3.20 DEUTZ EMR 2

The EMR2 consists of the sensors, the control unit and the actuator. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters In accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

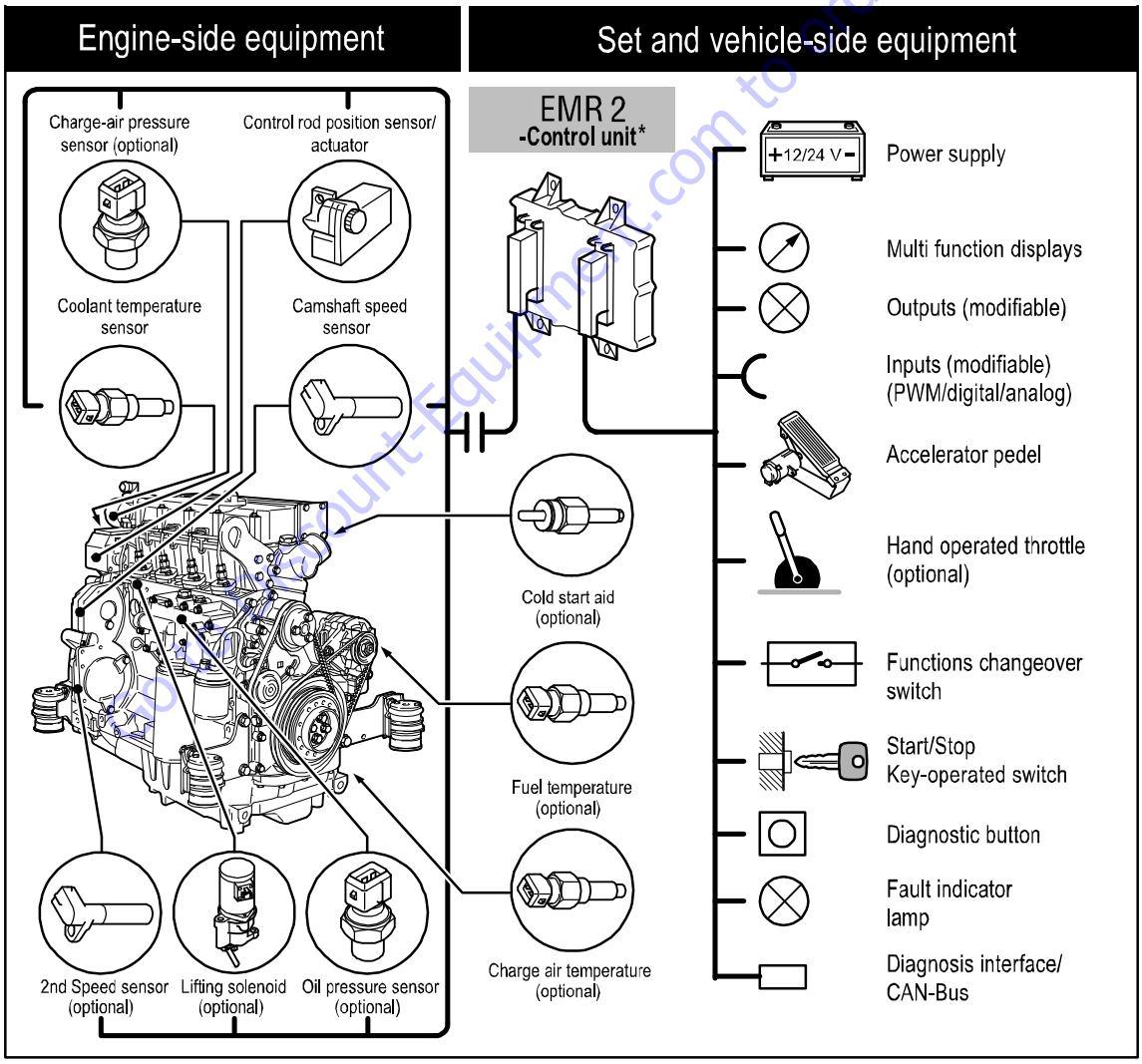


Figure 3-66. EMR 2 Engine Side Equipment

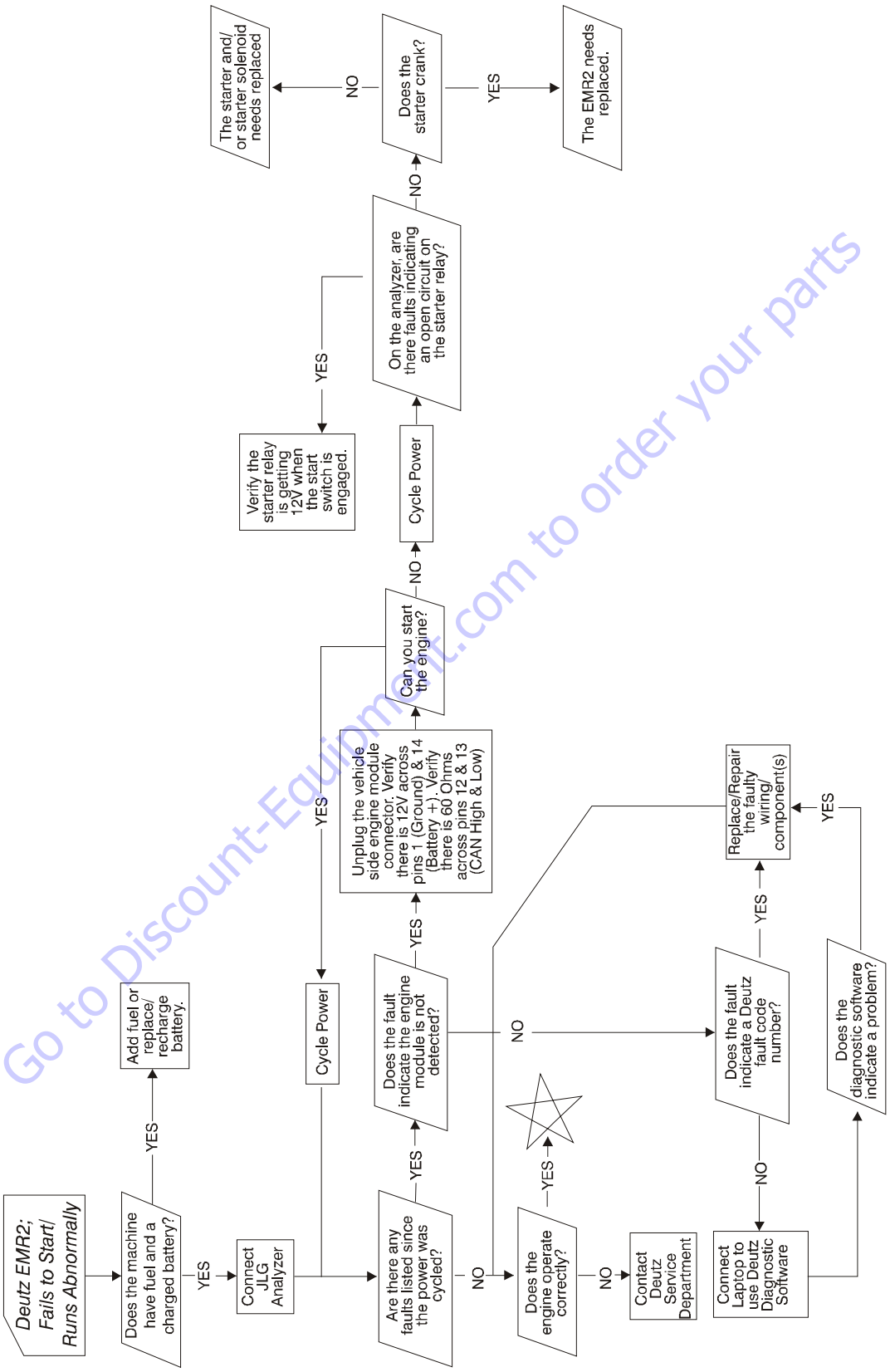


Figure 3-67. Deutz EMR 2 Troubleshooting Flow Chart

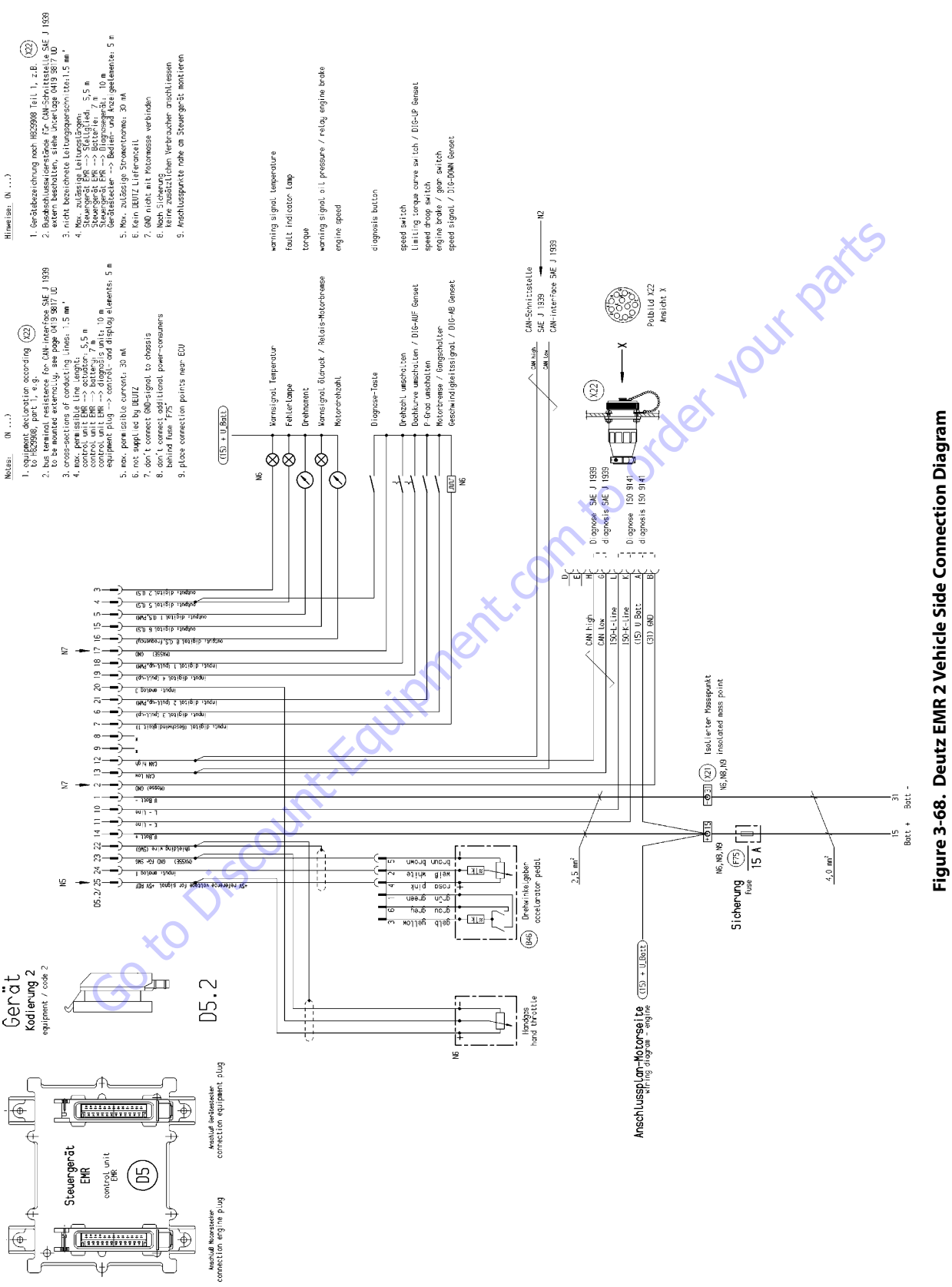


Figure 3-68. Deutz EMR 2 Vehicle Side Connection Diagram

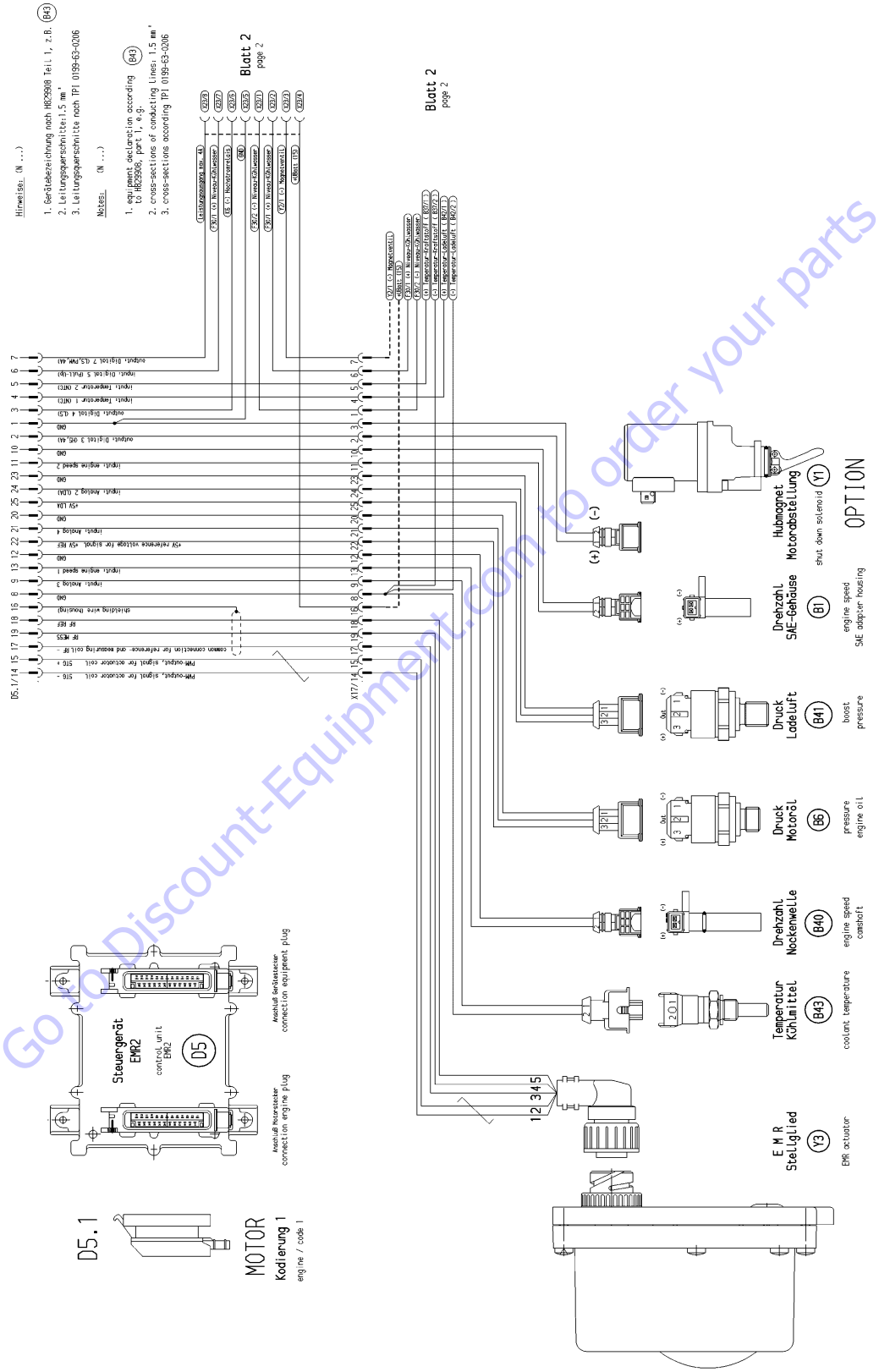


Figure 3-69. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

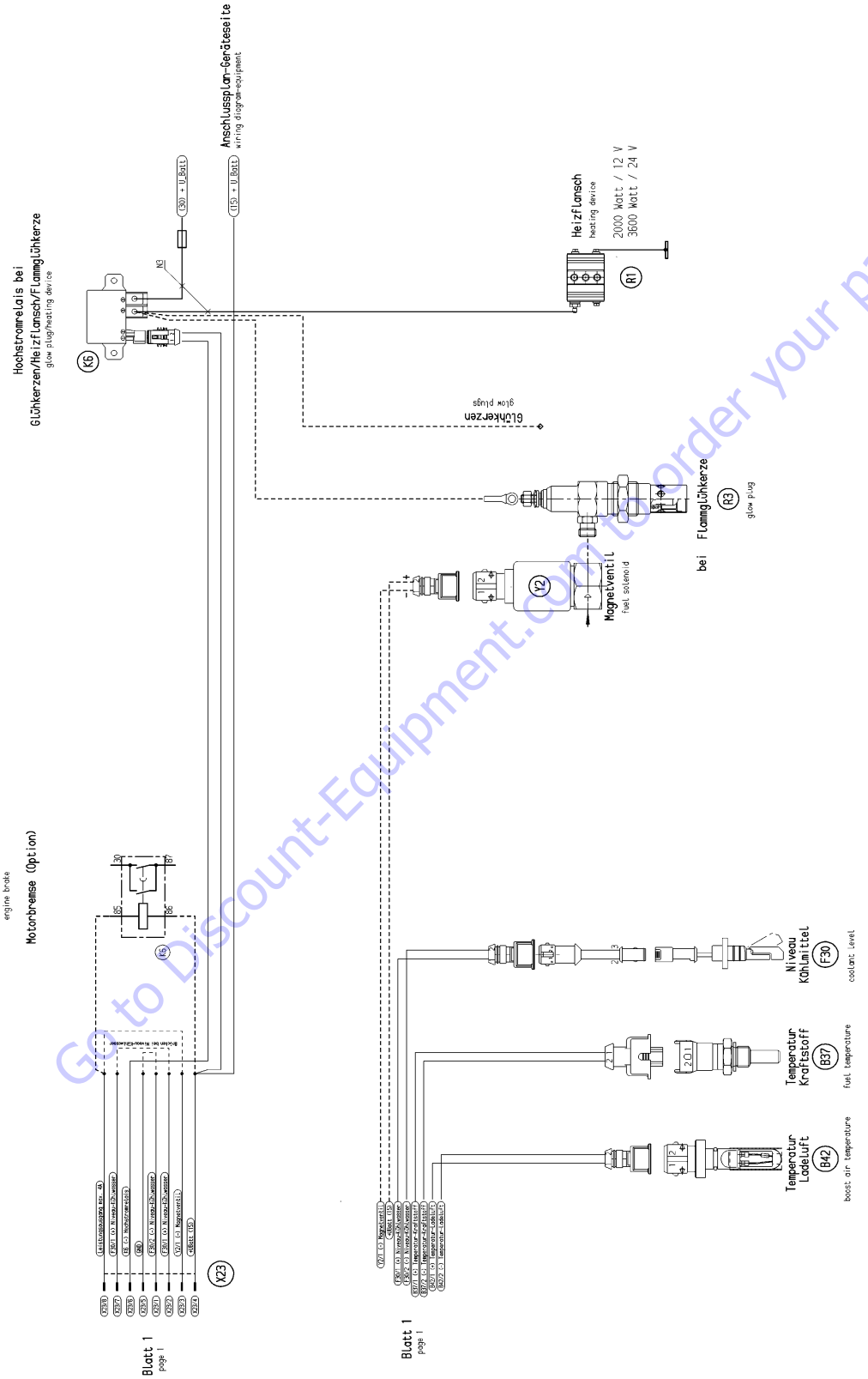
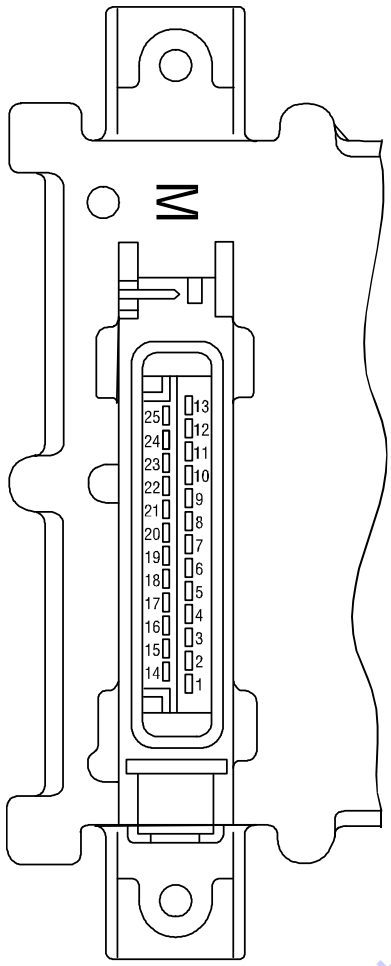


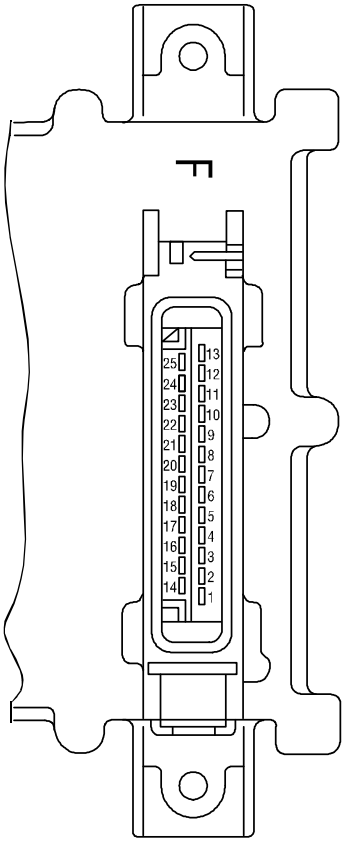
Figure 3-70. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid [1)]
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature [2)]
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant level / oil level
7	Output: PWM2/digital 6	
8	GND	Reference potential for analog signal at pin 9
9	Input: analog 7	Analog input for Coolant temperature sensor (NTC)
10	GND	Reference potential for analog signal at pin 11
11	Multi-function input: speed 2/DigIn 2	Digital input second engine speed (crankshaft) (optional) and speed signal (optional)
12	GND	Reference potential for analog signal at pin 13
13	Input: speed 1	Digital input first engine speed (camshaft)
14	STG -	PWM output, signal for actuator coil
15	STG +	PWM output, signal for actuator coil
16	Screen	Screening regulating rod travel sensor (for lines 17, 18, 19)
17	RF -	General connection for reference and measuring coil
18	RF REF	Analog input, reference signal of the reference coil
19	RF MESS	Analog input, measuring signal of the measuring coil
20	GND	Reference potential for signal at pin 21
21	Input: analog 4/digital 9	Analog input 4 (sensor signal oil pressure sensor) or digital input 9
22	+5 V REF	+5 V Reference voltage for signal at pin 21 (max. 15 mA)
23	GND	Reference potential for signal at pin 24
24	Input: analog 2/digital 7	Analog input 2 (sensor signal charge air) or digital input 7
25	+5 V LDA	+5 V Reference potential for signal at pin 24 (max. 15 mA)

1) For continuous power: < 4 A
2) Corresponds to special function"fuel temperature compensation at the EMR (0211 2571)

Figure 3-71. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-72. EMR 2 Vehicle Plug Pin Identification

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No **active** faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
						Governor in emergency operation (with sensor 1) Emergency switch-off (if sensor 1 not available or failed).	
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e.	Engine stop.	Check parameter (21). Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
Sensors	07	Charge air pressure	102	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-73. EMR2 Fault Codes - Sheet 1 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault warning	30	Oil pressure warning	100	1	Oil pressure below speed-dependent warning line characteristic	Fault message (disappears when oil pressure is again above recovery limit). After a delay time - fill limitation.	Check engine (oil level, oil pump). Check oil pressure sensor and cable. Check oil pressure warning line characteristic.
	31	Coolant temperature warning	110	0	Coolant temperature has exceeded warning level.	Fault message (disappears when coolant temperature again drops below recovery level). After a delay time - fill limitation.	Check coolant. Check coolant temperature sensor and cable.
	32	Charge air temperature warning	105	0	Charge air temperature has exceeded warning level.	Fault message (disappears when charge air temperature gain drops below recovery level). After a delay time - fill limitation.	Check charge air. Check charge air-temperature sensor and cable.
	34	Coolant level warning	111	1	Switch input “Low coolant level” is active.	Fault message.	Check coolant level. Check coolant level sensor and cable.
	35	Speed warning (with thrust mode operation).	SID 190	14	revolutions was/is above (top) revolution speed limit. “Thrust mode” function is active.		Check parameters. Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator. Check speed sensor (impulses on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
	36	Fuel temperature warning	174	0	Fuel-temperature has exceeded warning level.	Fault message (disappears when fuel temperature again drops below recovery level).	Check fuel. Check fuel temperature sensor and cable.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-74. EMR2 Fault Codes - Sheet 2 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input "Low coolant level" is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for "Confirmation".
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for "Rifeness confirmation".
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save values. Switch ignition off and on again.Check again. If faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-75. EMR2 Fault Codes - Sheet 3 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/ outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
Communi-cation	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	71	CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		
	74	Cable break, short circuit or bus-error	SID 231	14			Check CAN connection, cable connection. Check sensor and replace if required.
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.	Emergency switch-off. engine cannot be started.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called “Flash-test”).		
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		Note values of parameters (3895 and 3896). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-76. EMR2 Fault Codes - Sheet 4 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset.).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called “Stack overflow” fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-77. EMR2 Fault Codes - Sheet 5 of 5

