWG	114017	2	Deutsch
Breather Heater 2 Pin			
Breather Heater Connector 2 Pin	4212110	1	FEP
Terminal	929939-3	2	Tyco
Wire Seal	828905-1	2	Tyco
Low Pressure Fuel Pump			
Connector Plug 2 Pin	DT06-2S-EP06	1	Deutsch
Socket 16 AWG (Tin Plated) Stamped and Formed	1062-16-0677	2	Deutsch
Option - Socket 16 AWG (Tin Plated) Solid	0462-201-16141	0	Deutsch
Diagnostic Connector 9 Pin (G-C6)			
Diagnostic Connector 9 Pin - Receptacle	HDP10-9-96P	1	Deutsch
Pin 16 AWG (Gold Plated) Stamped and Formed	1060-16-0144	4	Deutsch
Pin 16 AWG (Gold Plated) Solid	0460-202-1631	0	Deutsch
Cavity Plug 16 AWG	114017	5	Deutsch
Factory CAN Access			
CAN Connector 3 Pin - Plug	DT06-3S-P032	1	Deutsch
Wedge Lock	W3S-P012	1	Deutsch
Socket 16 AWG (Tin Plated) Stamped and Formed	1062-16-0677	2	Deutsch
Option - Socket 16 AWG (Tin Plated) Solid	0462-201-16141	0	Deutsch
Cavity Seal 16 AWG	114017	4	Deutsch
Receptacle (Blanker)	DT04-3P-CE02	1	Deutsch

Table 7.1 – Cat C1.7-C2.2 Connector Requirements

Note: This table does not include those connectors required for interface with the factory-supplied umbilical harnesses. If selecting a factory-supplied umbilical harness, please review Section 8 for further connector information.