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
155	0	0	-	
1464	0	0	-	
1466	0	0	-	
1467	0	0	-	
1469	0	0	-	
1470	0	0	-	
1471	0	0	-	
1472	0	0	-	
83	16	0	271	No detail informationen!
87	16	0	271	BusOff error CAN No detail informationen!
978	29	2	126	Plausibility error between sensor and idle switch, Acceleratio Pedal Detection. In case of Hand Throttle with Low Idle Switch, it is the plausibility check between hand throttle and idle switch.
932	29	3	126	Handthrottle idle validation switch; short circuit to battery.
937	29	4	126	Handthrottle; short circuit to ground.
1924	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery (A02).
1925	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery (A67).
1935	51	3	594	Intake Throttle Flap, H-Bridge, short circuit to battery oder broken wiring harness.
1926	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground (A02).
1927	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground (A67).
1936	51	4	594	Intake Throttle Flap, H-Bridge, short circuit to ground.
1921	51	5	594	Intake Throttle Flap, H-Bridge, wiring harness broken at connected actuator.
1922	51	6	594	Intake Throttle Flap, H-Bridge, current above maximum threshold.
1931	51	7	594	Intake Throttle Flap, H-Bridge, position of actuator not plausible (deviation from setpoint more than 7%).
935	91	3	226	Sensor error accelerator pedal. signal range check high.
940	91	4	226	Sensor error accelerator pedal. Signal is below the range.
976	91	11	226	Plausibility error between APP1 and APP2 or APP1 and idle switch.
474	94	1	216	Low fuel pressure; warning threshold exceeded.
475	94	1	216	Low fuel pressure; shut off threshold exceeded.
472	94	3	216	Sensor error low fuel pressure; signal range check high.
473	94	4	216	Sensor error low fuel pressure; signal range check low.
464	97	3	228	Sensor error water in fuel; signal range check high.
465	97	4	228	Sensor error water in fuel; signal range check low.
1157	97	12	228	Water in fuel level prefilter; maximum value exceeded.
720	98	2	211	Plausibility Check. No detail informationen!
734	100	0	231	High oil pressure; warning threshold exceeded.
735	100	0	231	High oil pressure; shut off threshold exceeded.
736	100	1	231	Low oil pressure; warning threshold exceeded.
737	100	1	231	Low oil pressure; shut off threshold exceeded.
732	100	3	224	Sensor error oil pressure; signal range check high.
733	100	4	224	Sensor error oil pressure sensor; signal range check low.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
774	102	1	223	Pressure downstream charge air cooler, pressure below lower physical threshold.
88	102	2	223	Charged air pressure above warning threshold.
89	102	2	223	Charged air pressure above shut off threshold.
772	102	2	223	Pressure downstream charge air cooler, plausibility error.
776	102	3	223	Pressure downstream charge air cooler, short circuit to battery or open load.
777	102	4	223	Pressure downstream charge air cooler, short circuit to ground.
996	105	0	233	Charged air cooler temperature. System reaction initiated. High charged air cooler temperature. Warning threshold exceeded.
997	105	0	233	Low charged air cooler temperature. Shut off threshold exceeded.
992	105	1	128	Charged Air cooler down stream temperature. Temperature below lower physical threshold.
994	105	3	128	Electrical error charged air temperature. Signal range check high.(SRC).
995	105	4	128	Electrical error charged air temperature. Signal range check low.
998	105	11	128	Diagnostic fault check for charged air cooler downstream temperature sensor. No detail informationen!
751	107	0	136	Sensor error air filter differential pressure; short circuit to ground.
752	107	0	136	Air filter differential pressure; short circuit to ground.
750	107	3	136	Sensor error air filter differential pressure; short circuit to battery.
412	108	3	292	Sensor error ambient air pressure; signal range check high.
413	108	4	292	Sensor error ambient air pressure; signal range check low.
411	108	11	292	DFC for CAN message.
92	110	0	225	Physical Range Check high for Coolant temperature.
98	110	0	232	High coolant temperature; warning threshold exceeded.
99	110	0	232	Coolant temperature; system reaction initiated.
93	110	1	225	Physical Range Check low for Coolant temperature.
90	110	2	225	defect fault check for Absolute plausibility test No detail informationen!
96	110	3	225	Sensor error coolant temperature; signal range check high.
97	110	4	225	Sensor error coolant temperature; signal range check low.
1	110	11	226	Air flow sensor load correction factor exceeding the maximum drift limit; plausibility error.
101	111	1	235	Coolant level too low.
8	132	1	226	The air mass flow AFS_dm is greater than or equal to AFS_PhysRng.Min_C. Physical Range Check low for air mass flow sensor No detail informationen!
874	157	0	147	Rail pressure raw value is intermittent No detail informationen!
875	157	1	147	rail pressure raw value is above maximum offset No detail informationen!
877	157	3	147	Sensor error rail pressure. Sensor voltage above upper limit.
878	157	4	147	Sensor error rail pressure. Sensor voltage below lower limit.
1381	164	2	839	Rail pressure safety function is not executed correctly ().
1180	168	0	318	Physical range check high for battery voltage.
1181	168	1	318	Physical range check low for battery voltage.
47	168	2	318	High battery voltage; warning threshold exceeded.
48	168	2	318	High battery voltage; shot off threshold exceeded.
45	168	3	318	Sensor error battery voltage; signal range check high.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
46	168	4	318	Sensor error battery voltage; signal range check low.
415	171	0	312	Environment temperature sensor, temperature above upper physical threshold.
416	171	1	312	Environment Temperature Physical Range Check low.
417	171	3	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high.
418	171	4	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low.
1425	172	0	226	air temperature within air filter box above maximum physical value.
1183	172	1	226	Air inlet filter sensor out of physical range check.
9	172	2	226	Air inlet filter temperature, plausibility error.
981	172	3	226	Air flow temperature sensor; short circuit to battery or open load.
982	172	4	226	Air flow temperature sensor; short circuit to ground.
483	174	11	227	DFC for fuel temperature plausibility check function No detail informationen!
745	175	0	144	High oil temperature; warning threshold exceeded.
746	175	0	144	High oil temperature; shut off threshold exceeded.
1171	175	2	144	Customer oil temperature: signal unplausible.
743	175	3	144	Sensor error oil temperature; signal range check high.
744	175	4	144	Sensor error oil temperature; signal range check low.
388	190	0	214	Engine speed above warning threshold. Overspeed detection in component engine protection.
389	190	0	214	Engine speed above warning threshold (FOC-Level 1).
421	190	2	213	Offset angle between crank- and camshaft sensor is too large.
419	190	8	212	Sensor camshaft speed; disturbed signal.
422	190	8	212	Sensor crankshaft detection; out of range, signal disrupted; disturbed signal.
390	190	11	214	Engine speed above warning threshold (FOC-Level 2).
420	190	12	212	Sensor camshaft detection; out of range, signal disrupted; no signal.
423	190	12	212	Speed detection; out of range, signal disrupted Sensor crankshaft speed; no signal.
1222	190	14	212	Camshaft- and Crankshaft speed sensor signal not available on CAN.
391	190	14	214	Engine speed above warning threshold (Overrun Mode).
791	411	0	693	delta pressure across venturi in EGR line above physical high limit.
795	411	3	693	Sensor error differential pressure Venturiunit (EGR), signal range check low.
381	411	4	693	Physical range check low for EGR differential pressure.
796	411	4	693	Sensor error differential pressure Venturiunit (EGR), signal range check high.
793	411	11	693	Plausibility Check fault for deviation of desired and actual EGR-mass flow, where the latter is calculated out of EGR Delta Pressure Sensor.
1007	412	3	682	Electrical error EGR cooler downstream temperature. Signal range check high.
1008	412	4	682	electrical error EGR cooler downstream temperature. Signal range check low.
306	520	9	119	Timeout Error of CAN-Receive-Frame TSC1TR; control signal.
106	598	2	325	Plausibility check for Clutch No detail informationen!
971	624	3	513	SVS lamp; short circuit to battery.
972	624	4	513	SVS lamp; short circuit to ground.
969	624	5	513	SVS lamp; open load.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
970	624	12	513	SVS lamp: powerstage over temperature.
376	630	12	281	Access error EEPROM memory (delete).
377	630	12	281	Access error EEPROM memory (read).
378	630	12	281	Access error EEPROM memory (write).
84	639	14	271	CAN-Bus 0 "BusOff-Status"
580	651	3	154	Injector 1 (in firing order); short circuit.
568	651	5	154	Injector 1 (in firing order); interruption of electric connection.
581	652	3	155	Injector 2 (in firing order); short circuit.
569	652	5	155	Injector 2 (in firing order); interruption of electric connection.
582	653	3	156	Injector 3 (in firing order); short circuit.
570	653	5	156	Injector 3 (in firing order); interruption of electric connection.
583	654	3	161	Injector 4 (in firing order); short circuit.
571	654	5	161	Injector 4 (in firing order); interruption of electric connection.
584	655	3	162	Injector 5 (in firing order); short circuit.
590	655	4	162	High side to low side short circuit in the injector 5 (in firing order).
572	655	5	162	Injector 5 (in firing order); interruption of electric connection.
585	656	3	163	Injector 6 (in firing order); short circuit.
591	656	4	163	High side to low side short circuit in the injector 6 (in firing order).
573	656	5	163	Injector 6 (in firing order); interruption of electric connection.
543	676	11	263	Cold start device relay error.
544	676	11	263	Cold start aid relay open load.
956	677	3	512	Starter relay high side. Short circuit to battery.
960	677	3	512	Starter relay low side short circuit to battery.
957	677	4	512	Starter relay high side short circuit to ground.
961	677	4	512	Starter relay low side short circuit to ground.
958	677	5	512	Starter relay low side no load error.
959	677	12	512	Starter relay powerstage over temperature.
549	729	3	263	Intake Air Heater Device; Short circuit to battery.
551	729	4	263	Air intake heater; Short circuit to ground error for powerstage on CJ945.
545	729	5	263	Cold start aid relay open load.
547	729	12	263	Cold start aid relay; over temperature error.
305	898	9	118	Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint.
457	975	3	238	PWM-Signal Fan, short-circuit to plus.
458	975	4	238	PWM-Signal Fan, open load or short circuit to ground.
455	975	5	238	PWM-Signal Fan, Open load or short-circuit ground.
946	1079	13	282	Failure of sensor supply voltage 1.
947	1080	13	282	Failure of sensor supply voltage 2.
121	1109	2	341	Engine shut off demand ignored.
1398	1136	0	681	Physical range check high for ECU temperature.
847	1176	0	139	Pressure sensor upstream turbine, Physical Range Check high.
848	1176	1	139	Pressure sensor upstream turbine, Physical Range Check low.
849	1176	3	141	Pressure sensor upstream turbine, signal range check (SRC) high.
850	1176	4	141	Pressure sensor upstream turbine, signal range check (SRC) low.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1193	1180	0	556	Physical range check high for exhaust gas temperature upstream turbine.
1194	1180	1	556	Physical range check low for exhaust gas temperature upstream turbine.
1067	1180	3	556	Sensor error exhaust gas temperature upstream turbine; signal range check high.
1068	1180	4	556	Sensor error exhaust gas temperature upstream turbine; signal range check low.
1799	1188	0	814	Turbocharger wastegate, temperature critical high.
1414	1188	2	814	Wastegate; status message from ECU missing.
1789	1188	2	814	Turbocharger wastegate, CAN Error.
1794	1188	3	814	Turbocharger wastegate, supply voltage above maximum threshold.
1795	1188	4	814	Turbocharger wastegate, supply voltage below minimum threshold.
1793	1188	6	814	Turbocharger wastegate, current above maximum threshold.
1415	1188	7	814	Wastegate actuator; blocked.
1788	1188	7	814	Turbocharger wastegate, mechanical blocking detected.
1797	1188	7	814	Turbocharger wastegate, broken spring detected.
1411	1188	11	814	Wastegate actuator; internal error.
1412	1188	11	814	Wastegate actuator; EOL calibration not performed correctly.
1417	1188	11	814	Wastegate actuator; over temperature (> 135°C).
1418	1188	11	814	Wastegate actuator; operating voltage error.
1791	1188	12	814	Turbocharger wastegate, internal electrical error.
1413	1188	13	814	Wastegate actuator calibration deviation too large, recalibration required.
1790	1188	13	814	Turbocharger wastegate, EOL calibration error.
1792	1188	13	814	Turbocharger wastegate, learning process aborted.
1796	1188	13	814	Turbocharger wastegate, learning process out of range.
85	1231	14	271	CAN-Bus 1 "BusOff-Status"
82	1235	14	271	CAN-Bus 2 = CAN_C reports Bus-error (for engines <8L and CV52 it is the engine-CAN@250kbaud) CAN Bus error passive; warning CAN C - engine CAN.
86	1235	14	271	CAN-Bus 2 = engine bus "BusOff-Status"
747	1237	2	145	Override switch; plausibility error.
604	1323	12	241	Too many recognized misfires in cylinder 1 (in firing order).
611	1346	0	241	Misfire detection monitoring No detail informationen!
542	1638	2	314	Hydraulic oil temperature check for Shut off condition No detail informationen!
460	1639	0	238	Sensor error fan speed; signal range check high or engine speed resp. fan speed too big.
461	1639	1	238	Sensor error fan speed; signal range check low or fan speed too low.
459	1639	12	238	Fan speed sensor; electrical error or signal disturbed or very low fan speed.
1593	1761	0	129	DEF tank, DEF level above upper physical threshold.
1594	1761	1	129	DEF tank, DEF level below lower physical threshold.
1869	1761	2	129	DEF tank level, plausibility error.
1074	1761	14	127	DEF tank level; warning threshold exceeded.
1654	1761	14	138	Urea Tank Signal to HMI for indicating the Urea Tank-Level (Urea tank volume ratio low threshold 1).
1655	1761	14	138	DEF tank, DEF level below first warning threshold.
1656	1761	14	138	DEF tank, DEF level below second warning threshold.
1880	1761	14	138	DEF tank, DEF level below third warning threshold.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
654	2634	12	757	Early opening defect of main relay No detail informationen!
656	2634	12	757	DFC for stuck main relay error No detail informationen!
1524	2659	0	822	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value above maximum physical value.
1525	2659	1	822	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value below minii-mum physical value.
1523	2659	2	822	Exhaust Gas Recirculation AGS Sensor; signal not plausible.
1527	2659	2	822	Exhaust Gas Recirculation AGS Sensor; Temperature of EGR mass not plausible.
1526	2659	12	822	Exhaust Gas Recirculation AGS Sensor; plausibility error, AGS sensor has not passed the burn off process.
1763	2791	0	415	EGR actuator, temperature critical high.
1753	2791	2	415	EGR actuator, CAN error.
1758	2791	3	415	EGR actuator supply voltage is above the maximum threshold.
1759	2791	4	415	EGR actuator supply voltage is below minimum threshold.
1757	2791	6	415	EGR actuator current is above maximum threshold.
1752	2791	7	415	EGR actuator, actuator blocked.
1761	2791	7	415	EGR actuator, broken spring detected.
384	2791	12	415	Actuator EGR Valve; powerstage over temperature.
1755	2791	12	415	EGR Actuator, internal electrical fault.
1754	2791	13	415	EGR actuator, EOL calibration error.
1756	2791	13	415	EGR actuator, learning process aborted.
1760	2791	13	415	EGR actuator, learning process out of range.
1762	2791	16	415	EGR actuator, temperature high.
1337	2797	4	565	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 0; _IVDiaShCirGndToutBnk_0.
1339	2797	4	565	Injector diagnostic; Short circuit to ground cylinder bank 0.
1338	2798	4	566	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 1; _IVDiaShCirGndToutBnk_1.
1340	2798	4	566	Injector diagnostic; Short circuit to ground cylinder bank 1.
1135	3031	0	669	DEF tank, DEF temperature in DEF tank is to high.
1136	3031	1	669	DEF tank, DEF temperature below lower physical threshold.
1870	3031	2	669	Urea tank temperature outside of plausible thresholds.
273	3219	2	649	DFC SAE J1939 error No detail informationen!
889	3224	1	185	DFC for plausibility error Max for NOx sensor upstream of SCR Cat.
127	3224	2	596	DLC Error of CAN-Receive-Frame AT1IG1 NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect.
129	3224	2	596	DLC Error of CAN-Receive-Frame AT1IG1Vol NOX sensor.
128	3224	9	597	Timeout Error of CAN-Receive-Frame AT1IG1; NOX sensor upstream.
130	3224	9	597	Timeout Error of CAN-Receive-Frame AT1IG1Vol; NOX sensor.
659	3226	2	813	Nox feed back fault detection No detail informationen!
196	3227	2	638	DFC SAE J1939 error No detail informationen!
136	3234	2	114	DLC Error of CAN-Receive-Frame AT1O1 No detail informationen!
138	3234	2	114	DLC Error of CAN-Receive-Frame AT1O1Vol NOX.
137	3234	9	117	Timeout Error of CAN-Receive-Frame AT1OG1; NOX sensor (SCR-system down-stream cat; DPF-system downstream cat).
139	3234	9	117	Timeout Error of CAN-Receive-Frame AT1OG1Vol.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
887	3234	11	184	DFC for plausibility error Min for NOx sensor downstream of SCR Cat.
905	3241	0	883	Sensor SCR catalyst upstream temperature too high; plausibility error.
1047	3248	4	685	Sensor error particle filter downstream temperature; signal range check low.
809	3251	0	692	Differential pressure DPF maximum value is exceeded.
810	3251	0	692	Differential pressure sensor across DPF exceeds warning high limit.
812	3251	1	692	Differential pressure DPF, pressure below lower shutoff threshold.
813	3251	1	692	Differential pressure DPF, pressure below lower warning threshold.
807	3253	2	692	Differential pressure DPF, plausibility error.
1380	3253	2	692	Sensor differential pressure (DPF); plausibility error.
814	3253	3	692	Electrical error differential pressure B58 (DPF). (signal range check high).
815	3253	4	692	Electrical error differential pressure (DPF). signal range check low.
1077	3361	3	677	DEF dosing valve; short circuit to battery on low side.
1078	3361	3	677	DEF dosing valve; short circuit to battery or open load on high side.
1079	3361	4	677	Urea dosing valve; short circuit to ground or open load on low side.
1080	3361	4	677	DEF dosing valve; short circuit on high side.
1075	3361	6	677	DEF dosing valve; power at the end of injection too high.
908	3361	7	886	DEF dosing valve blocked (SCR).
1898	3519	3	277	DEF quality sensor, internal temperature sensor short circuit to battery or open load
1899	3519	4	277	DEF quality sensor, internal temperature sensor short circuit to ground.
1895	3519	12	277	DEF tank temperature, temperature too high
1908	3519	13	277	Temperature at UQS invalid.
1904	3520	2	278	DEF quality seonsor, bad DEF quality detected or no DEF measuring possible.
1896	3520	3	278	DEF quality sensor, short circuit to battery or open load
1897	3520	4	278	DEF quality sensor, short circuit to ground
1907	3520	13	278	Urea quality at UQS invalid.
943	3532	3	127	Sensor error DEF tank level; signal range check high.
1911	3532	3	127	The DEF Level at UQS out of max. physical range.
945	3532	4	127	Sensor error DEF tank level; signal range check low.
1912	3532	4	127	Quality at UQS out of min. physical range.
1635	3699	0	818	Maximum standstill time reached; oil exchange request ignored.
1616	3699	2	818	Passive regeneration of DPF; plausibility error. DPF differential pressure sensor and a further sensor or actuator CRT system defective.
1617	3699	2	818	Passive regeneration of DPF; DOC error. Temperature sensor us. and ds. DOC simultaneously defect.
1455	3711	12	711	Temperature during stand-still main phase too low or too high.
1917	3936	14	286	Standstill request ignored too long.
1918	3936	14	286	Standstill time based escalation requests Inducement step 2.
2011	4171	2	668	Dynamic temperatur check of temp before SCR.
1089	4243	11	783	SCR heater; Pressure line heater error and temperature condition to perform an afterrun (Group error diagnosis heater). SCR system heater diagnostic reports error; shut off SCR-system.
1122	4334	0	665	Supply module DEF, DEF pressure above upper physical threshold.
1124	4334	0	665	Urea pump pressure sensor; high signal not plausible.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1123	4334	1	665	Urea supply module pressure sensor; physical range check low (defect pressure sensor).
1125	4334	1	665	Urea pump pressure sensor; low signal not plausible.
1866	4334	2	665	DEF supply module pressure, plausibility error.
1104	4341	3	675	SCR-heater DEF supplyline; short circuit to battery.
1105	4341	4	675	SCR-heater DEF supply line; short circuit to ground.
1086	4341	5	675	SCR heater relay DEF supplyline secondary side; open load.
1102	4341	5	675	SCR heater relay DEF supply line primary side; open load.
1096	4343	3	673	SCR heater DEF pressureline; short circuit to battery.
1097	4343	4	673	SCR heater DEF pressureline; short circuit to ground.
1083	4343	5	673	SCR heater relay DEF pressureline secondary side; open load.
1094	4343	5	673	SCR heater relay DEF pressureline primary side; open load.
893	4343	11	871	SCR Monitoring; Pressure stabilisation error, general pressure check error (SCR).
1095	4343	12	673	Over Temperature error No detail informationen!
1092	4345	3	674	SCR heater DEF returnline; short circuit to battery.
1093	4345	4	674	SCR heater DEF returnline; short circuit to ground.
1081	4345	5	674	SCR heater relay DEF returnline sekondary side; open load.
1090	4345	5	674	SCR heater relay DEF returnline primary side; open load.
892	4345	11	236	Sensor backflow line pressure (SCR); plausibility error.
1091	4345	12	674	Over Temperature error . No detail informationen!
1069	4360	0	668	Exhaust temperature upstream SCR-Cat, temperature above upper physical threshold.
1070	4360	1	668	Sensed exhaust temperature before SCR-Cat is < physical low limit.
1865	4360	2	668	Exhaust temperature sensor upstream SCR, plausibility error.
1071	4361	2	668	Signal error for CAN message . No detail informationen!
1072	4361	3	668	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check high.
1073	4361	4	668	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check low.
903	4365	0	881	DEF tank temperature too high.
1137	4365	2	669	Tank temperature signal error for CAN message.
1138	4365	3	669	Sensor error urea tank temperature: short circuit to battery.
1914	4365	3	669	DEF qualitysensor, tank temperatur; Short circuit to battery or open load.
1139	4365	4	669	Sensor error urea tank temperature; short circuit to ground.
1915	4365	4	669	DEF qualitysensor, tank temperatur; Short circuit to ground.
1112	4366	3	671	SCR Tank heating valve; short circuit to battery.
1113	4366	4	671	SCR Tank heating valve; short circuit to ground.
1088	4366	5	671	SCR Tank heating valve secundary side: open load.
1110	4366	5	671	SCR tank heating valve primary side; open load.
1082	4366	5	762	SCR main relay (secondary side): open load.
1084	4366	5	762	SCR main relay (secondary side); Shortcut to battery.
1085	4366	5	762	SCR main relay (secondary side), heat relay (secondary side), heating elements or heating valve short to ground.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1111	4366	12	671	SCR-heater relay urea tank powerstage output; over temperature.
894	4374	13	872	Pressure stabilisation error dosing valve (SCR).
1120	4375	3	666	Urea pump motor; short circuit to battery.
1121	4375	4	666	Urea pump motor; short circuit to ground.
1118	4375	5	666	Urea pump motor; open load.
1131	4376	3	667	SCR reversal valve; short circuit to battery.
1132	4376	4	667	SCR reversing valve; short circuit to ground.
1493	4376	4	667	SCR reverting valve; short circuit to ground.
1129	4376	5	667	SCR reversal valve; open load.
1490	4376	5	667	SCR reverting valve; open load.
1130	4376	12	667	SCR reversing valve; over temperature.
1491	4376	12	667	SCR reverting valve; over temperature.
1039	4765	0	683	Temperature upstream DOC, temperature above upper shutoff threshold.
1040	4765	0	683	Temperature upstream DOC, temperature above upper warning threshold.
1029	4766	0	684	Temperature downstream DOC, temperature above upper shutoff threshold.
1030	4766	0	684	Temperature downstream DOC, temperature above upper warning threshold.
1036	4768	2	683	Temperature upstream DOC, plausibility error.
1881	4768	2	683	exhaust gas temperature sensors up- and downstream DOC are physically swapped
1044	4768	3	683	Electrical error exhaust gas temperature upstream (DOC); signal range check high.
1045	4768	4	683	Electrical error exhaust gas temperature upstream (DOC); signal range check low.
1026	4769	2	684	Temperature downstream DOC, plausibility error.
1402	4769	2	684	Sensor exhaust gas temperature OxiCat downstream (normal operation); plausibility error.
1403	4769	2	684	Sensor exhaust gas temperature OxiCat downstream (regeneration); plausibility error.
1034	4769	3	684	Sensor error exhaust gas temperature downstream (DOC); signal range check high.
1035	4769	4	684	Sensor error exhaust gas temperature downstream (DOC); signal range check low.
1423	5763	0	594	Warning threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap.
1424	5763	1	594	Shut off threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap.
1024	5763	3	594	Position sensor error of actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check high.
1226	5763	3	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery.
1227	5763	3	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery.
1025	5763	4	594	Position sensor error actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check low.
1228	5763	4	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground.
1229	5763	4	594	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground.
1232	5763	4	594	actuator AGR valve (2.9;3.6) throttle valve (4.1;6.1;7.8); Voltage below threshold.
1023	5763	5	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check low.
1223	5763	5	594	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); open load.
1014	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check high.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1022	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check high.
1224	5763	6	594	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (6.1,7.8); over current.
1230	5763	6	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Overload by short-circuit.
1016	5763	7	594	Actuator position for EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8) not plausible.
1231	5763	11	594	Power stage over temperature due to high current.
1015	520521	5	594	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check low.
648	523008	1	424	Manipulation control was triggered.
649	523008	2	424	Timeout error in Manipulation control.
825	523009	9	253	The pressure relief valve (PRV) has reached the number of allowed activations.
833	523009	10	253	Open time of Pressure Relief Valve (PRV) for wear out monitoring had exceeded.
362	523090	2	329	Engine Brake Pre-Selection switch; Plausibility Error.
164	523211	9	331	Timeout Error of CAN-Receive-Frame EBC1.
171	523212	9	333	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection.
174	523213	12	334	Timeout Error of CAN-Transmit-Frame ERC1 No detail informationen!
198	523216	9	337	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command.
179	523240	9	527	Timeout CAN-message FunModCtl; Function Mode Control.
919	523330	14	131	Immobilizer status; fuel blocked.
920	523330	14	131	DFC to block the fuel by Sia No detail informationen!
921	523330	14	131	DFC to indicate that TEN-code or UC-code received if ECU is learned. No detail informationen!
922	523330	14	131	DFC to indicate that no code is received via CAN. No detail informationen!
923	523330	14	131	DFC to indicate that wrong code is received. No detail informationen!
565	523350	4	151	Injector cylinder-bank 1; short circuit.
566	523352	4	152	Injector cylinder-bank 2; short circuit.
567	523354	12	153	Injector powerstage output defect.
826	523470	2	146	Pressure relief valve is forced to open, perform pressure increase.
827	523470	2	146	Pressure Relief Valve (PRV) forced to open. Performed by pressure increase.
876	523470	7	146	Maximum rail pressure exceeded (PRV).
831	523470	11	146	Pressure Relief Valve (PRV) error; Rail pressure out of tolerance range.
832	523470	11	146	Rail pressure out of tolerance range. The PRV can not be opened at this operating point with a pressure shock.
828	523470	12	146	Pressure Relief Valve (PRV) forced to open. Shutoff conditions.
829	523470	12	146	Pressure Relief Valve (PRV) forced to open. Warning conditions.
830	523470	14	146	Open Pressure Relief Valve (PRV).
980	523550	12	515	Terminal 50 was operated too long.
952	523580	2	555	Data set variant with the desired number not found Invalid variant dataset Identifier error. No detail informationen!

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
953	523580	11	555	An error has occurred in the switch over to the desired data set variant in the code word. Variant dataset switching error No detail informationen!
954	523580	11	555	The code word could not be read correctly from the EEPROM Variant dataset switching error. No detail informationen!
948	523601	13	282	Failure of sensor supply voltage 3.
462	523602	0	238	High fan speed; warning threshold exceeded.
463	523602	0	238	High fan speed; shut off threshold exceeded.
126	523603	9	338	Timeout Error of CAN-Receive-Frame AMB; Ambient Temperature Sensor.
300	523605	9	118	Timeout Error of CAN-Receive-Frame TSC1AE; Traction Control.
301	523606	9	119	Timeout Error of CAN-Receive-Frame TSC1AR; Retarder.
644	523612	3	555	Reported Over Voltage of Supply.
646	523612	4	555	Reported UnderVoltage of Supply.
387	523612	12	555	Internal software error ECU; injection cut off.
612	523612	12	555	Internal ECU monitoring detection reported error.
613	523612	12	555	ECU reported internal software error. Internal ECU monitoring detection reported error.
614	523612	12	555	ECU reported internal software error.
615	523612	12	555	ECU reported internal software error.
616	523612	12	555	ECU reported internal software error.
617	523612	12	555	ECU reported internal software error.
618	523612	12	555	ECU reported internal software error.
619	523612	12	555	Injection system, electrical error injectors.
620	523612	12	555	ECU reported internal software error.
621	523612	12	555	ECU reported internal software error.
623	523612	12	555	ECU reported internal software error.
624	523612	12	555	ECU reported internal software error.
625	523612	12	555	ECU reported internal software error.
627	523612	12	555	ECU reported internal software error.
628	523612	12	555	ECU reported internal software error.
629	523612	12	555	Diagnostic fault check to report the accelerator pedal position error.
630	523612	12	555	Diagnostic fault check to report the engine speed error.
631	523612	12	555	Error in the plausibility of the injection energizing time.
632	523612	12	555	Error in the plausibility of the start of energising angles.
633	523612	12	555	Diagnostic fault check to report the error due to non plausibility in ZFC.
634	523612	12	555	Diagnosis fault check to report the demand for normal mode due to an error in the PoI2 quantity.
635	523612	12	555	Diagnosis fault check to report the error to demand for an ICO due to an error in the PoI2 shut-off.
636	523612	12	555	Diagnosis fault check to report the error to demand for an ICO due to an error in the PoI3 efficiency factor.
637	523612	12	555	Internal ECU monitoring detection reported error.
638	523612	12	555	Monitoring of Fuel Quantity Correction.
639	523612	12	555	Diagnostic fault check to report the plausibility error in rail pressure monitoring.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
640	523612	12	555	Diagnostic fault check to report the error due to torque comparison.
641	523612	12	555	Diagnosis of curr path limitation forced by ECU monitoring level 2.
642	523612	12	555	Diagnosis of lead path limitation forced by ECU monitoring level 2.
643	523612	12	555	Diagnosis of set path limitation forced by ECU monitoring level 2.
714	523612	12	555	Diagnostic fault check to report WDA active due to errors in query-/response communication.
715	523612	12	555	Diagnostic fault check to report ABE active due to undervoltage detection.
716	523612	12	555	Diagnostic fault check to report ABE active due to overvoltage detection.
717	523612	12	555	Diagnostic fault check to report WDA/ABE active due to unknown reason.
1170	523612	12	555	Internal software error ECU.
1857	523612	12	555	Engine starter, plausibility error of starter release condition.
973	523612	14	555	Softwarereset CPU SWReset_0.
974	523612	14	555	Softwarereset CPU SWReset_1.
975	523612	14	555	Softwarereset CPU SWReset_2.
856	523613	0	134	Rail pressure metering unit, Positive governor deviation.
857	523613	0	134	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure exceeded.
858	523613	0	134	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure in metering unit exceeded (RailMeUn1).
859	523613	0	134	Rail pressure metering unit, Rail pressure below the target range. (RailMeUn2) Railsystem leakage detected.(RailMeUn10).
862	523613	0	134	Rail pressure metering unit, Maximum rail pressure exceeded.
865	523613	0	134	Setpoint of metering unit in overrun mode not plausible.
861	523613	1	134	Rail pressure metering unit, Minimum rail pressure exceeded (RailMeUn3). Negative deviation of rail pressure second stage (RailMeUn22).
864	523613	2	134	Rail pressure metering unit, Setpoint of metering unit in overrun mode not plausible.
594	523615	3	135	Metering unit (Fuel-System); short circuit to battery highside.
596	523615	3	135	Metering unit (Fuel-System); short circuit to battery low side.
598	523615	3	135	Metering unit, short circuit to battery.
595	523615	4	135	Metering unit (Fuel-System); short circuit to ground high side.
597	523615	4	135	Metering Unit (Fuel-System); short circuit to ground low side.
599	523615	4	135	Metering unit, short circuit to ground.
592	523615	5	135	Metering unit (Fuel-System); open load.
593	523615	12	135	Metering unit (Fuel-System); powerstage over temperature.
486	523618	3	133	Gearbox oil temperature; Short circuit to battery or broken harness.
487	523618	4	133	Gearbox oil temperature; Short circuit to ground.
488	523619	2	133	Physical range check high for exhaust gas temperature upstrem (SCR-CAT).
899	523632	0	877	Pressure overload of SCR-System.
900	523632	1	878	Pressure build-up error SCR-System.
1126	523632	2	665	Signal error for CAN message. No detail informationen!
1127	523632	3	665	Sensor error urea pump pressure; signal range check high.
1128	523632	4	665	Sensor error urea pump pressure; signal range check low.
1117	523632	11	666	Pump motor not available for actuation.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
897	523632	16	875	Pump pressure SCR metering unit too high.
898	523632	18	876	Pump pressure SCR metering unit too low.
881	523633	11	149	Lonterm adaption factor below threshold.
882	523633	11	149	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality).
883	523633	11	149	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality); temperature range 1.
122	523698	11	591	Shut off request from supervisory monitoring function.
780	523699	3	113	Boost pressure control; negative governor deviation below limit.
781	523699	4	113	learning valu too high No detail informationen!
167	523704	12	615	Timeout Error of CAN-Transmit-Frame EEC3.
178	523706	12	623	Timeout Error of CAN-Transmit-Frame FlEco No detail informationen!
125	523717	12	595	Timeout Error of CAN-Transmit-Frame AmbCon; Weather environments.
1100	523718	3	676	SCR main relay (primary side); short circuit to battery.
1488	523718	3	676	SCR mainrelay; short circuit to battery (only CV56B).
1101	523718	4	676	SCR main relay (primary side); short circuit to ground.
1489	523718	4	676	SCR mainrelay; short circuit to ground (only CV56B).
1098	523718	5	676	SCR main relay (primary side); open load.
1486	523718	5	676	SCR mainrelay; open load (only CV56B).
1099	523718	12	676	SCR main relay (primary side); powerstage over temperature.
1108	523719	3	672	SCR heater DEF supplymodule; short circuit to battery.
1109	523719	4	672	SCR heater DEF supplymodule; short circuit to ground.
1087	523719	5	672	SCR heater relay DEF supply modul secondary side; open load.
1106	523719	5	672	SCR heater relay DEF supplymodule primary side; open load.
1107	523719	12	672	Over Temperature error . No detail informationen!
914	523720	2	148	DEF supply module heater temperature; plausibility error (normal condition).
915	523720	2	148	Sensor DEF supply module heater temperature; plausibility error (cold start condition).
925	523720	8	148	DEF supply module heater temperature; duty cycle in failure range.
926	523720	8	148	DEF supply module heater temperature; duty cycle in invalid range.
916	523721	2	689	Sensor DEF supply module temperature; plausibility error (normal condition).
917	523721	2	689	Sensor DEF supply module temperature; plausibility error (cold start condition).
930	523721	8	689	DEF supply module temperature; duty cycle in failure range.
931	523721	8	689	Urea supply module temperature; duty cycle in invalid range.
927	523721	11	689	Urea supply module temperature measurement not available.
928	523722	8	691	DEF supply module PWM signal; period outside valid range.
929	523722	8	691	Detect faulty PWM signal from Supply Modul.
172	523741	14	618	Engine shut off request through CAN No detail informationen!
692	523752	0	758	Plausibiliti error during Rich to Lean switch over No detail informationen!
693	523752	0	758	Monitoring of Nox signal readyness No detail informationen!
575	523756	14	155	special pattern for special cases No detail informationen!
576	523757	14	156	special pattern for special cases No detail informationen!
577	523758	14	161	special pattern for special cases No detail informationen!
578	523759	14	162	special pattern for special cases No detail informationen!

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
579	523760	14	163	special pattern for special cases No detail informationen!
281	523766	9	118	Timeout Error of CAN-Receive-Frame Active TSC1AE.
282	523767	9	118	Timeout Error of CAN-Receive-Frame Passive TSC1AE.
283	523768	9	119	Timeout Error of CAN-Receive-Frame Active TSC1AR.
284	523769	9	119	Timeout Error of CAN-Receive-Frame Passive TSC1AR.
291	523776	9	119	Timeout Error of CAN-Receive-Frame TSC1TE - active.
292	523777	9	119	Passive Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint.
293	523778	9	118	Timeout Error of CAN-Receive-Frame TSC1TR.
294	523779	9	118	Passive Timeout Error of CAN-Receive-Frame TSC1TR.
1299	523788	0	655	Wastegate plauisibility error off CAN transmit message.
1300	523788	0	655	Timeout Error of CAN-Receive-Frame ComTrbChActr; Wastegate.
299	523788	12	655	Timeout Error of CAN-Transmit-Frame TrbCH; Status Wastegate.
202	523793	9	678	Timeout Error of CAN-Receive-Frame UAA10; AGS sensor service message.
203	523794	9	678	Timeout Error of CAN-Receive-Frame UAA11; AGS sensor data.
212	523803	9	678	Timeout error of CAN Receive Message RxEngPres; Status Burner Air Pump.
313	523858	12	679	Timeout Error of CAN-Transmit-Frame UAA11.
322	523867	12	679	Ansteuerung Brenner Luftpumpe;_Timeout Error of CAN-Transmit-Frame UAA1 on CAN A.
785	523889	3	113	over teperature of device driver of pressure control valve No detail informationen!
26	523891	14	263	When AirHt_ctDefSRCLoOn_mp is less than AirHt_ctMaxDef_C. DFC to SRC Low error when heater is On No detail informationen!
559	523895	13	158	Check of missing injector adjustment value programming (IMA) injector 1 (in firing order).
560	523896	13	158	check of missing injector adjustment value programming (IMA) injector 2 (in firing order).
561	523897	13	158	check of missing injector adjustment value programming (IMA) injector 3 (in firing order).
562	523898	13	158	check of missing injector adjustment value programming (IMA) injector 4 (in firing order).
563	523899	13	158	check of missing injector adjustment value programming (IMA) injector 5 (in firing order).
564	523900	13	158	check of missing injector adjustment value programming (IMA) injector 6 (in firing order).
836	523906	3	761	Electrical fuel pre - supply pump; short circuit to battery.
837	523906	4	761	Electrical fuel pre - supply pump. Short circuit to ground.
834	523906	5	761	Electrical fuel pre - supply pump; open load.
835	523906	12	761	Electrical fuel pre - supply pump. ECU powerstage over temperature.
1252	523910	0	695	Air Pump; operating voltage error.
1261	523910	6	695	Burner Control Air Pump; over current. Air pump electrically overloaded.
1249	523910	7	695	Air pump; CAN communication interrupted no purge function available.
1248	523910	9	695	Burner Control; Air Pump - CAN Lost. Air Pump; CAN communication lost.
1250	523910	12	695	Air Pump; internal error.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
55	523910	14	695	Air pump doesn´t achieve air mass flow setpoint. Burner Control - burner air pump.
58	523911	0	723	Burner dosing valve (DV2); overcurrent at the end of the injection phase.
60	523911	3	723	Burner dosing valve (DV2); short circuit to battery.
62	523911	4	723	Burner dosing valve (DV2); short circuit to ground.
63	523911	11	723	Burner dosing valve (DV2); short circuit high side powerstage.
59	523911	12	723	Burner dosing valve (DV2); powerstage over temperature.
66	523912	0	722	Physical range check high for burner dosing valve (DV2) downstream pressure; shut off regeneration.
69	523912	1	722	Physical range check low for burner dosing valve (DV2) downstream pressure; shut off regeneration. When burner injector is actuated, the measured pressure does not rise above ca. 1250mbar abs (expected: ca. 2400mbar).
64	523912	2	722	Burner dosing valve (DV2) downstream pressure sensor; plausibility error.
72	523912	3	722	Sensor error burner dosing valve (DV2) downstream pressure sensor; signal range check high.
73	523912	4	722	@ engines < 4l: Throttle valve error, Open Load or Short cut to Battery, blocked valve or wrong control signal for valve. @ engines with Burner T4i: Pressure Sensor error after valve (DV2), lower limit reached.
74	523913	3	721	Sensor error glow plug control diagnostic line voltage; signal range check high.
75	523913	4	721	Sensor error glow plug control diagnostic line voltage; signal range check low.
78	523914	3	721	Glow plug control; short circuit to battery water pump control (PWM).
79	523914	4	721	Glow plug control; short circuit to ground.
76	523914	5	721	Glow plug control; open load water pump control (PWM).
77	523914	12	721	Glow plug control; powerstage over temperature.
500	523915	0	165	HCl dosing valve (DV1); overcurrent at the end of the injection phase.
502	523915	3	159	HCl dosing valve (DV1); short circuit to battery.
503	523915	3	164	HCl dosing valve (DV1); short circuit to battery high side.
504	523915	4	159	HCl dosing valve (DV1); short circuit to ground.
1257	523915	7	853	HCl dosing valve (DV1); blocked open.
505	523915	11	164	HCl dosing valve (DV1); short circuit high side powerstage.
501	523915	12	166	HCl dosing valve (DV1); powerstage overtemperature.
508	523916	0	719	Physical range check high for HCl dosing valve (DV1) downstream pressure; shut off regeneration.
511	523916	1	719	Physical range check low for HCl dosing valve (DV1) downstream pressure; shut off regeneration.
506	523916	2	719	Sensor HCl dosing valve (DV1) downstream pressure; plausibility error.
514	523916	3	719	Sensor error HCl dosing valve (DV1) downstream pressure; signal range check high.
515	523916	4	719	Sensor error HCl dosing valve (DV1) downstream pressure; signal range check low.
524	523917	3	718	Sensor error DV1 & DV2 upstream pressure; signal range check high.
525	523917	4	718	Sensor error DV1 & DV2 upstream pressure; signal range check low.
534	523918	3	717	Sensor error DV1 & DV2 upstream temperature; signal range check high.
535	523918	4	717	Sensor error DV1 & DV2 upstream temperature; signal range check low.
755	523919	0	694	DPF burner air pump pressure sensor, pressure above upper shutoff threshold.
758	523919	1	694	DPF burner air pump pressure sensor, pressure below lower shutoff threshold.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
753	523919	2	694	DPF burner air pump pressure sensor, plausibility error.
1378	523919	2	694	Sensor air pump air pressure; plausibility error.
761	523919	3	694	DPF burner air pump pressure sensor, short circuit to battery or open load.
762	523919	4	694	DPF burner air pump pressure sensor, short circuit to ground.
765	523920	0	716	Exhaust gas pressure upstream burner, pressure above upper shutoff threshold.
763	523920	2	716	Exhaust gas pressure upstream burner, plausibility error.
1379	523920	2	716	Sensor exhaust gas back pressure burner; plausibility error.
770	523920	3	716	Exhaust gas pressure upstream burner, short circuit to battery or open load.
771	523920	4	716	Exhaust gas pressure upstream burner, short circuit to ground.
986	523921	0	714	Burner temperature, temperature above upper shutoff threshold.
989	523921	1	714	Burner temperature, temperature below lower shutoff threshold.
1395	523921	2	714	Burner temperature sensor; Plausibility Check for burner temperature sensor. Sensor burner temperature; plausibility error.
942	523921	3	714	Sensor error burner temperature; signal range check high.
944	523921	4	714	Sensor error burner temperature; signal range check low.
965	523922	3	715	Burner shut of valve; short circuit to battery.
1392	523922	4	715	Burner Shut Off Valve; short circuit to ground.
1389	523922	5	715	Burner Shut Off Valve; open load.
1262	523922	7	854	Burner Control; Shut-off Valve - Blocked closed. Burner Shut Off Valve; blocked closed.
1264	523922	7	855	Burner Shut Off Valve; blocked open.
1390	523922	12	715	Burner Shut Off Valve; power stage over temperature.
36	523923	3	729	UB1; Short circuit to battery error of actuator relay 1.
41	523923	4	729	Short circuit to ground error No detail informationen!
37	523924	3	167	UB2; Short circuit to battery error of actuator relay 2.
42	523924	4	167	UB2; Short circuit to ground actuator relais 2.
38	523925	3	731	UB3: Short circuit to battery error of actuator relay 3.
43	523925	4	731	UB3; Short circuit to ground actuator relais 3.
44	523926	4	732	UB4; Short circuit to ground aktuator relais 4.
40	523927	3	733	UB5; Short circuit to battery error of actuator relay 5, SCR-Heater/Rev. Valve.
168	523935	12	763	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages.
169	523936	12	764	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages.
193	523937	9	765	Timeout DFC for NOxSensGlbReqTx. No detail informationen!
133	523938	9	766	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1.
134	523939	9	766	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed.
135	523940	9	766	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1
140	523941	9	767	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2.
141	523942	9	767	Calibration message 1 of the after catalyst NOx sensor has failed.
142	523943	9	767	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2.
1158	523946	0	772	Zero fuel calibration injector 1 (in firing order); maximum value exceeded.
1164	523946	1	772	Zero fuel calibration injector 1 (in firing order); minimum value exceeded.
1159	523947	0	772	Zero fuel calibration injector 2 (in firing order); maximum value exceeded.
1165	523947	1	772	Zero fuel calibration injector 2 (in firing order); minimum value exceeded.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1160	523948	0	772	Zero fuel calibration injector 3 (in firing order); maximum value exceeded.
1166	523948	1	772	Zero fuel calibration injector 3 (in firing order); minimum value exceeded.
1161	523949	0	772	Zero fuel calibration injector 4 (in firing order); maximum value exceeded.
1167	523949	1	772	Zero fuel calibration injector 4 (in firing order); minimum value exceeded.
1162	523950	0	772	Zero fuel calibration injector 5 (in firing order); maximum value exceeded.
1168	523950	1	772	Zero fuel calibration injector 5 (in firing order); minimum value exceeded.
1163	523951	0	772	Zero fuel calibration injector 6 (in firing order); maximum value exceeded.
28	523953	2	728	Healing takes place if the condition for error detection is not present. Air temprature monitoring plausibility check array No detail informationen!
30	523955	2	728	Healing takes place if the condition for error detection is not present. Air temprature monitoring plausibility check array No detail informationen!
1011	523960	0	771	Physical range check high for EGR cooler downstream temperature.
1458	523960	0	771	High exhaust gas temperature EGR cooler downstream; warning threshold exceeded.
1012	523960	1	771	Physical range check low for EGR cooler downstream temperature.
124	523969	11	774	Fault entry for override control mode. No detail informationen!
1173	523973	14	779	SCR Tamper detection; derating timer below limit 1.
1174	523974	14	779	SCR Tamper detection; derating timer below limit 2.
1175	523975	14	175	Urea quality; derating timer below limit 1.
1176	523976	14	175	Urea qulaity; derating timer below limit 2.
1177	523977	14	781	Urea tank level; derating timer below limit 1.
1178	523978	14	781	Urea tank level; derating timer below limit 2.
918	523981	11	243	SCR plausibility, OBD and diagnosis; Stuck in range check of DEF tank temperature sensor. DEF-tank without heating function (heating phase).
360	523982	0	737	Powerstage diagnosis disabled; high battery voltage.
361	523982	1	737	Powerstage diagnosis disabled; low battery voltage.
1239	523984	3	788	UB7; Short circuit to battery error of actuator relay 6.
1241	523986	4	176	Relais SCR-Heater, Short Circuit to Ground (High side Control side).
1242	523987	4	791	UB6; Short circuit to ground actuator relay 6.
153	523992	9	793	
1282	523993	9	794	
1324	523995	13	795	Check of missing injector adjustment value programming (IMA) injector 7 (in firing order).
1325	523996	13	796	check of missing injector adjustment value programming (IMA) injector 8 (in firing order).
1326	523997	4	797	Injector cylinder bank 1 slave; short circuit.
1327	523998	4	798	Injector cylinder bank 2 slave; short circuit.
1328	523999	12	799	Injector powerstage output Slave defect.
1333	524000	3	177	Injector 7 (in firing order); short circuit.
1329	524000	5	177	Injector 7 (in firing order); interruption of electric connection.
1334	524001	3	178	Injector 8 (in firing order); short circuit.
1330	524001	5	178	Injector 8 (in firing order); interruption of electric connection.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
56	524013	7	856	Burner Control; burner Flame;Burner does not start after x trials (burner flame lost detection). Burner flame unintentional deleted.
1255	524013	7	857	Burner Control; Flame lost max. Burner operation is interrupted too often.
1254	524014	1	858	Air inlet EPV - pressure too low. Air pressure glow plug flush line; below limit.
1259	524016	2	859	Burner Control; HFM - Plausibilitätsfehler 1. Amount of air is not plausible to pump speed.
1258	524016	11	859	Burner Control; HFM - Electrical Fault. HFM sensor; electrical fault.
1219	524018	14	786	HMI engine derate service state. DPF wasn´t regenerated, power reduction phase 1 (manuell regeneration request).
1247	524019	11	862	Burner Control; Air Line - Blocked. Air Pump; air lines blocked.
57	524020	14	863	Burner Control: power reduction due to low lambda. Engine power; Not enough oxygen for regeneration.
1263	524021	11	864	Burner Control; Fuel line ShutOff downstream - broken. Burner fuel line pipe leak behind Shut Off Valve.
1220	524022	14	786	HMI engine derate stop state. DPF wasn´t regenerated, power reduction phase 2 (manuell regeneration request).
1302	524024	11	866	Deviation of the exhaust gas temperature setpoint to actual value downstream (DOC) too high.
1481	524025	5	845	DPF system; operating voltage error.
805	524025	14	845	Particulate filter regeneration. Regeneration after time X is not successful (The error occurs when the regeneration times (3x) over the max. has been aborted allowed recovery time).
1882	524025	14	845	The standstill-regeneration mode time exceeds the long-limit. Vehicle was too long or too often in standstill mode. Make oil change and reset counter.
1883	524025	14	845	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Make oil change and reset counter.
1431	524028	2	815	CAN message PROEGRActr; plausibility error.
1432	524029	2	815	Timeout Error of CAN-Receive-Frame ComEGRActr - exhaust gas recirculation positioner.
1440	524030	7	815	EGR actuator; internal error.
1441	524031	13	815	EGR actuator, calibration error.
1442	524032	2	815	EGR actuator; status message "EGRCust" is missing.
1443	524033	7	815	EGR actuator; due to overload in Save Mode.
1438	524034	3	816	Disc separator; short circuit to battery.
1439	524034	4	816	Disc separator; short circuit to ground.
1436	524034	5	816	Disc Separator; open load.
1437	524034	12	816	Disc Separator; powerstage over temperature.
1341	524035	12	555	Injector diagnostics; time out error in the SPI communication.
1342	524036	12	555	Injector diagnostics Slave; time out error in the SPI communication.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1285	524038	9	824	Timeout error of CAN-Receive-Frame ComMS_Sys1TO (error memory Slave); Master-Slave internal CAN message.
1286	524039	9	825	Timeout error of CAN-Receive-Frame ComMS_Sys2TO (error memory Slave); Master-Slave internal CAN message.
1287	524040	9	826	Timeout error of CAN-Receive-Frame ComMS_Sys3TO (error memory Slave); Master-Slave internal CAN message.
1288	524041	9	827	Timeout error of CAN-Receive-Frame ComMS_Sys4TO (error memory Slave); Master-Slave internal CAN message.
1289	524042	9	828	Timeout error of CAN-Receive-Frame ComMS_Sys5TO (error memory Slave); Master-Slave internal CAN message.
1290	524043	9	829	Timeout error of CAN-Receive-Frame ComMS_Sys6TO (error memory Slave); Master-Slave internal CAN message.
1482	524044	9	188	CAN message ComMS_Sys7 not received from slave.
1291	524045	9	831	Master Slave, Error of message counter CAN receive message ComMSMoFOvR; ComMSMoFOvR1CNT.
1292	524046	9	832	Master-Slave CAN; Error Checksum of CAN-Receive Message.
1293	524047	9	833	Master-Slave CAN; Error of message length of CAN receive message ComMSMoFOvR;_ComMSMoFOvR1DLC.
1294	524048	9	834	Timeout error CAN message ComMSMoFOvR1TO error memory Slave.
1357	524052	11	836	Error memory Slave reports FID MSMonFC2 (collective error).
1368	524052	11	836	Error memory Slave reports FID MSMonFC3 (collective error).
1485	524052	11	836	Master ECU and Slave ECU data sets or software are not identical.
1505	524057	2	843	Fuel low pressure pump; error pressure build up.
806	524058	2	844	Particulate filter; regeneration not successful.
1558	524063	3	869	SCR heater main relay; short circuit to battery.
1559	524063	4	869	SCR heater main relay load side (K31) on heating valve (Y31), Short cut to ground.
1555	524063	5	869	SCR heater return line; open load.
1556	524063	5	869	SCR main relay not connected.
1557	524063	5	869	SCR heater pressure line; open load.
1560	524063	5	869	SCR relay for suction line not connected.
1561	524063	5	869	SCR heater supply module; open load.
1562	524063	5	869	SCR heater tank; open load.
1646	524063	12	869	DEF supply modul, time for defrosting too long.
1647	524063	12	869	DEF tank, time for defrosting too long.
1565	524065	0	892	Pressure sensor upstream SCR-CAT, pressure above upper physical threshold.
1566	524065	1	892	Pressure sensor upstream SCR-CAT, pressure below lower physical threshold.
1598	524065	2	892	Pressure sensor upstream SCR-CAT, plausibility error.
1569	524065	3	892	Pressure sensor upstream SCR-CAT; short circuit battery or open load.
1570	524065	4	892	Pressure sensor upstream SCR-CAT; short circuit ground.
1579	524066	3	893	SCR measurement heater output stage; short circuit battery or open load.
1581	524067	0	894	DEF supply module, heater temperature above upper physical threshold.
1585	524067	0	894	DEF supply module, temperature above upper physical threshold.
1582	524067	1	894	DEF supply module, heater temperature below lower physical threshold.
1586	524067	1	894	DEF supply module, temperature below lower physical threshold.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1867	524067	2	894	Supply module heater temperature, plausibility error.
1868	524067	2	894	Supply module temperature, plausibility error.
1484	524068	2	895	Master ECU and Slave ECU have been identified as the same types.
1345	524069	9	896	Timeout Error of CAN-Receive-Frame MSMon_FidFCCTO; Master-Slave CAN communication faulty.
1529	524070	2	897	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream NOx value (Sensor self diagnostic DFC set by Deutz-SW). NOx-Sensor before SCR-Cat: Invalid upstream NOx value.
1530	524071	2	898	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream lambda value (Sensor self diagnostic DFC set by Deutz-SW).
1531	524072	2	899	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream lambda value (Sensor self diagnostic DFC set by Deutz-SW).
1532	524073	2	245	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream NOx value (Sensor self diagnostic DFC set by Deutz-SW).
1860	524074	2	246	NOx-Sensor after SCR-Cat: Nox-Sensor dew point problem or plausibility problem.
1533	524074	9	246	NOx sensor downstream SCR-CAT, sensor internally open load.
1534	524075	11	247	NOx sensor downstream SCR-CAT, sensor internally short circuit.
1861	524076	2	248	NOx-Sensor before SCR-Cat: Nox-Sensor dew point problem or plausibility problem.
1535	524076	9	248	NOx sensor upstream SCR-CAT, sensor internally open line.
1536	524077	11	249	NOx sensor upstream SCR-CAT, sensor internally short circuit.
1537	524078	9	255	NOx sensor downstream SCR-CAT, lambda value above upper physical threshold.
1538	524079	9	256	NOx sensor downstream SCR-CAT, lambda value below lower physical threshold.
1539	524080	9	257	NOx sensor upstream SCR-CAT, lambda value above upper physical threshold.
1540	524081	9	258	NOx sensor upstream SCR-CAT, lambda value below lower physical threshold.
1541	524082	9	259	(Downstream NOx-Sensor) Diagnostic Fault Check for downstream NOx value over maximum limit (DFC set by Deutz-SW).
1542	524083	9	261	NOx-Sensor downstream SCR-CAT, NOx value below minimum value.
1543	524084	9	911	NOx-Sensor upstream SCR-CAT, NOx value above maximum value.
1544	524085	9	912	NOx sensor upstream SCR-CAT, NOx value below lower physical threshold.
1621	524087	3	884	Urea Error Lamp; short circuit battery.
1622	524087	4	884	Urea Error Lamp; short circuit ground.
1619	524087	5	884	Urea Error Lamp; open load.
1620	524087	12	884	Urea Error Lamp; temperatur over limit.
1658	524096	14	196	Control of the SCR system; If the start stop counter (EPA-Counter) exceeds the threshold. SCRCtl_ctEngStrtStopThresh_C. This counter will increment only once in each driving cycle in case of an SCR error. If the counter reaches the threshold, the DFC will be set to inhibit the engine start. Engine will not be started, because of EPA-Counter.
1663	524097	9	921	Timeout error of CAN-Transmit-Frame DPFBrnAirPmpCtl.
1664	524098	9	922	Timeout error of CAN-Transmit-Frame ComDPFBrnPT.
1665	524099	9	923	Timeout error of CAN-Transmit-Frame ComDPFC1.
1666	524100	9	924	Timeout error of CAN-Transmit-Frame ComDPFHisDat.
1667	524101	9	925	Timeout error of CAN-Transmit-Frame ComDPFTstMon.
1674	524102	9	926	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmpCtl.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1675	524103	9	927	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmp.
1676	524104	9	928	Timeout error of CAN-Receive-Frame ComRxDPFCtl.
1668	524105	9	929	Timeout error of CAN-Transmit-Frame ComEGRMsFlw.
1677	524106	9	195	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw1.
1678	524107	9	931	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw2.
1669	524108	9	932	Timeout error of CAN-Transmit-Frame ComEGRTVActr.
1679	524109	9	933	Timeout error of CAN-Receive-Frame ComRxEGRTVActr.
1670	524110	9	934	Timeout error of CAN-Transmit-Frame ComETVActrTO.
1680	524111	9	935	Timeout error of CAN-Receive-Frame ComRxETVActr.
1671	524112	9	936	Timeout ComIntake Throttle Valve Actr.
1681	524113	9	937	Timeout error of CAN-Receive-Frame ComRxITVActr.
1659	524114	9	938	Timeout error of CAN-Transmit-Frame A1DOC.
1660	524115	9	939	Timeout error of CAN-Transmit-Frame AT1S.
1661	524116	9	194	Timeout error of CAN-Transmit-Frame SCR2.
1662	524117	9	941	Timeout error of CAN-Transmit-Frame SCR3.
1672	524118	9	942	Timeout error of CAN-Receive-Frame ComRxCM1.
1673	524119	9	943	Timeout error of CAN-Receive-Frame ComRxCustSCR3.
1682	524120	9	944	Timeout error of CAN-Receive-Frame ComRxSCRHtDiag.
1683	524121	9	945	Timeout error of CAN-Receive-Frame ComRxTrbChActr.
1684	524122	9	946	Timeout error of CAN-Receive-Frame ComRxUQSens.
1685	524123	9	947	Timeout error of CAN-Receive-Frame ComSCRHtCtl.
1686	524124	9	948	Timeout error of CAN-Receive-Frame ComTxAT1IMG.
1687	524125	9	949	Timeout error of CAN-Receive-Frame ComTxTrbChActr
1631	524132	0	955	Fuel low pressure upstream fuel low pressure pump, pressure above maximum warning threshold.
1632	524132	0	955	Fuel low pressure upstream fuel low pressure pump, pressure above maximum shut off threshold.
1633	524132	1	955	Fuel low pressure upstream fuel low pressure pump, pressure below minimum shut off threshold.
1634	524132	1	955	Fuel low pressure upstream fuel low pressure pump, pressure below minimum warning threshold.
1630	524132	2	955	Fuel low pressure upstream fuel low pressure pump not plausible.
1698	524133	2	956	HMI system; set if restore button blocked.
1699	524134	0	957	DPF, ash load exceeds the shutoff threshold.
1700	524134	0	957	DPF, ash load exceeds the warning threshold.
1701	524135	0	958	DPF, soot load exceeds the shutoff threshold.
1703	524135	0	958	DPF, soot load exceeds the warning threshold.
1702	524135	14	958	DPF, soot load exceeds the service request threshold.
1827	524141	7	192	DEF dosing valve, dosing valve blocked.
1858	524147	7	966	SCR-System, reverting valve blocked
1639	524147	13	966	SCR System,pressure build up not possible.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
2013	524147	13	996	Set together with DFC_SCRCoBldUpLoPres. DFC_SCRCoBldUpLoPresRst is only used for inducement purposes. It ensures that legal inducement is working correctly.
1545	524149	2	968	Plausibility error between pressure downstream turbine (PTrbnDs) and ambient air pressure (EnvP).
1597	524149	2	968	Pressure downstream turbine, plausibility error.
1874	524152	2	971	Urea Quality Sensor; Timeout CAN message.
1875	524153	2	997	Urea tank level & urea tank temperature via CAN bus, timeout of CAN message.
1705	524156	9	972	Timeout error of CAN-Receive-Frame ComRxEBC2.
1859	524175	0	993	SCR-CAT, Nox emissions above maximum threshold.
1863	524177	7	995	SCR System, DEF suction line blocked.
1864	524178	7	996	SCR System, DEF pressure out of range.
1889	524189	9	269	Master / Slave Can disturbed.
1891	524190	14	272	Inducement level 1 activ.
1892	524191	14	273	Inducement level 2 activ.
1893	524193	8	275	The standstill-regeneration mode time exceeds the long limit threshold. Vehicle was too long or too often in standstill mode. Change oil and reset counter.
1894	524194	8	276	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Change oil and reset counter.
1900	524195	14	279	Standstill request due to crystalisation ignored too long.
1902	524196	2	283	Variant handling, Synchronisation error.
1901	524196	13	283	Variant handling, address error.
1943	524202	11	313	SCR error code in master ECU active.
1944	524203	11	313	DEF tank level failure is in master ECU active.
1945	524204	11	313	SCR afterrun failure is in master ECU active.
1946	524205	11	313	SCR Co2Off failure is in master ECU active.
1947	524206	11	313	SCR disable DEF dosing failure is in master ECU active.
1971	524230	11	315	Inducement HW Failure Slave.
1972	524231	11	315	Inducement SCR Tamp. Slave.
1973	524232	11	315	Inducement DEF Qualitity in Slave ECU.
1980	524239	11	315	SCR regeneration failure is in slave ECU active.
1989	524248	11	315	NOX sensor downstream error in slave ECU.
1990	524249	11	315	DEF dosing valve error in slave ECU.
1992	524251	11	315	DEF pressure problems in slave ECU.
1993	524252	11	315	Reverting valve error in slave ECU.
1994	524253	11	315	DEF back flow line heater error on slave ECU.
1995	524254	11	315	Error NOx-Tailpipe emissions exceeded on Slave ECU.
1996	524255	11	315	DEF suction line heater error on slave ECU.
1997	524256	11	315	DEF supply module heater error on slave ECU.
1998	524257	11	315	Error Exhaust pressure upstream SCR on Slave ECU.

Table 3-11. Deutz Trouble Codes (D2.9 Engine)

KWP-Code	SPN	FMI	Blink code	Error Identification
1999	524258	11	315	Error Exhaust temperature upstream SCR on Slave ECU.
2000	524259	11	315	DEF pressure line heater error on slave ECU.
2001	524260	11	315	Error Urea pump temperature on Slave ECU.
2002	524261	11	315	Error DEF heater relais on Slave ECU.
2007	524266	14	287	Announcement triggers the Inducement Level 2.
2008	524267	14	845	Max. launch time for stand still exceeded (60min).

Table 3-12. DTC to SPN/FMI Cross Reference Chart

SPN Code	FMI Code	DTC	Description
51		2112	Unable to Reach Higher TPS
51	0	221	TPS 2 Signal Voltage Low
51	1	121	TPS 1 Lower Than TPS 2
51	3	123	TPS 1 Signal Voltage High
51	4	122	TPS 1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	31	2135	TPS 1/2 Simultaneous Voltages
94	3	92	Fuel Pump High Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP High Pressure
108	0	2229	BP Pressure High
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High Voltage
174	4	182	Fuel Temp Gasoline Low Voltage
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 Loss
629	31	1614	RTI 3 Loss
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
636	2	336	Crank Sync Noise
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
639	12	1626	CAN Tx Failure
639	12	1627	CAN Rx Failure
639	13	1628	CAN Address Conflict Failure

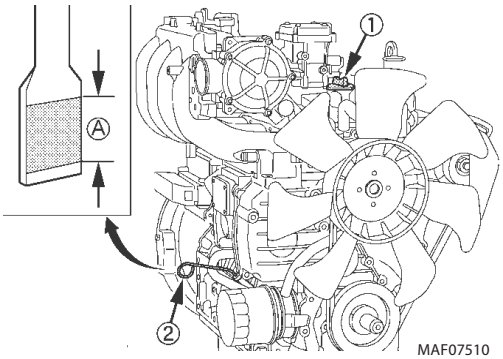
Table 3-12. DTC to SPN/FMI Cross Reference Chart

SPN Code	FMI Code	DTC	Description
639	31	1629	Loss of TSC 1
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
724	10	134	EGO 1 Open/Inactive
1079	3	643	External 5V Reference High
1079	4	642	External 5V Reference Low
1384	31	1625	Shutdown Request
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
5294	4	91	Fuel Pump Low Voltage
520200	0	171	Adaptive Learn High Gasoline
520200	1	172	Adaptive Learn Low Gasoline
520202	0	1161	Adaptive Learn High LPG
520202	1	1162	Adaptive Learn Low LPG
520204	0	1155	Closed Loop Multiplier High Gasoline
520204	1	1156	Closed Loop Multiplier Low Gasoline
520206	0	1151	Closed Loop Multiplier High LPG
520206	1	1152	Closed Loop Multiplier Low LPG
520208	10	154	EGO 2 Open/Inactive
520211	10	420	Gasoline Cat Monitor
520213	10	1165	LPG Cat Monitor
520240	3	188	Fuel Temp LPG High Voltage
520240	4	187	Fuel Temp LPG Low Voltage
520251	3	223	TPS 2 Signal High Voltage
520251	4	222	TPS 2 Signal Low Voltage
520260	0	1171	LPG Pressure Higher Than Expected
520260	1	1172	LPG Pressure Lower Than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	12	1178	EPR Internal Comm Fault
520260	31	1173	EPR Comm Lost

3.21 KUBOTA ENGINE GENERAL MAINTENANCE

Checking Oil Level

1. Make sure machine and engine are level and stop engine before checking oil level.
2. Remove oil level gauge and wipe it clean.
3. Put oil level gauge and remove again.
4. Check oil level. Oil level should be within range as shown in below Figure.



1. Oil Filler Plug **2.** Oil Level Gauge

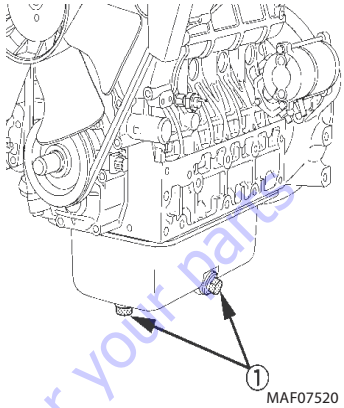
Replacing Engine Oil

1. Make sure machine and engine are level.
2. Allow engine to warm up as it will be easier to drain oil when it is warm.
3. Stop engine.
4. Place oil tray under engine.

⚠ CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.

5. Remove drain plug at the bottom of the engine and drain oil.
6. Replace the drain plug gasket and close the drain plug.



1. Oil Drain Plug

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

7. Add new engine oil up to the upper limit of the oil level gauge.
8. Refer Section 1 for capacity and refer to Figure 3-78., Engine Oil Viscosity for the proper grade.

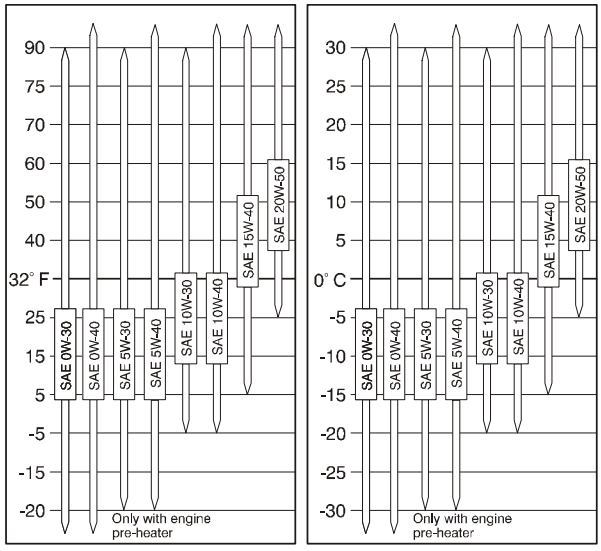


Figure 3-78. Engine Oil Viscosity

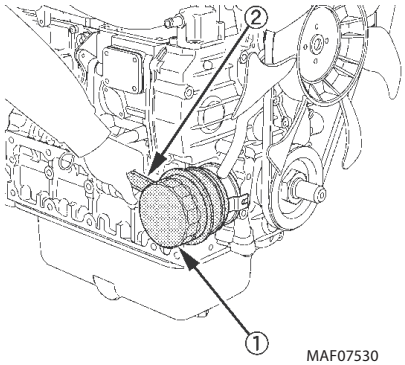
Replacing the Oil Filter

1. Stop the engine and allow it to cool down before replacing the filter.

⚠ CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN REPLACING FILTER

2. Clean all debris, hydraulic fluid etc. around the filter area.
3. Use a filter wrench, remove the oil filter. Collect any escaping oil in a suitable container.

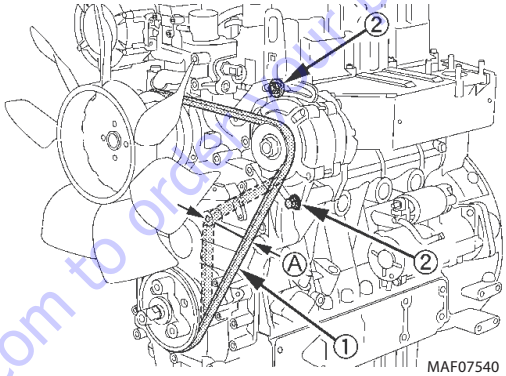


1. Oil Filter Cartridge
2. Wrench

4. Apply a light film of clean oil to the gasket of new oil filter cartridge.
5. Install oil filter cartridge and turn by hand until the gasket contacts the seal surface.
6. Check Oil level and pressure. Add oil if necessary.
7. Clean any oil sticking to the oil filter or machine completely.

Maintenance of the Drive Belt

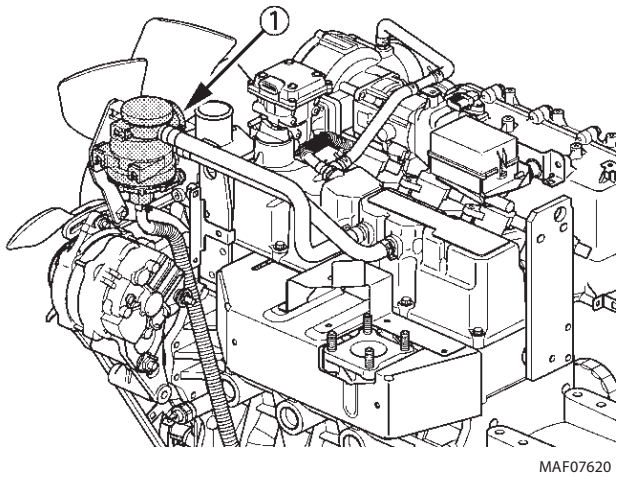
1. Make sure to stop the engine and remove key before checking the belt tension.
2. Check belt tension by applying thumb pressure to belt between the pulleys.
3. If belt tension is not correct, loosen the alternator mounting bolts, using a lever placed between alternator and engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace the fan belt, if damaged.



1. Fan Belt
2. Bolt and Nut

REPLACING OIL SEPARATOR

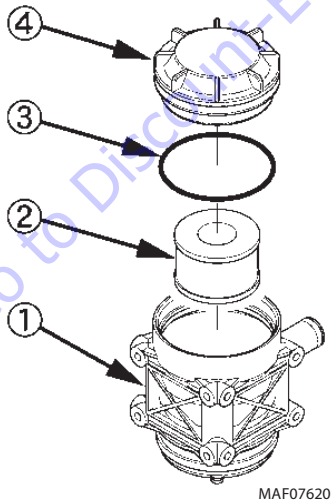
1. Stop the engine and allow it to cool before replacing the oil separator.



MAF07620

1. Oil Separator

2. Remove the cover and take out oil separator element and gasket.
3. Clean any oil and grease in the area.
4. Install a new oil separator element and gasket into position.
5. Install the cover.



MAF07620

1. Body
2. Oil Separator Element
3. Gasket
4. Cover

Table 3-13. Engine Fault Codes - Kubota Engine

SPN Code	FMI Code	DTC	Description
29	3	2128	FPP2 voltage high
29	4	2127	FPP2 voltage low
51	0	221	TPS1 Higher Than TPS2
51	1	121	TPS1 Lower Than TPS2
51	3	123	TPS1 Signal Voltage High
51	4	122	TPS1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	7	2112	Unable to Reach Higher TPS
51	31	2135	TPS 1/2 Simultaneous Voltages
91	3	2122	FPP1 Voltage High
91	4	2123	FPP1 Voltage Low
91	16	2126	FPP1 Higher Than FPP2
91	18	2121	FPP1 Lower Than FPP2
91	31	1121	FPP Voltage Error
94	0	88	Fuel pressure high
94	1	87	Fuel pressure low
94	3	92	Fuel Pump High Voltage
94	4	91	Fuel Pump Low Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP high pressure
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High
174	4	182	Fuel Temp Gasoline Low
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 loss

Table 3-13. Engine Fault Codes - Kubota Engine

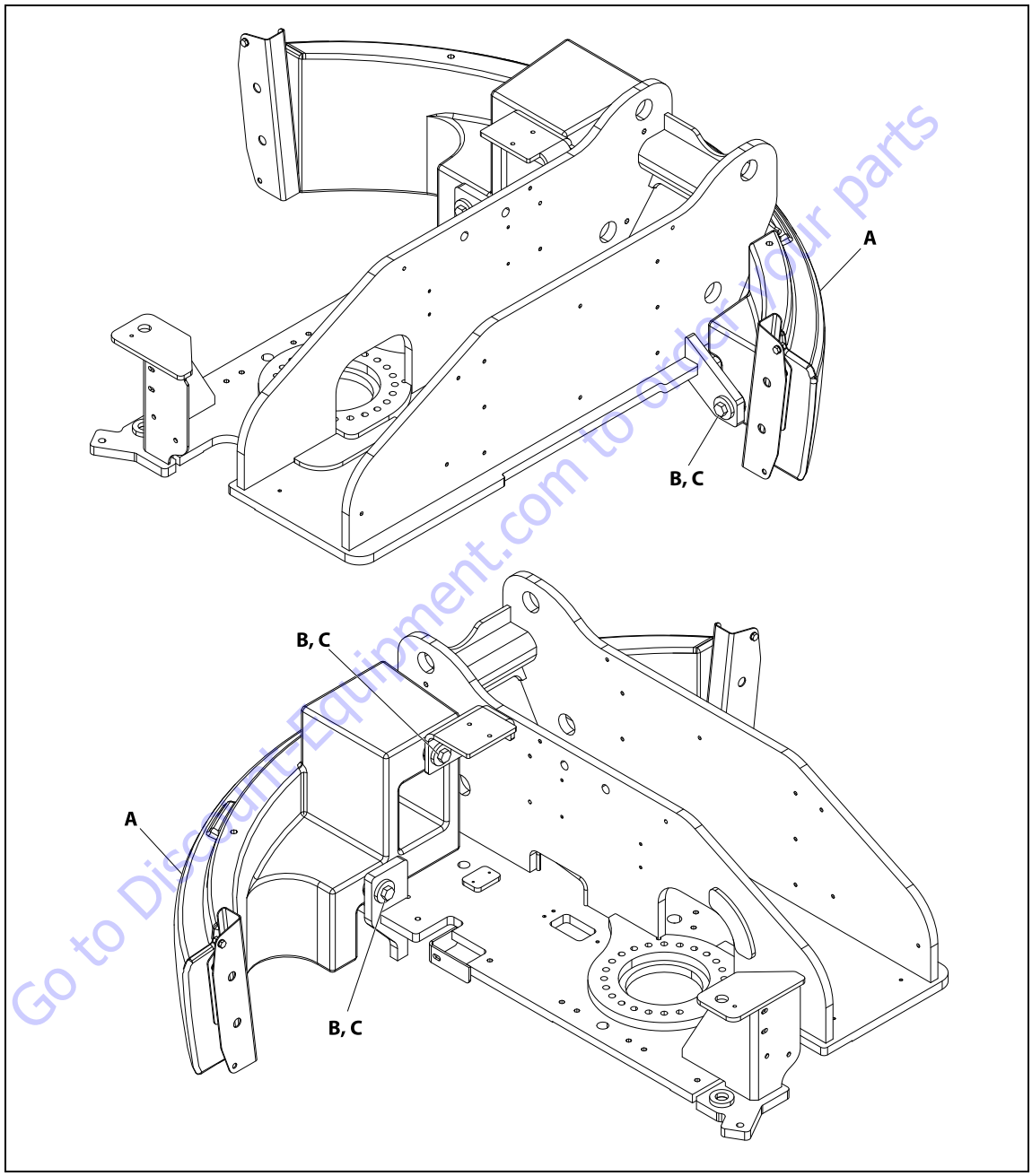
SPN Code	FMI Code	DTC	Description
629	31	1614	RTI 3 Loss
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
632	31	359	Fuel run-out
636	2	336	Crank Sync Noise
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
731	2	326	Excessive Knock 1
731	4	327	Knock 1 Sensor Open
1079	3	643	External 5V Reference 1 High
1079	4	642	External 5V Reference 1 Low
1079	31	1611	External 5V Reference Shorted
1080	3	653	External 5V Reference 2 High
1080	4	652	External 5V Reference 2 Low
1268	5	2300	Spark Coil 1 Primary Shorted
1268	6	2301	Spark Coil 1 Primary Short to Power
1269	5	2303	Spark Coil 2 Primary Shorted
1269	6	2304	Spark Coil 2 Primary Short to Power
1270	5	2306	Spark Coil 3 Primary Shorted
1270	6	2307	Spark Coil 3 Primary Short to Power
1271	5	2309	Spark Coil 4 Primary Shorted
1271	6	2310	Spark Coil 4 Primary Short to Power
1347	6	629	Fuel Pump Relay Shorted
1348	3	629	Fuel Pump Relay Shorted
1348	4	628	Fuel Pump Relay Shorted
1348	5	627	Fuel Pump Relay Open
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
1634	13	1673	Calibration Configuration Error
3050	11	420	Gasoline Cat Monitor
3050	11	1165	LPG Cat Monitor

Table 3-13. Engine Fault Codes - Kubota Engine

SPN Code	FMI Code	DTC	Description
3050	11	1166	NG Cat Monitor
3147	5	628	Fuel Pump Relay Shorted
3217	5	134	EGO 1 Open/Inactive
3227	5	154	EGO 2 Open/Inactive
3468	1	187	Fuel Temp LPG Low
3673	3	223	TPS2 Signal Voltage High
3673	4	222	TPS2 Signal Voltage Low
4236	0	1151	Closed Loop Multiplier High LPG
4236	0	1153	Closed Loop Multiplier High NG
4236	0	1155	Closed Loop Multiplier High Gasoline
4236	1	1152	Closed Loop Multiplier Low LPG
4236	1	1154	Closed Loop Multiplier Low NG
4236	1	1156	Closed Loop Multiplier Low Gasoline
4237	0	171	Adaptive Learn High Gasoline
4237	0	1161	Adaptive Learn High LPG
4237	0	1163	Adaptive Learn High NG
4237	1	172	Adaptive Learn Low Gasoline
4237	1	1162	Adaptive Learn Low LPG
4237	1	1164	Adaptive Learn Low NG
520260	0	1171	EPR Pressure Higher than Expected
520260	1	1172	EPR Pressure Lower than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	31	1173	EPR Comm Lost

3.22 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-79., Counterweight.



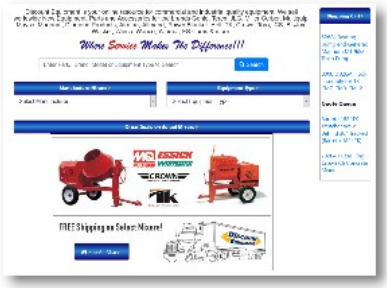
A. Counterweight Casting
B. Apply High Strength Threadlocking Compound to Bolt Threads and to Threads in Counterweight.
C. Torque to 345.9 ft. lbs. (469 Nm). Typical Three Places.

Figure 3-79. Counterweight

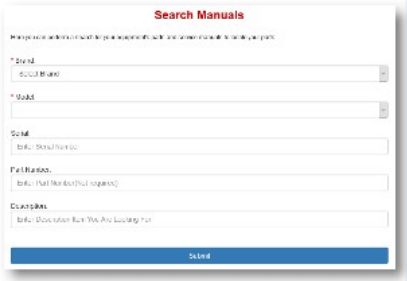
PARTS FINDER

Search Website by Part Number

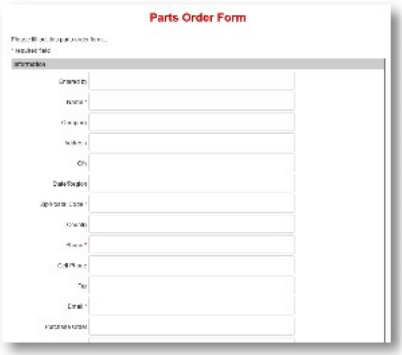
Discount Equipment



Search Manual Library For Parts Manual & Lookup Part Numbers – Purchase or Request Quote



Can't Find Part or Manual? Request Help by Manufacturer, Model & Description



Discount-Equipment.com is your online resource for quality parts & equipment.
Florida: 561-964-4949 Outside Florida TOLL FREE: 877-690-3101

Need parts?

Click on this link: http://www.discount-equipment.com/category/5443-parts/ and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on once of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 4. BOOM & PLATFORM

4.1 BOOM SYSTEMS

Platform Control Enable System

The platform controls make use of a time dependent enable circuit to limit the time avail ability of "live" or enabled controls. When the footswitch is depressed, the controls are enabled and the operator has 7 seconds to operate any control. The controls will remain enabled as long as the operator continues to use any function and will remain enabled 7 seconds after the last function has been used. While the controls are "live", the enabled light will be illuminated in the platform display panel. When the time limit has been reached, the enabled light will turn off and the controls will be disabled. To continue use of the machine the controls must be re-enabled to start the timer system over again. This is done by releasing all functions, then releasing and re-depressing the footswitch.

Transport Position Sensing System

The transport position sensing system uses a rotary angle sensor with internal redundancy (mounted on the upper upright at the lift cylinder pivot bushing) and the tower boom angle switch (mounted on the lower upright at the upper link pivot bushing) to sense when the boom is in the position associated with high speed travel. The rotary angle sensors have inverse signals with a spring return to a safe state. The tower boomswitch is normally closed and positively open in the safe state. Above transport angle is recognized when the main boom travels from the stowed position to 4° to 6° above horizontal (it resets at less than 3° above horizontal) or when the upper tower boom is sensed to be more than 6° to 10° above horizontal (it resets at 1° to5° above horizontal). The main boom may be telescoped to any position, and the articulating jib (if equipped) may be in any position. This system is used to control the following systems:

- Above Elevation - Drive Speed Cutback System
- Drive/Steer – Boom Function Interlock System (CE Only)
- Tower boom soft stop.
- Main Boom soft stop (top and bottom).

Platform Load Sensing System (LSS)

The Platform Load Sensing System consists of 4 load cells, mounted between the platform and platform support, and a dedicated electronic interface module (EIM) located below the platform console. This system measures the weight in the platform. When the capacity is exceeded, or when there is a fault in the system, the platform overload indicator will flash, the platform alarm will sound at the standard JLG duty cycle of 5sec on / 2sec off and all platform controls (except emergency descent) will be disabled.

Beyond Transport Position - Drive Speed Cutback System

When boom is positioned beyond the Transport Position as described in the Transport Position Sensing System (item 11), the drive pump command is automatically restricted to a value that results in a drive speed of approximately 0.5 mph(0.4 mph for 520AJ). See Drive System (item 18) for more detail on the drive speeds, and see the Chassis Tilt Indicator System (item 3) for interaction with the tilt sensor.

Drive/Steer –Boom Function Interlock System

The Drive/Steer – Boom Function Interlock System uses the Transport Position Sensing System (item 11) to sense when the boom is out of the transport position. Drive and Boom functions are simultaneously functional when the booms are within the transport position, as on the standard machine.
When the boom is beyond the transport position, the control functions are interlocked to prevent simultaneous operation of any boom function with drive/steer. The first function set to be operated in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are inoperable. Likewise, while operating boom functions drive/steer functions are inoperable.

Jib Lift End of Stroke Dampening (if equipped)

The jib lift cylinder is constructed in a way that causes the jib lift cylinder oil flow to be restricted by an orifice while lowering the jib near the end of stroke at minimum elevation. This flow restriction reduces the speed of this function just before bottoming out the cylinder.

Main Boom Lift End of Stroke Dampening

When the lift cylinder is activated to lower or raise the main boom, the UGM monitors the main boom angle through an angle sensor. When the boom is approaching maximum angle and is within 5° of end of stroke, the UGM will slow down the travelling speed of the cylinder to provide end of stroke dampening by controlling hydraulic valve flow rate of the lift cylinder. The damping rate can be adjusted by personal settings through JLG hand analyzer.

Emergency Decent System

The emergency descent system allows the boom and jib (if equipped) to be lowered in the event of primary power (engine power) loss. This system uses a secondary set of electrically powered solenoid valves and the force of gravity to lower the booms. The following functions are included in this system and will operate normally if the engine is not running and the "auxiliary power" switch has been activated: Main Lift Up/Down, Tower Lift Up/Down, Jib Up/Down (if equipped), Telescope In/Out, Swing Left/Right.

4.2 PLATFORM

Platform/Support Removal

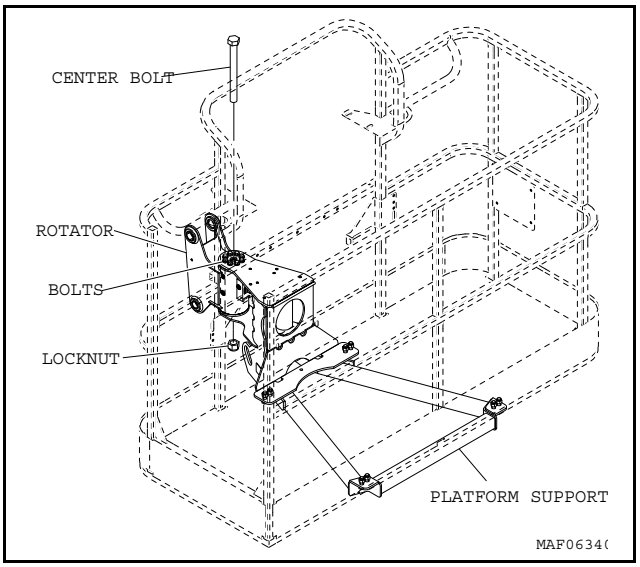
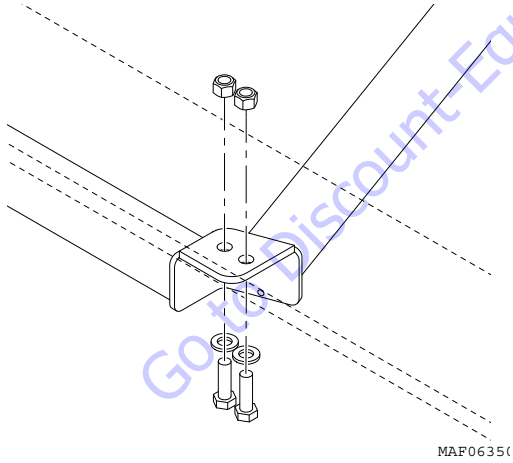


Figure 4-1. Location of Components

1. Disconnect electrical cable from control console.

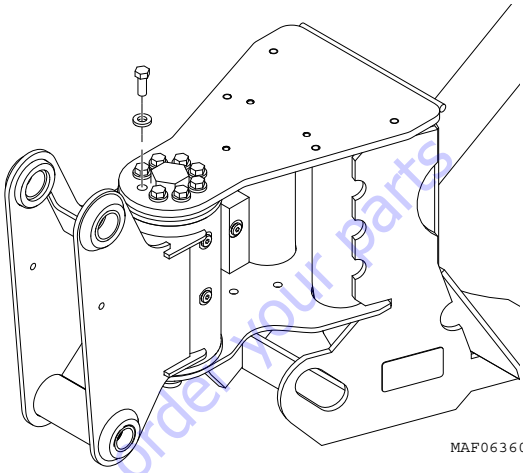
NOTE: *The platform weighs approximately 176 lb (80 kg).*

2. Remove the bolts securing the platform to the platform support, then remove the platform.

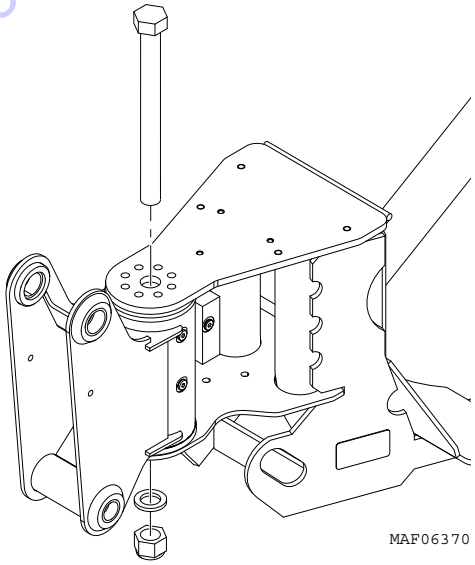


NOTE: *The platform support weighs approximately 132 lb (60 kg).*

3. Using a suitable device, support the platform support.
4. Remove the bolts and locknuts securing the support to the rotator.



5. Using a suitable brass drift and hammer, remove the center bolt and locknut.

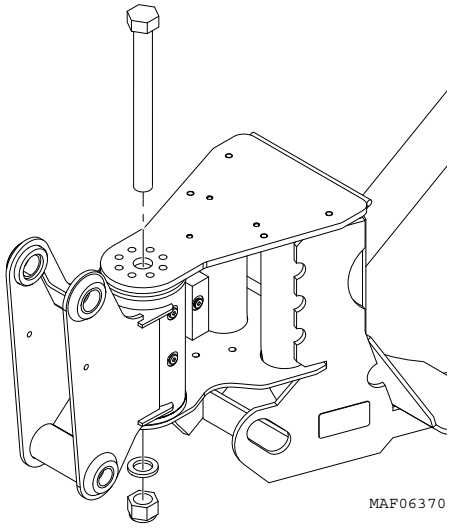


6. Remove the platform support from rotator.

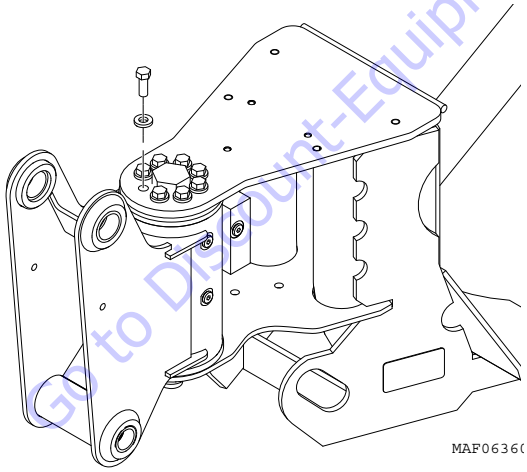
Platform/Support Installation

NOTE: *The platform support weighs approximately 132 lb (60 kg).*

1. Using a suitable device, support the platform support and position it on the rotator.
2. Install the rotator center bolt and locknut.



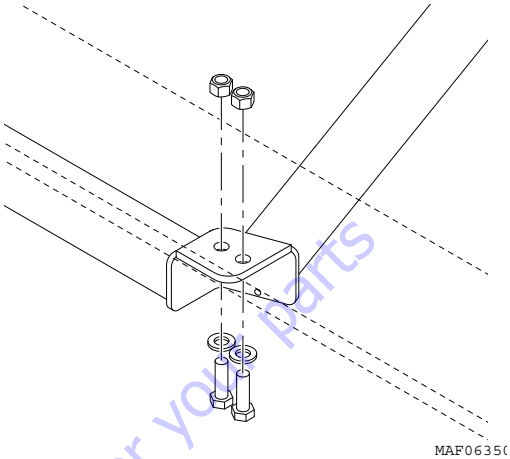
3. Apply Medium Strength Threadlocking Compound to the eight bolts securing the support to the rotator and install the bolts.



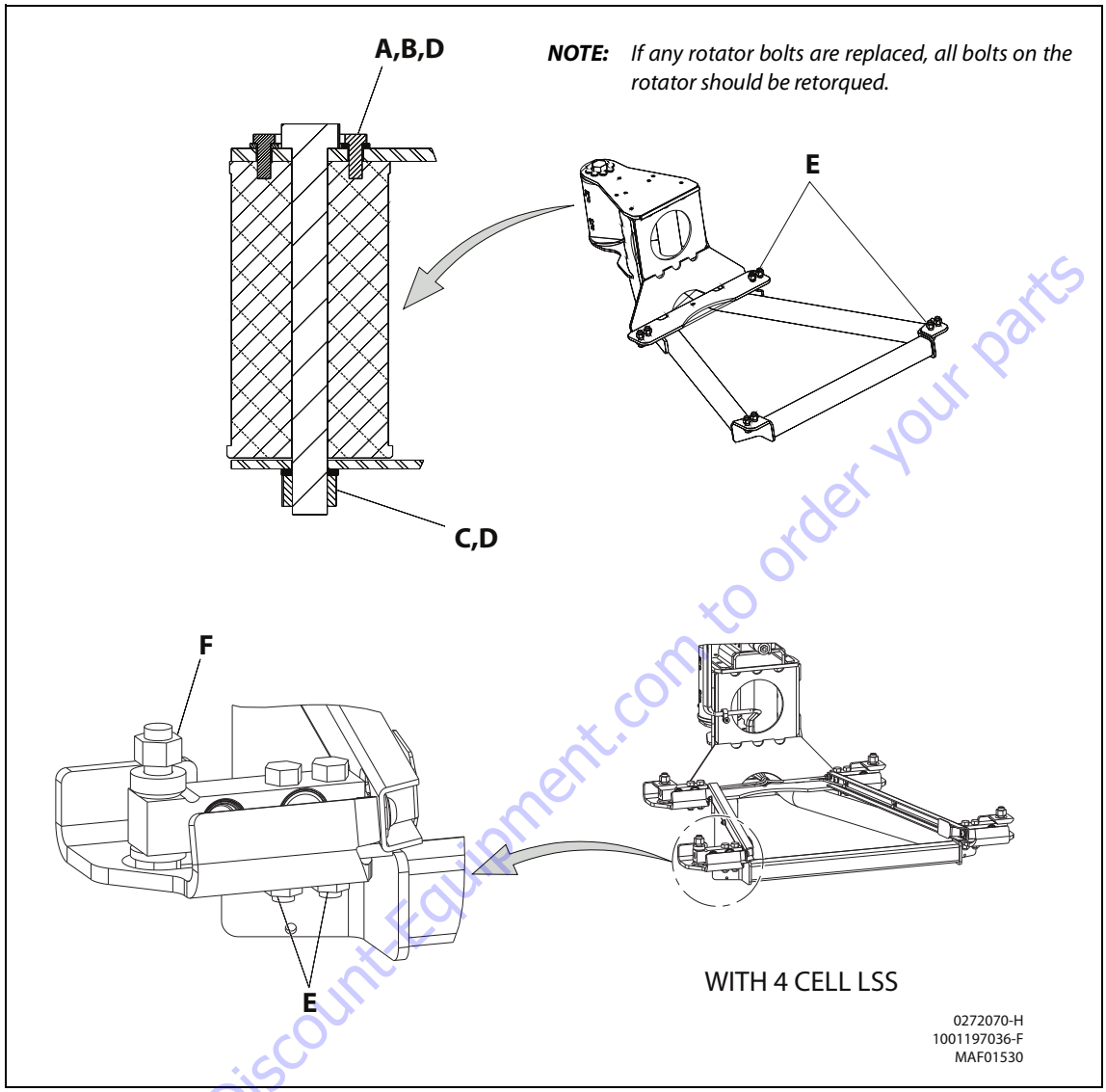
4. Torque the nut on the rotator center bolt and the retaining bolts. See Figure 4-2.

NOTE: *The platform weighs approximately 176 lb (80 kg).*

5. Using a suitable lifting device., position the platform on the platform support and install the bolts securing the platform to the platform support. See Figure 4-2.

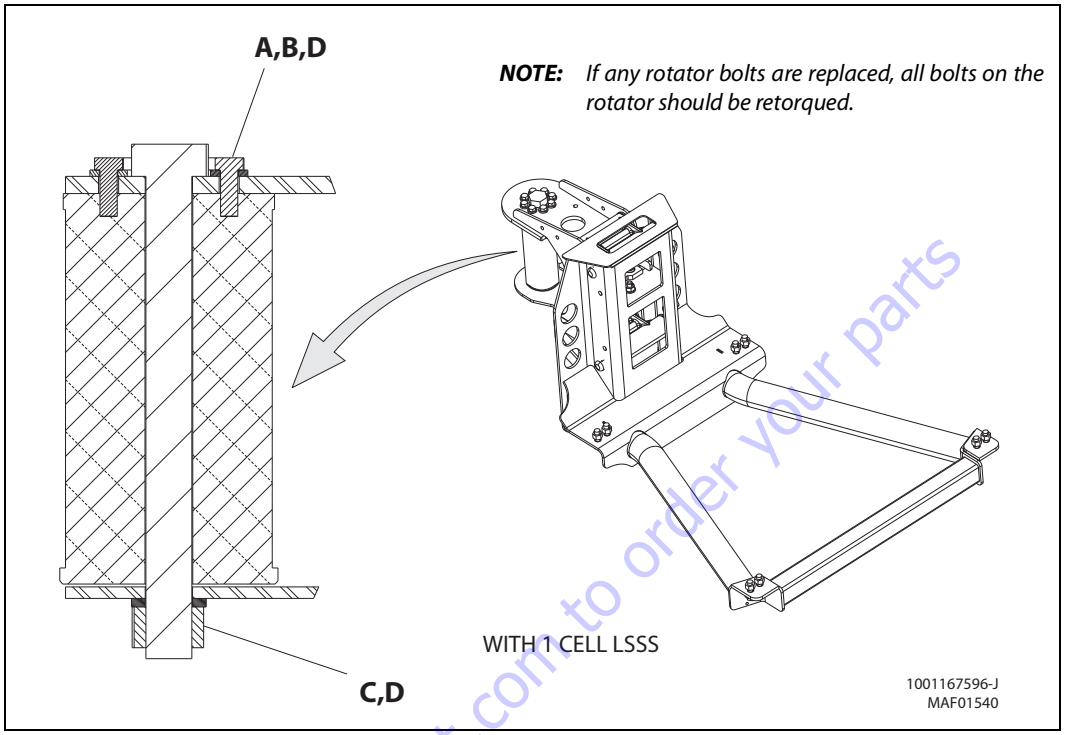


6. Connect the electrical cable to the platform control console.



A Torque to 40 ft. lbs. (55 Nm)
B Medium Strength Threadlocking Compound
C Torque to 586 ft. lbs. (795 Nm)
D Check torque every 150 hours of operation
E Torque to 75 ft. lbs. (102 Nm)
F Torque to 50 ft. lbs. (68 Nm)

Figure 4-2. Platform Support Torque Values (without LSS and with 4 Cell LSS)



A Torque to 40 ft. lbs. (55 Nm)
B Medium Strength Threadlocking Compound
C Torque to 586 ft. lbs. (795 Nm)
D Check torque every 150 hours of operation

Figure 4-3. Platform Support Torque Values (with 1 Cell LSS)

4.3 ROTATOR

Removal

1. Remove the Platform and Platform Support. Refer to Section 4.2, Platform.
2. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

NOTE: *The rotator approximately weighs 50 lb (23 kg).*

NOTE: *The jib lift cylinder approximately weighs 45 lb (21 kg).*

3. Supporting the rotator and jib lift cylinder, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1.
4. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 and remove the rotator.

Installation

NOTE: *The rotator approximately weighs 50 lb (23 kg).*

NOTE: *The jib lift cylinder approximately weighs 45 lb (21 kg).*

1. Supporting the rotator and jib lift cylinder, align rotator with jib lift cylinder and jib. Using a soft head mallet, install pin #1 to the jib assembly. Install hardware securing pin #1.
2. Using a soft head mallet install pin #2 to jib assembly and install the rotator. Install hardware securing pin #2.
3. Install the platform and platform support. Refer Section 4.2, Platform.
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the rotator as tagged during removal.

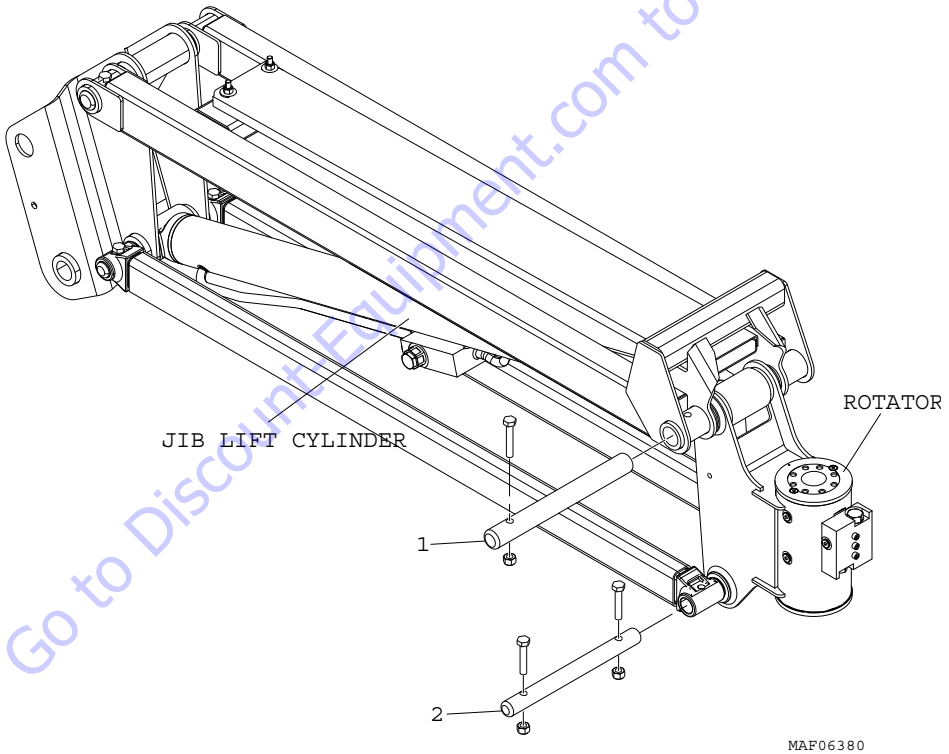


Figure 4-4. Rotator Removal/Installation

4.4 JIB

Removal

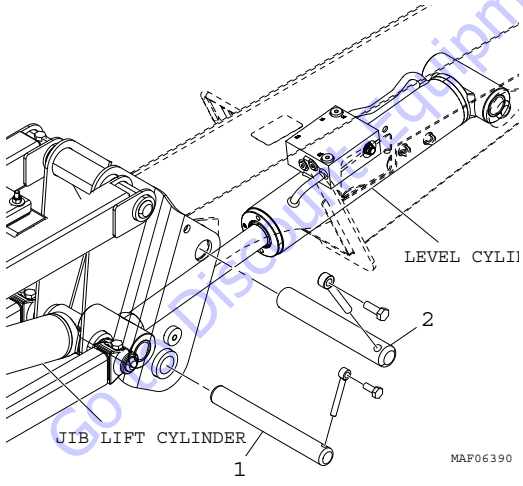
1. Remove the platform and platform support. Refer to Section 4.2, Platform.

NOTE: *The jib assembly approximately weighs 220 lb (100 kg).*

2. Using a suitable lifting device, adequately support jib assembly weight along entire length.
3. Tag and disconnect hydraulic lines from level cylinder and jib lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

NOTE: *The level cylinder approximately weighs 42 lb (19 kg).*

4. Attach an adequate supporting device to the Level cylinder to support its weight.
5. Remove mounting hardware from level cylinder pin #1. Using a suitable brass drift and hammer, remove the pin #1.
6. Remove mounting hardware from jib pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from jib assembly.
7. Remove the jib assembly from the boom.

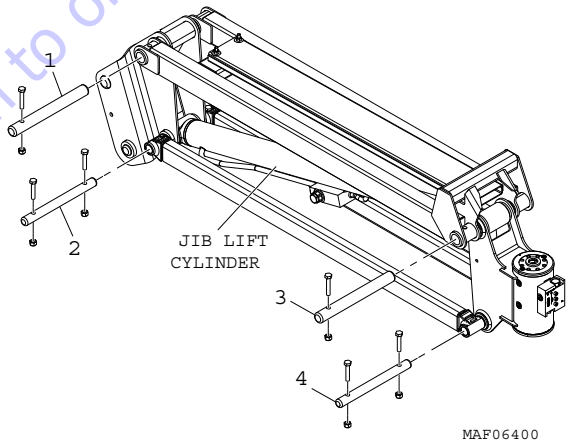


Disassembly

1. Remove mounting hardware from jib pivot pin #1 and #2. Using a suitable brass drift and hammer, remove the pin #1 and #2 from jib pivot.
2. Remove the jib pivot from jib assembly.

NOTE: *The jib lift cylinder approximately weighs 45 lb (21 kg).*

3. Attach an adequate supporting device to the lift cylinder assembly to support its weight.
4. Remove mounting hardware from pin #3. Using a suitable brass drift and hammer, remove the pin #3.
5. Carefully remove the lift cylinder from jib assembly.
6. Remove mounting hardware from pin #4. Using a suitable brass drift and hammer, remove the pin #4.
7. Remove rotator from jib assembly.



Inspection

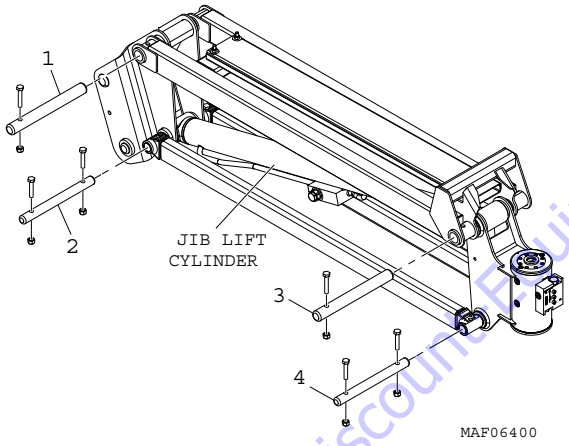
NOTE: *When inspecting pins and bearings Refer to Section 2.5, Pins and Composite Bearing Repair Guidelines*

1. Inspect pivot pins for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.
4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage.

6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of jib assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

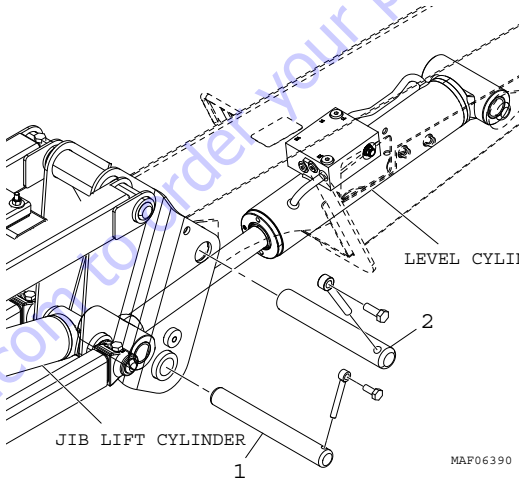
1. Supporting the rotator and jib lift cylinder, align the jib lift cylinder rod end and rotator with the jib assembly. Using a soft head mallet, install pin #3. Install hardware securing pin #3.
2. Using a soft head mallet install pin #4 to jib assembly and rotator. Install hardware securing pin #4.
3. Align the jib lift cylinder barrel end and jib pivot to the jib assembly. Using a soft head mallet, install pin #2 and secure with mounting hardware.
4. Align jib pivot with jib assembly. Using a soft head mallet, install pin #1 into jib assembly and secure with mounting hardware.



Installation

NOTE: *The jib assembly approximately weighs 220 lb (100 kg).*

1. Attach an adequate lifting device to the jib assembly and position it in front of the fly boom.
2. Lift the jib assembly into position on the boom fly section and install the pin #2 using a soft head mallet. Secure the pin #2 in place with the bolt and keeper pin.
3. Align level cylinder with fly boom and jib pivot and install pin #1 using a soft head mallet. Secure the pin #1 in place with the bolt and keeper pin.



4. Install the platform and platform support. Refer Section 4.2, Platform.
5. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the level cylinder and jib lift cylinder as tagged during removal.

4.5 PLATFORM LEVEL CYLINDER

Removal

1. Tag and disconnect hydraulic lines from platform level cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.
2. Place blocking or a soft material under the platform level cylinder barrel to protect the rod from being scratched.

NOTE: *The jib assembly approximately weighs 220 lb (100 kg).*

3. Using a suitable lifting device, adequately support jib assembly.
4. Remove mounting hardware from platform level cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin #1 from level cylinder.
5. Remove mounting hardware from platform level cylinder pin #2. Using a suitable brass drift and hammer, remove the cylinder pin #2 from jib pivot.

NOTE: *The platform level cylinder approximately weighs 42 lb (19 kg).*

6. Carefully remove the platform level cylinder assembly from fly boom.

Installation

NOTE: *The jib assembly approximately weighs 220 lb (100 kg).*

1. Using a suitable lifting device, adequately support jib assembly.

NOTE: *The platform level cylinder approximately weighs 42 lb (19 kg).*

2. Support the platform level cylinder. Using a soft head mallet, install pin #1 to the level cylinder. Install hardware securing pin #1 and torque to 40.5 ft. lbs. (55 Nm).
3. Using soft head mallet install pin #2 to jib pivot and install the level cylinder. Install hardware securing pin #2 and torque to 40.5 ft. lbs. (55 Nm).
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the platform level cylinder as tagged during removal.

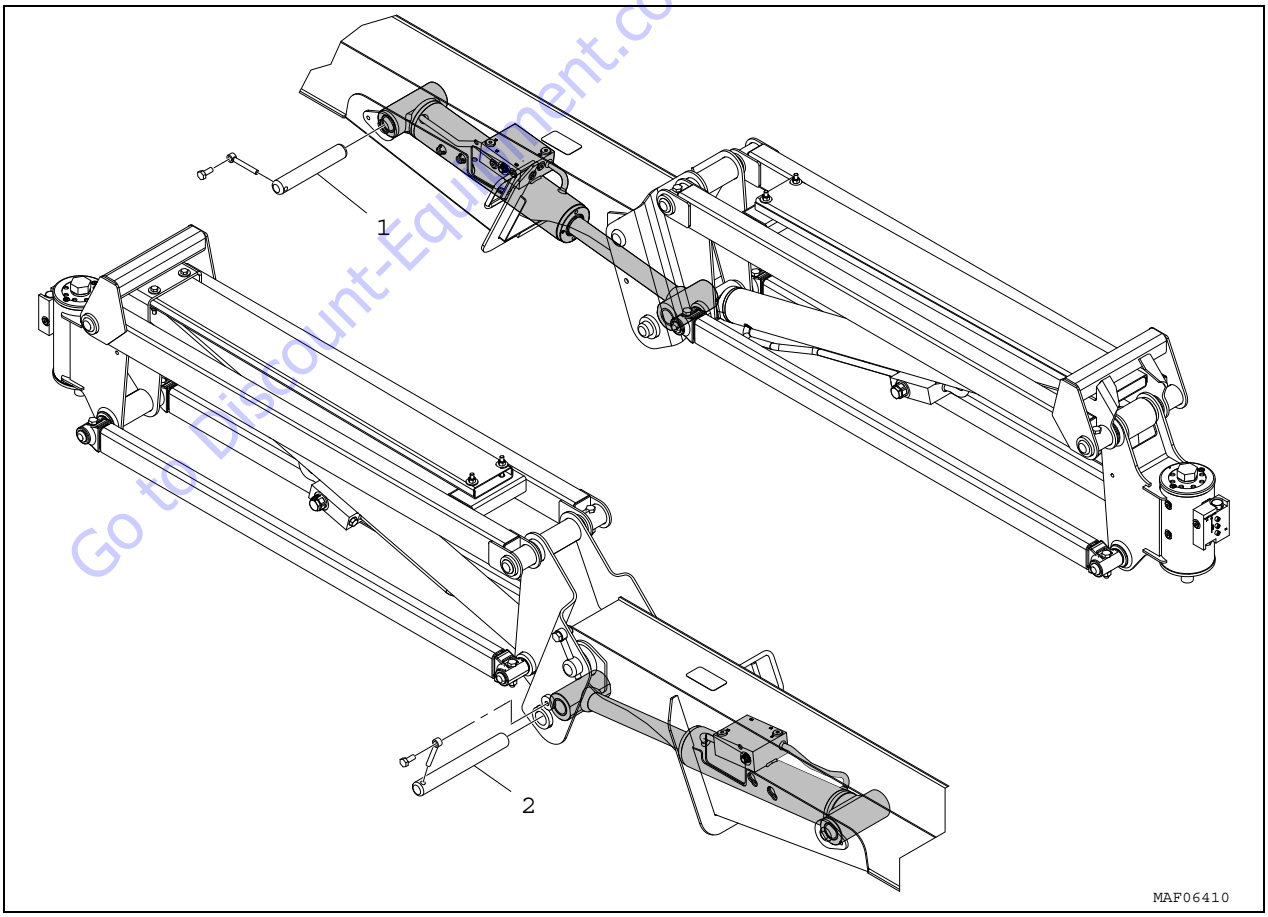


Figure 4-5. Platform Level Cylinder Removal and Installation

4.6 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in turntable.
2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings hydraulic lines and ports.
3. Remove hydraulic lines and electrical cables from Powertrack.

NOTE: *The powertrack weighs approximately 12.6 lb (5.7 kg).*

4. Using suitable lifting device, adequately support Powertrack weight along entire length.
5. Remove hardware #1 securing the powertrack on the tube carrier.
6. Remove bolt #2 securing the powertrack on the base boom section. Remove the powertrack assembly.

Installation

1. Using suitable lifting device, adequately support the powertrack weight along entire length.

NOTE: *The powertrack weighs approximately 12.6 lb (5.7 kg).*

2. With powertrack supported and using all applicable safety precautions, install hardware #2 securing rail to the base boom.
3. Install hardware #1 to tube carrier.
4. Remove cap or plugs from openings of hydraulic lines and ports. Remove tag and reconnect all hydraulic lines and electrical cable from powertrack.
5. Remove cap or plugs from openings of hydraulic lines and ports. Remove tag and reconnect hydraulic lines from connectors at boom assembly.

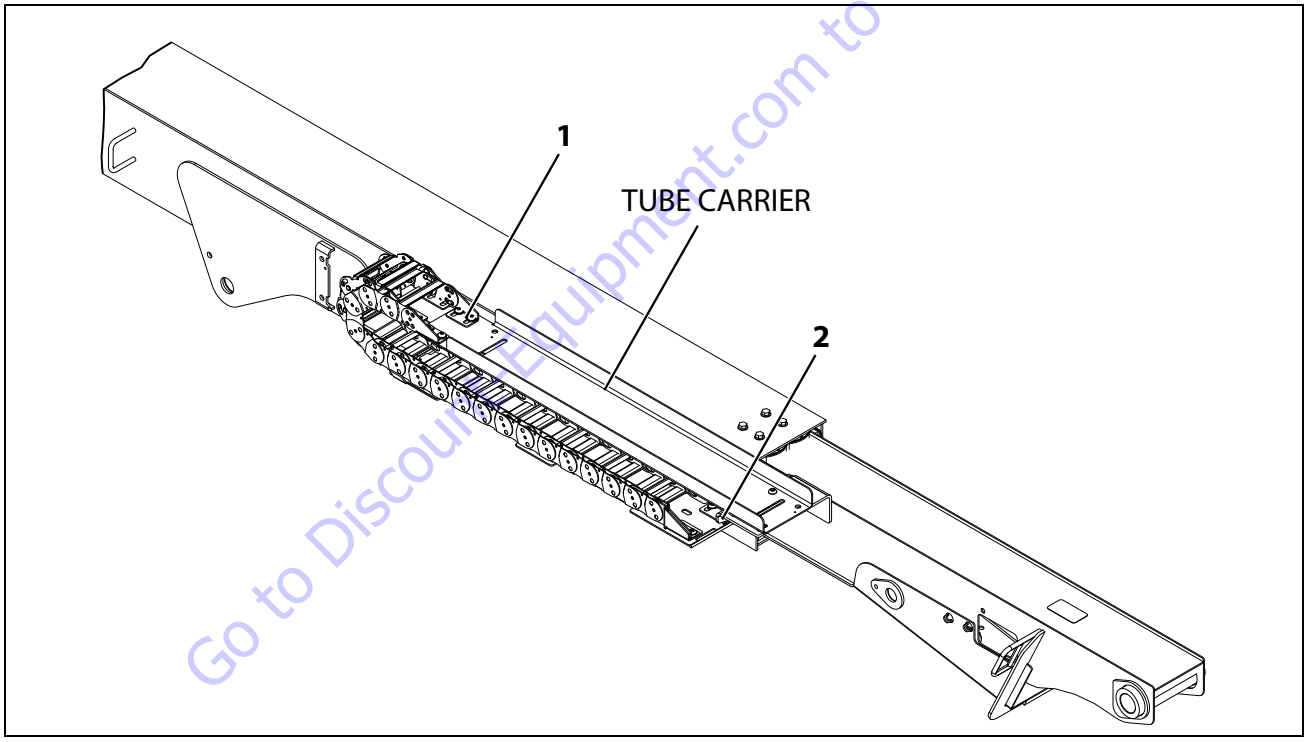


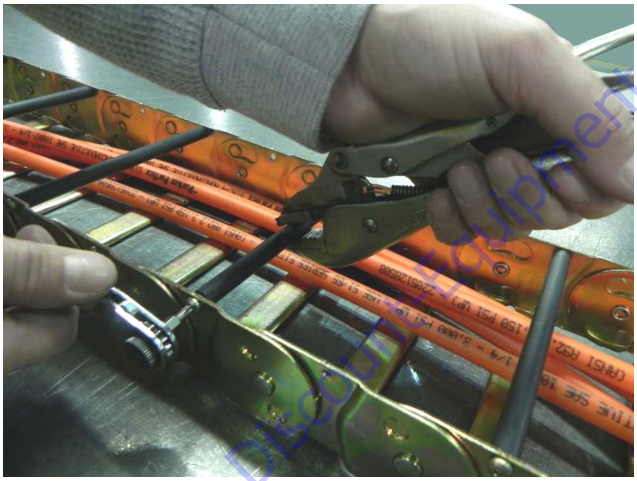
Figure 4-6. Location of Components - Powertrack

4.7 POWERTRACK MAINTENANCE

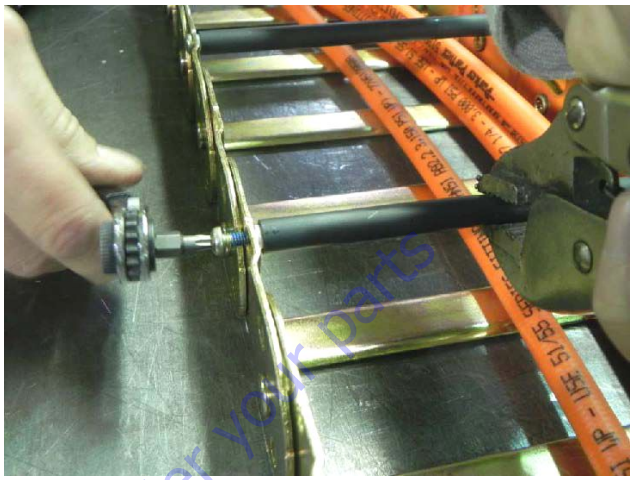
Remove Link

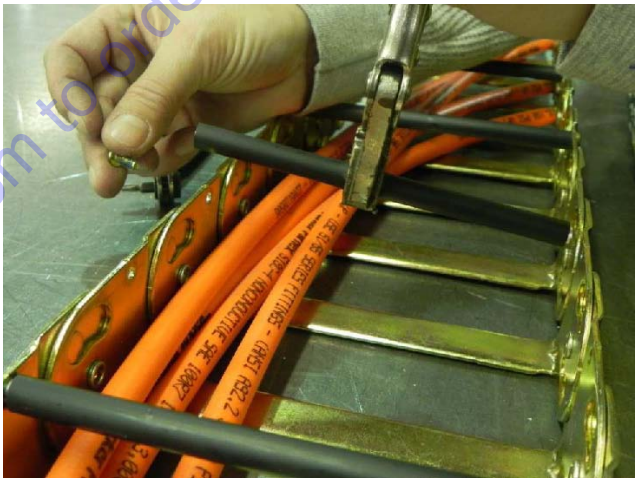
NOTE: *Hoses shown in powertrack are for example only. Actual hose and cable arrangements are different.*

1. Clamp bar and poly roller tightly so they do not spin when removing screw. With a small 1/4 in. ratchet and a T-20 torx bit, remove 8-32 x 0.500 screw from one side.



2. Repeat step 1 and remove screw from other side of track. Remove bar/poly roller from powertrack.

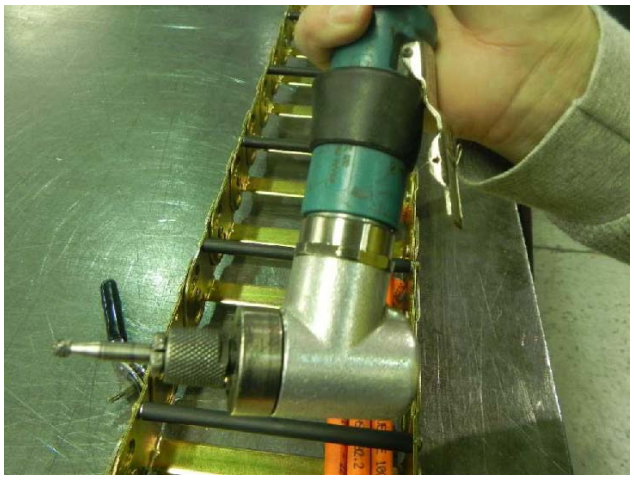




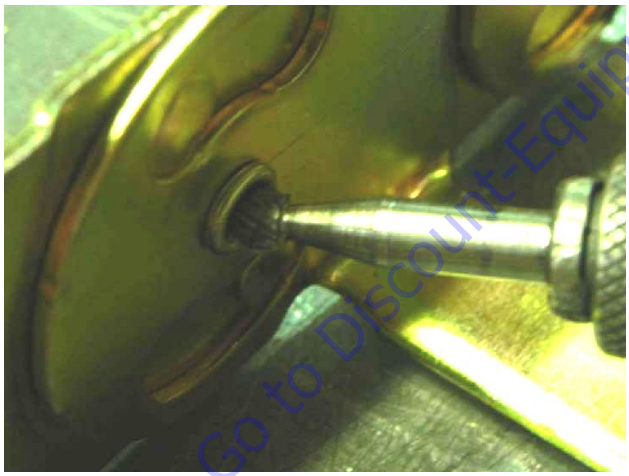
NOTICE

REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

3. To remove a link, rivets holding links together must be removed. Use a right-angle pneumatic die grinder with a 1/4 in. ball double cut bur attachment.

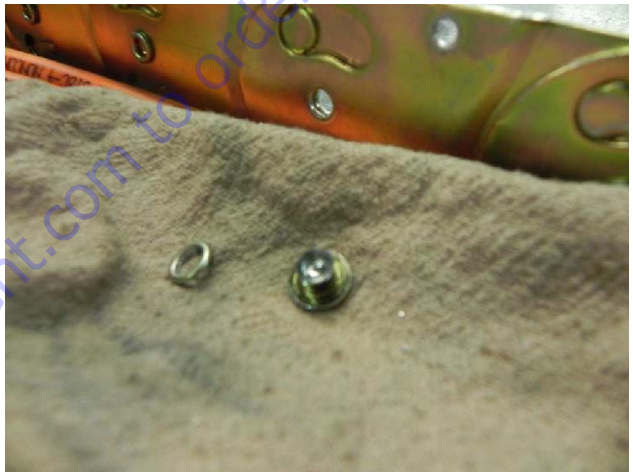


4. insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.

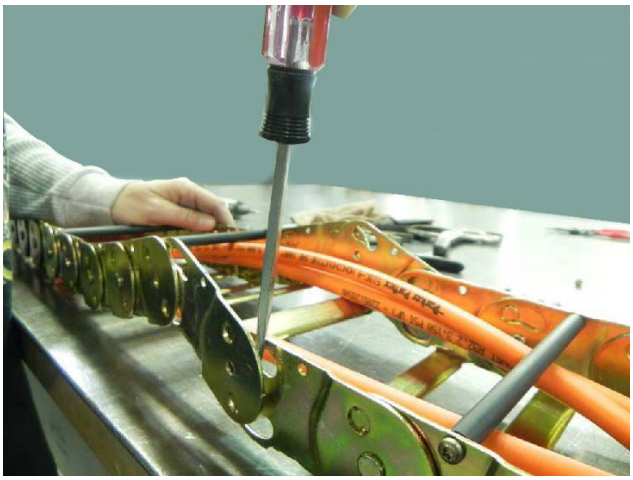


5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

NOTE: *It may be necessary to loosen fixed end brackets from machine to move track section enough to disconnect links.*



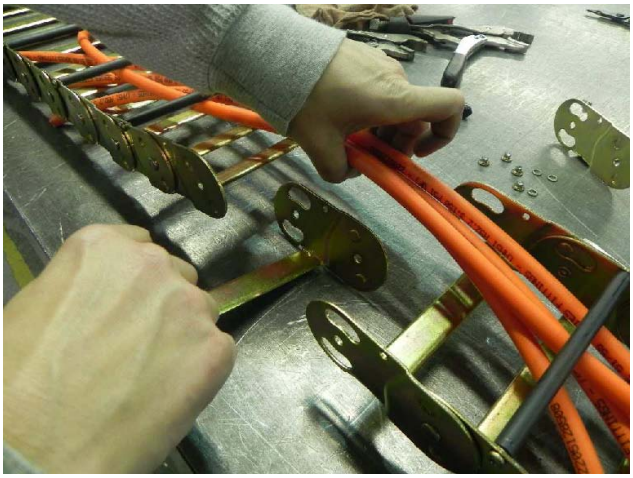
6. Insert flat head screwdriver between links. Twist and pull links apart.



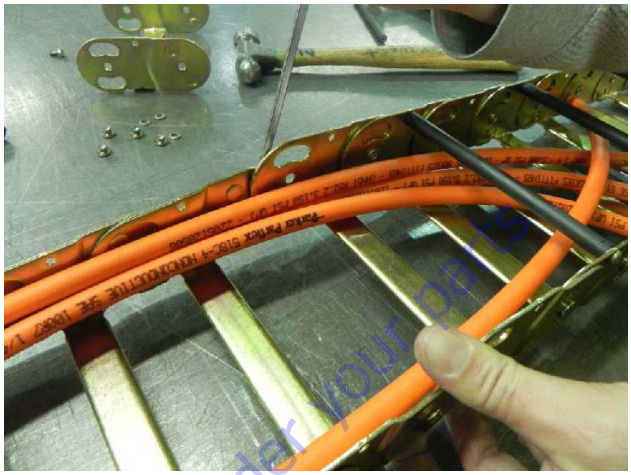
7. Remove link from other section of powertrack using screwdriver.

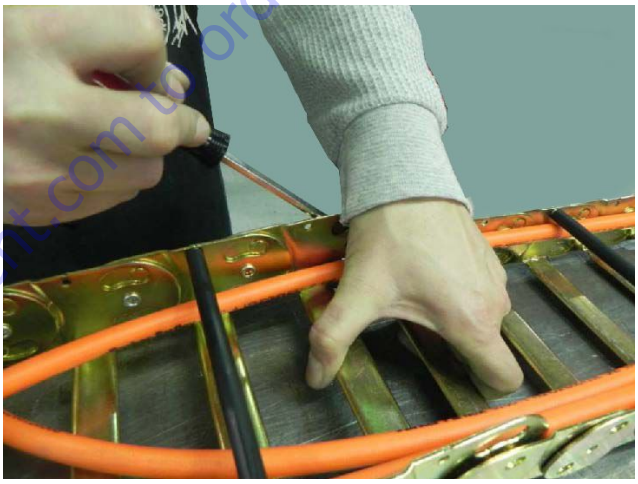
Install New Link

1. Squeeze cut-out end of new link into half-shear (female) end of track section.

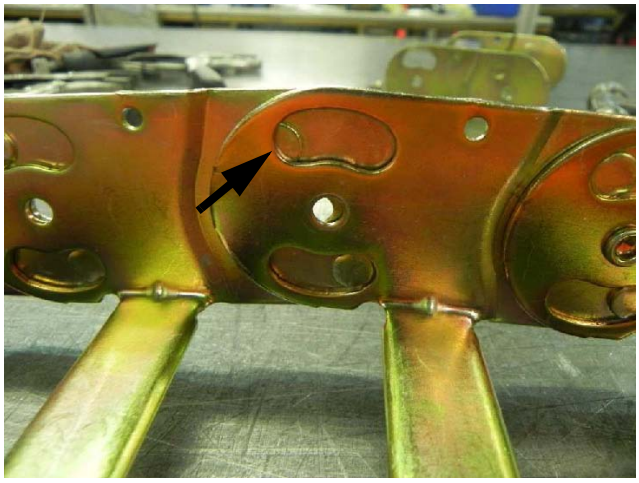


2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use a screwdriver if necessary.

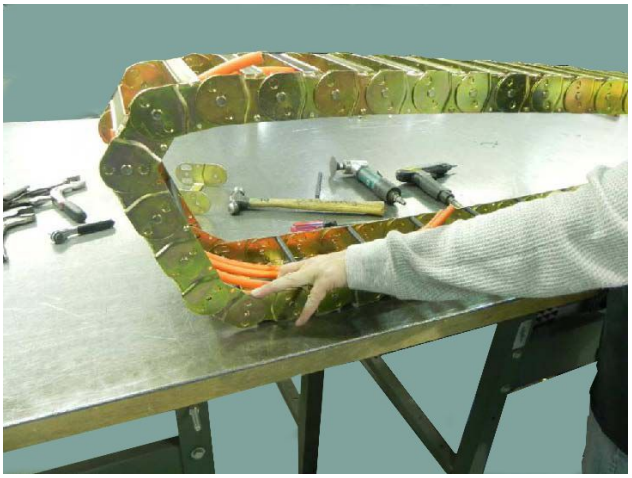




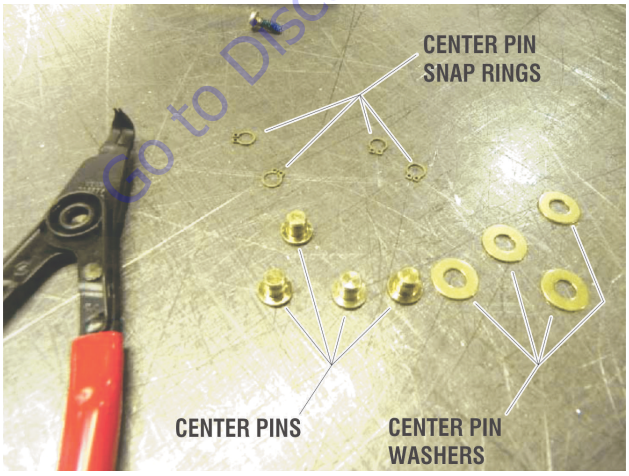
3. After new link is installed round half-shears do not fit properly in cut-outs.



4. Pull moving end over track so new connection is positioned in curve of powertrack. Round half-shears will rotate into cut-outs.



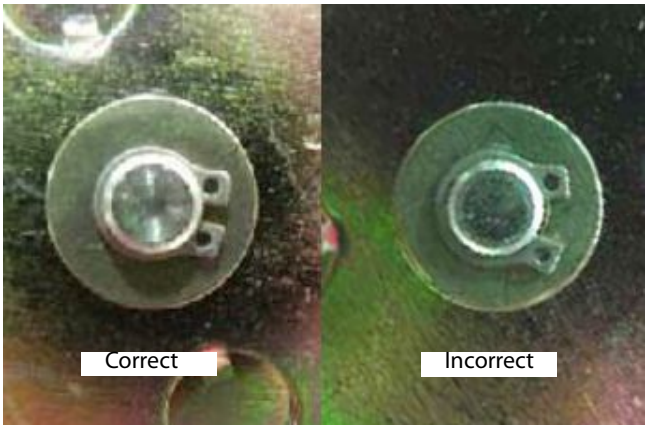
5. Parts shown below connect new link to powertrack.



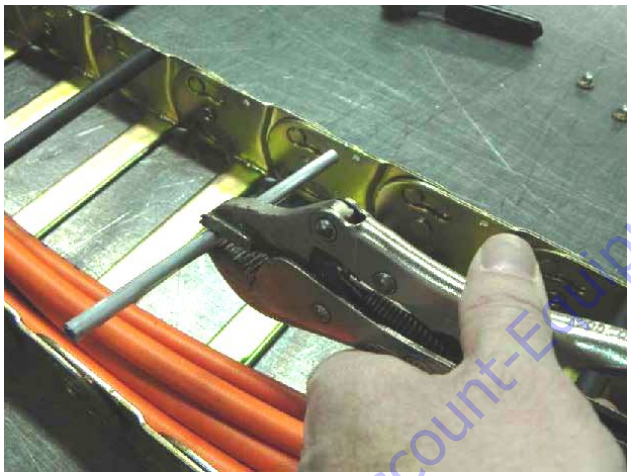
6. Push pin through center hole then slide washer on pin.

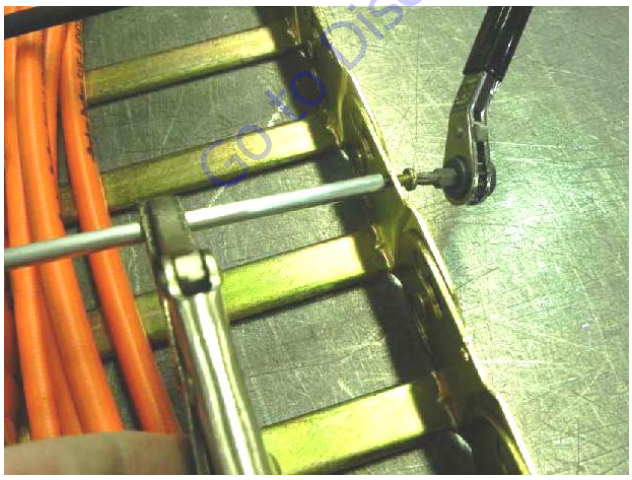
7. Install snap ring in groove on pin. Repeat pin installation steps for all center holes with rivets removed.

NOTE: *Make sure snap rings are seated in pin groove and closed properly.*

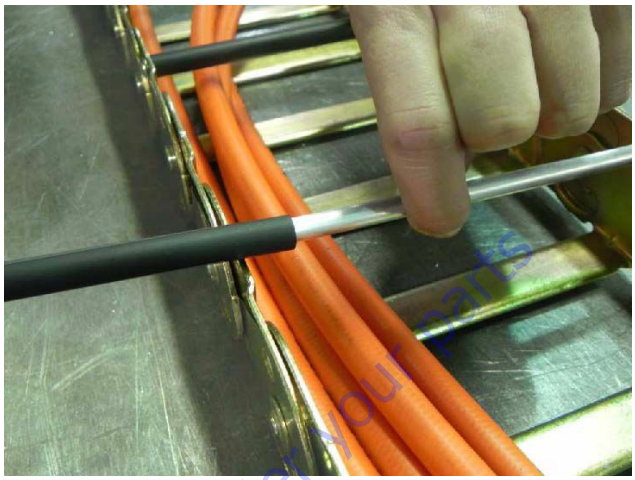


1. Install new 8-32 x 0.500 self-threading torx head screw in end of new aluminum round bar. Torque to 18-20 in. lbs. (2-2.25 Nm).

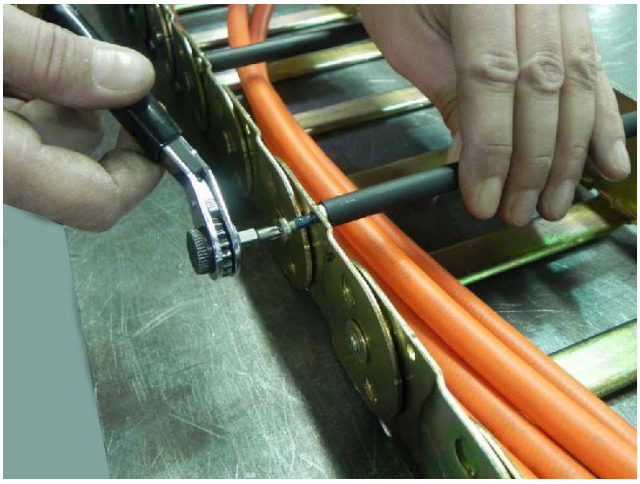




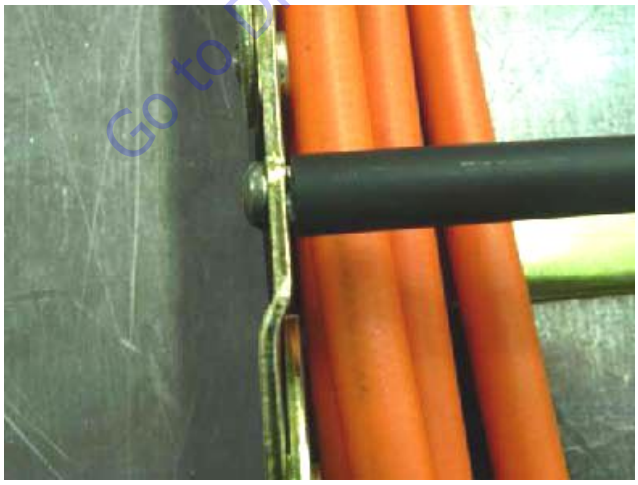
2. Pull up on other end of round bar and slide new poly roller on bar.



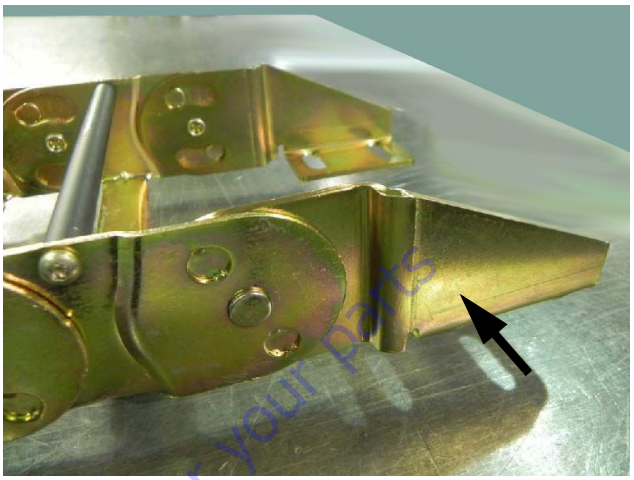
3. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in. lbs. (2-2.25 Nm).



NOTE: *When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.*



Replace Fixed End Brackets



NOTICE

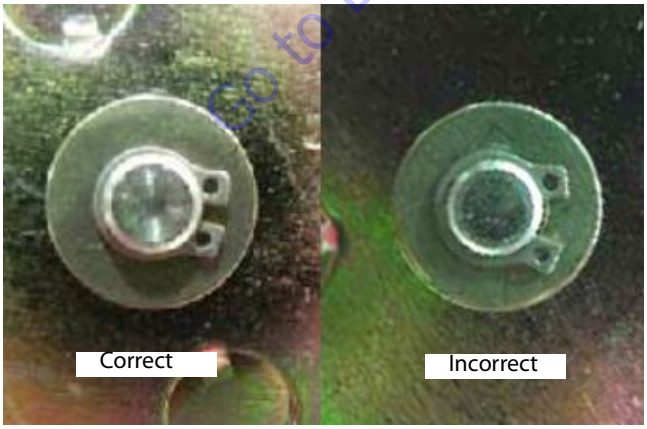
REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

1. Remove rivets as shown in link removal instructions on page 12.

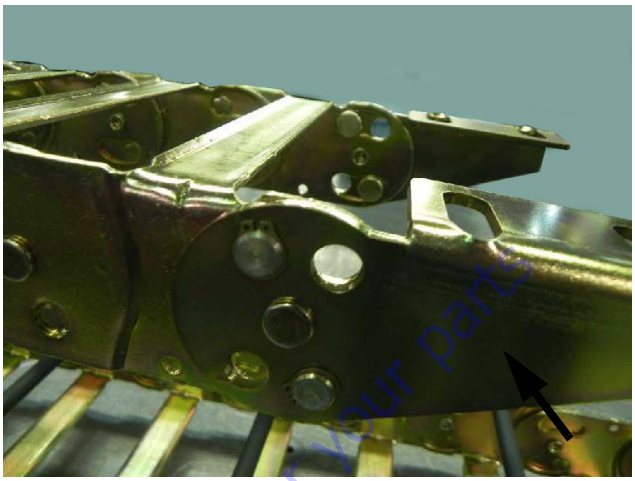
2. Parts used: Bracket Center Pin and Center Pin Snap Ring.

3. Take new bracket and install bracket center pin and snap ring. Repeat on other bracket if replacing it.

NOTE: *When installing snap rings make sure they are seated in pin groove and closed properly.*



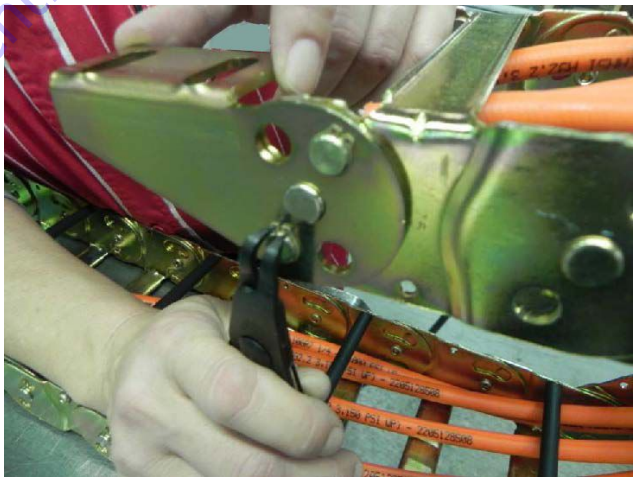
Replace Moving End Brackets



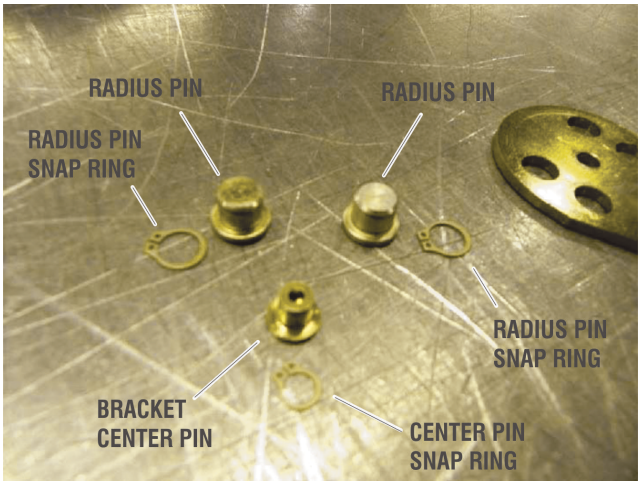
NOTICE

REPOSITION CABLES/HOSES AND KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

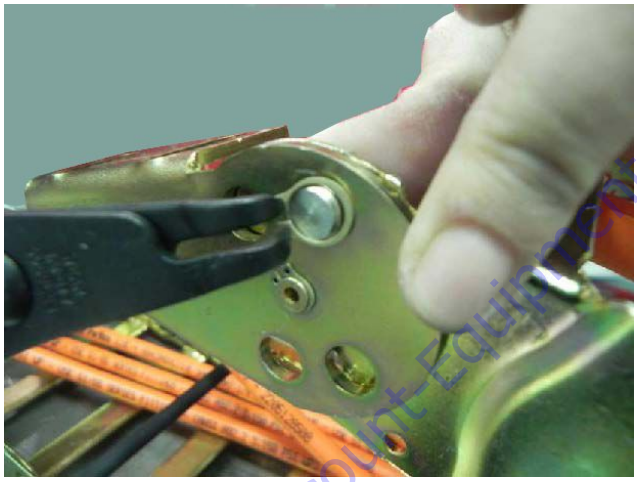
1. Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 4-20. Repeat on other bracket if replacing it.



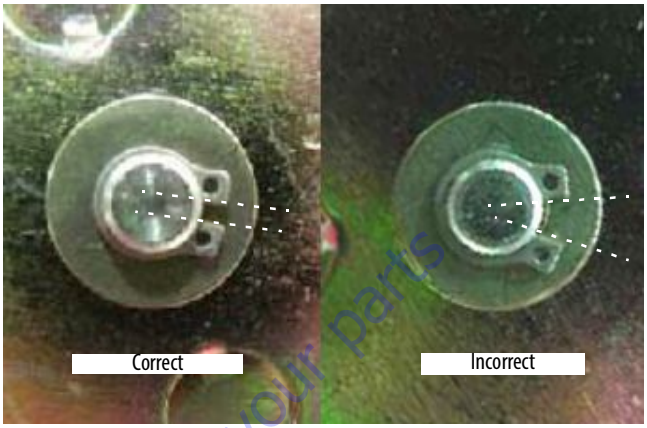
2. Install center pin with snap ring in new bracket.



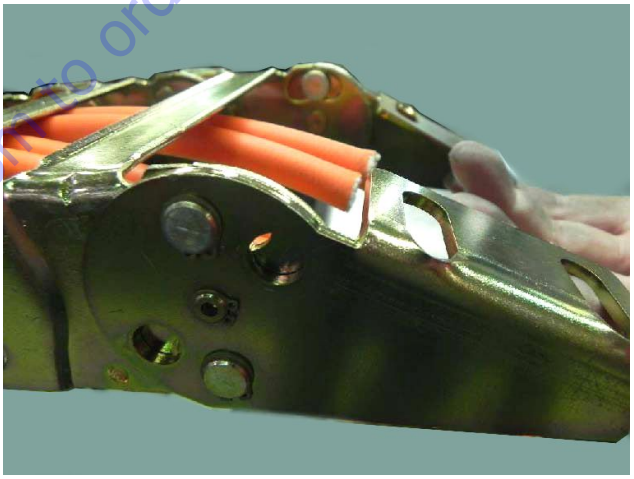
3. Install radius pins and snap rings in original locations. Repeat with other moving end if replacing it.



NOTE: *When installing snap rings make sure they are seated in pin groove and closed properly.*



4. Make sure both brackets rotate correctly.



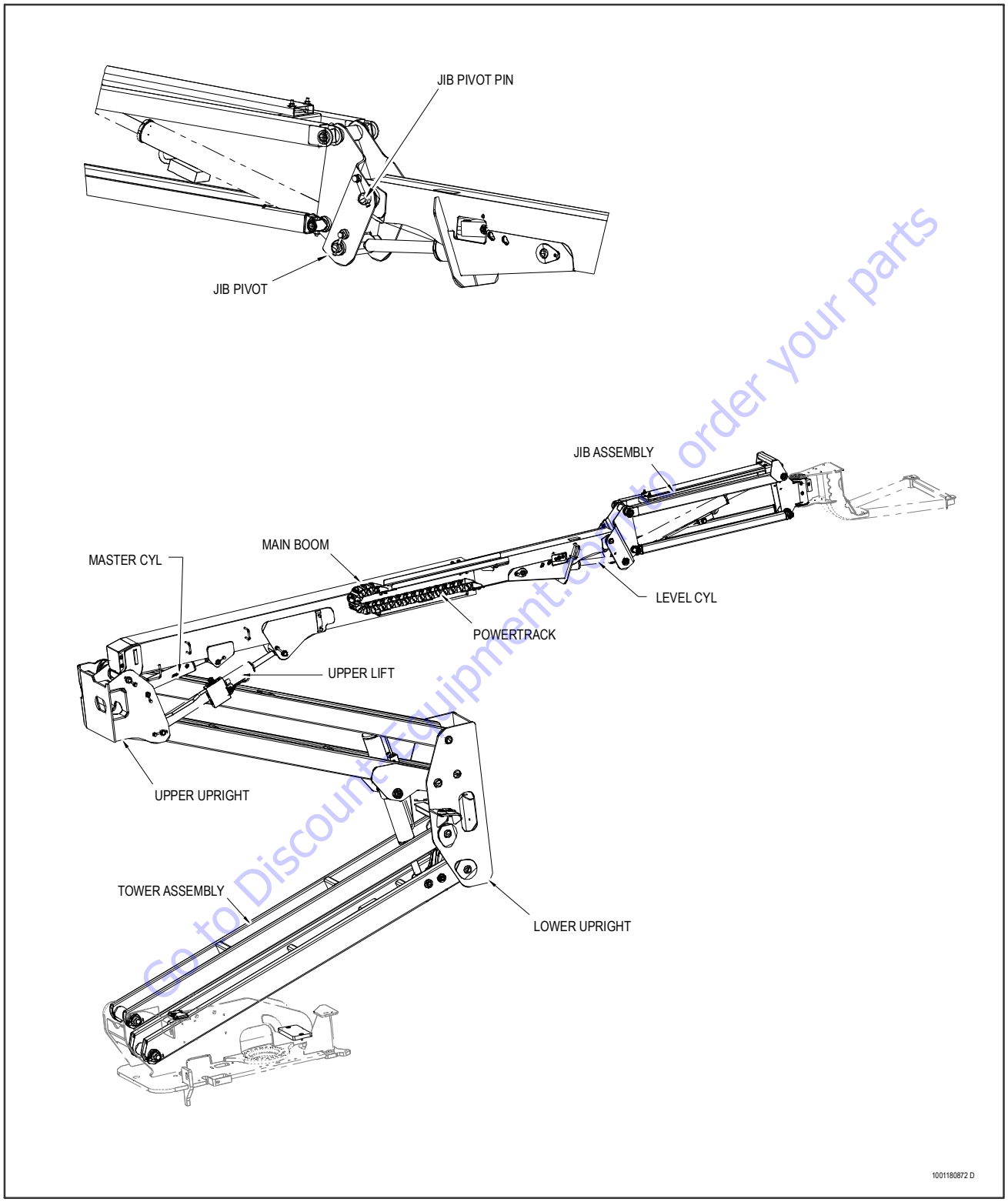


Figure 4-7. Boom Assembly

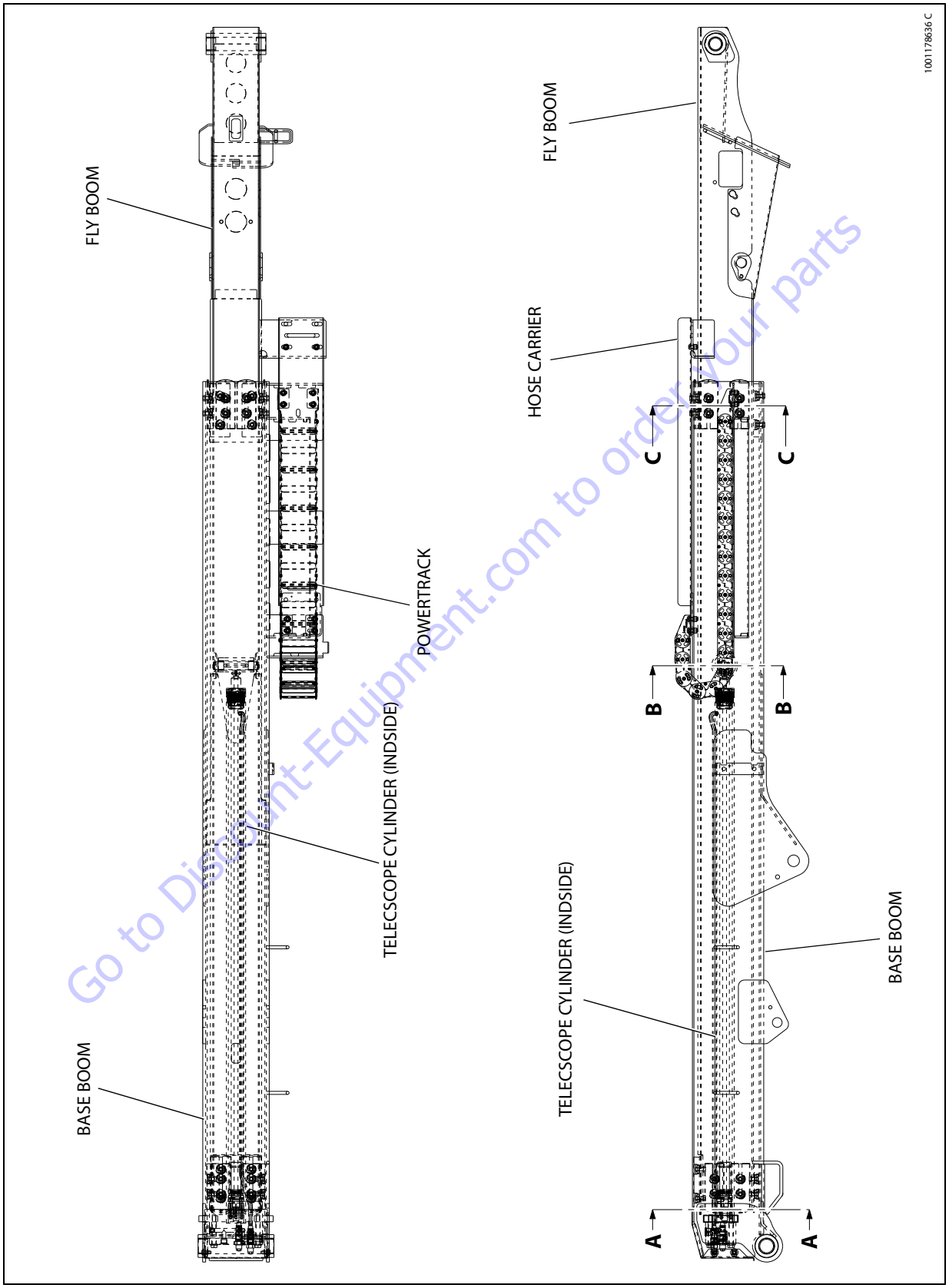


Figure 4-8. Main Boom Assembly - Sheet 1 of 2

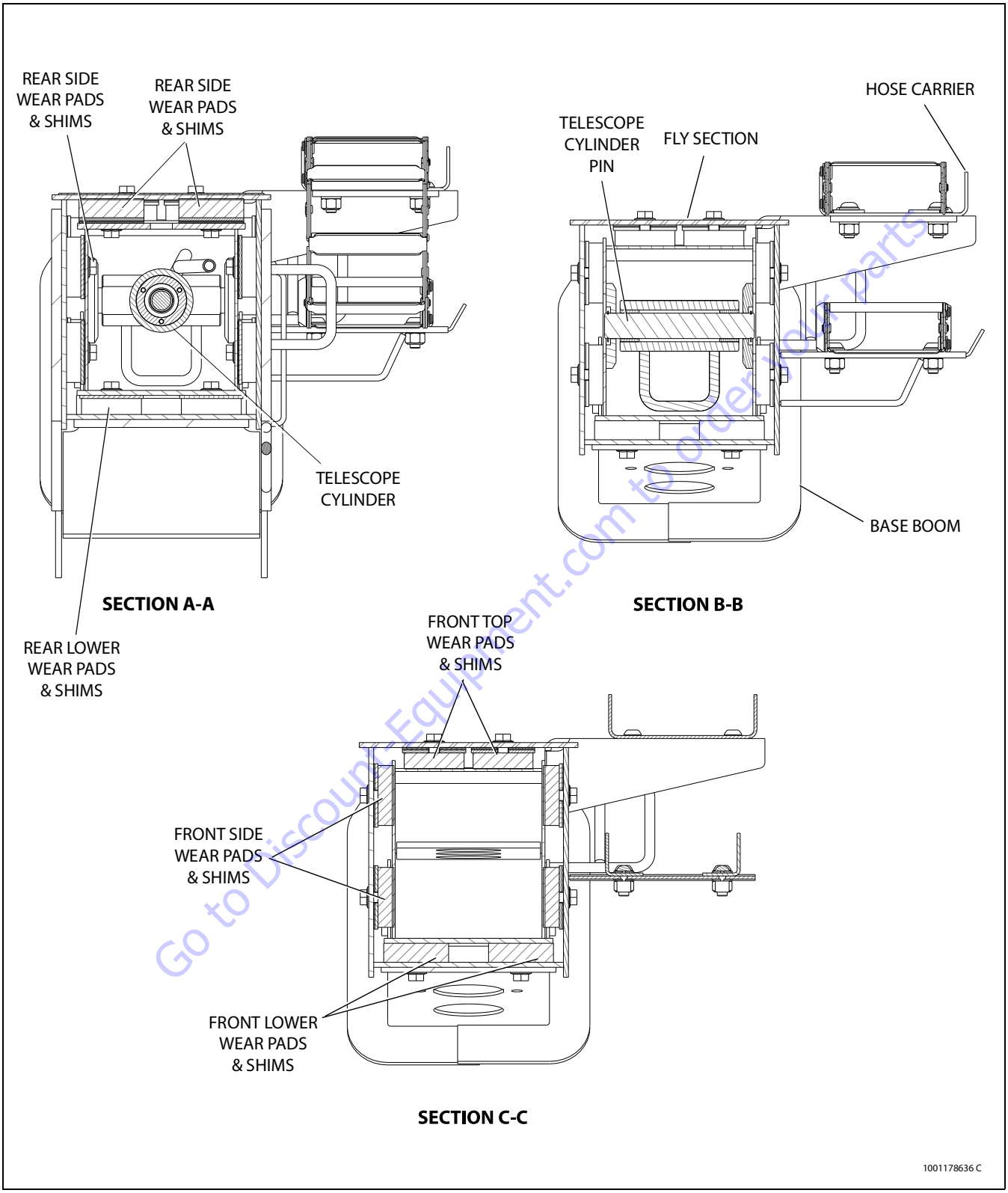


Figure 4-9. Main Boom Assembly - Sheet 2 of 2

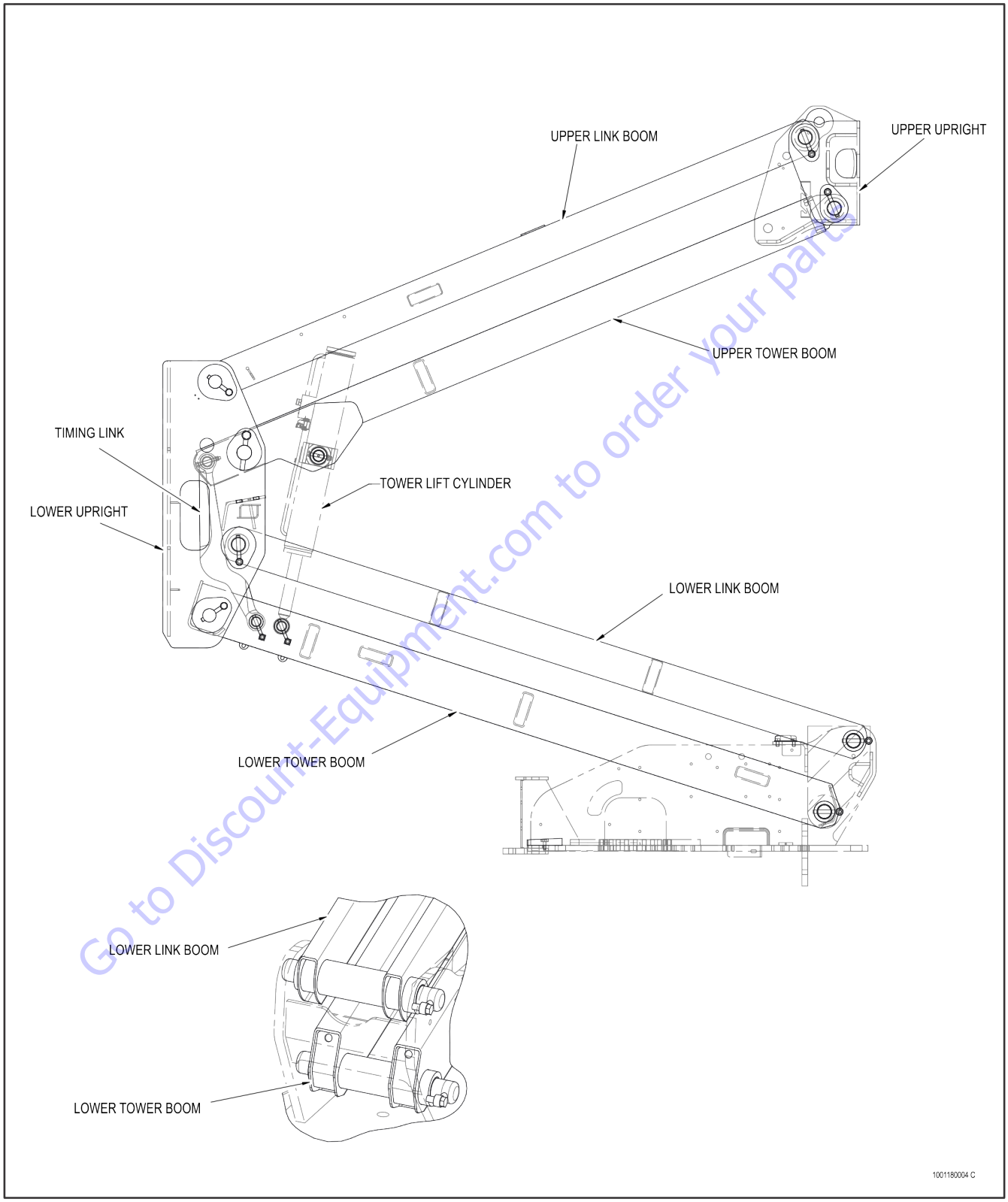


Figure 4-10. Upper Boom Assembly

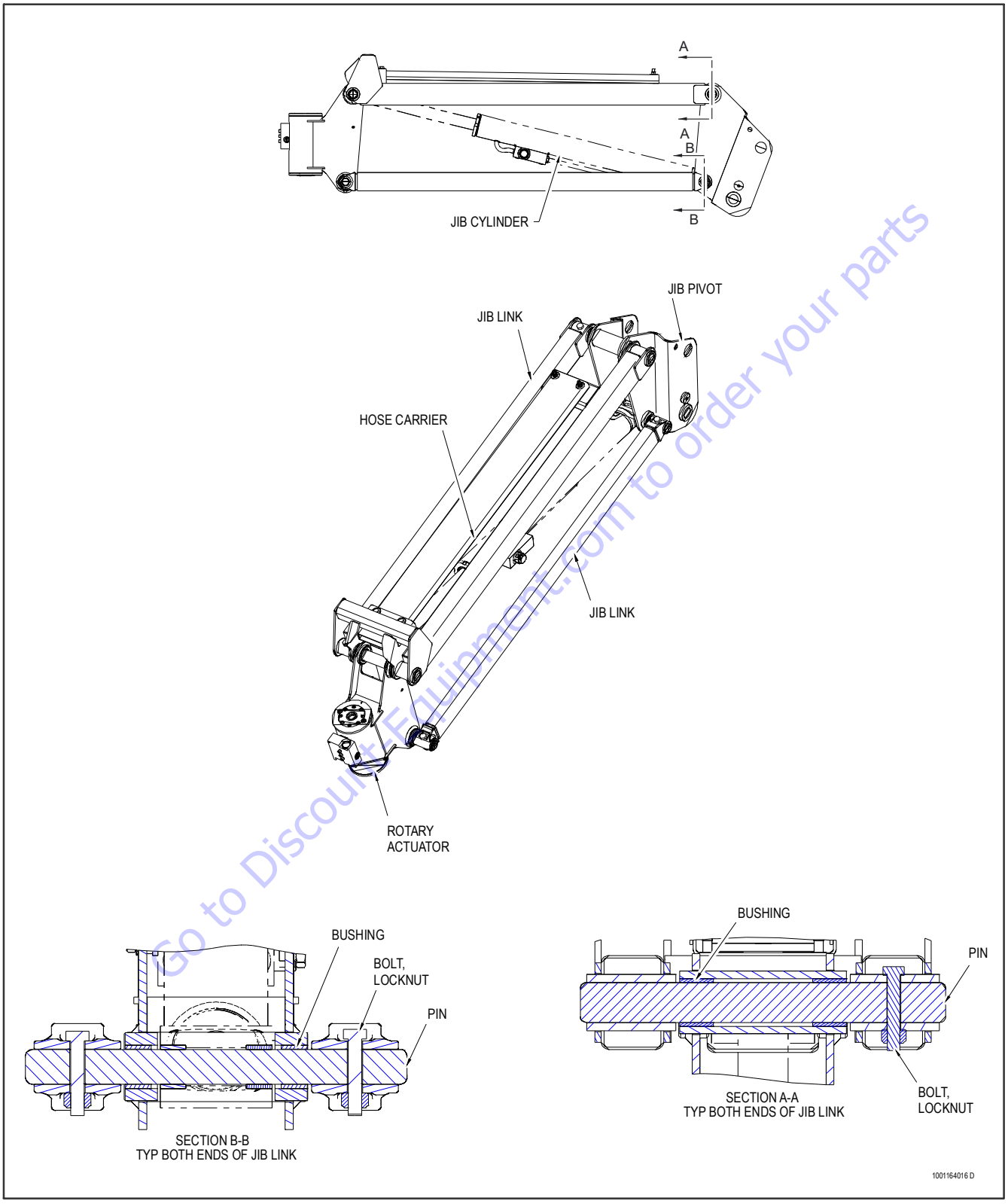


Figure 4-11. Jib Assembly

4.8 BOOM CLEANLINESS GUIDELINES

The following are guidelines for internal boom cleanliness for machines that are used in excessively dirty environments.

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no “puddling” of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

4.9 BOOM SHIMMING PROCEDURE

NOTE: *When installing wear pads, the wear pad bolt lengths may need to be adjusted as shim thicknesses are adjusted. Bolt lengths should be flush or up to one thread below the surface of the insert.*

1. Measure and take note of the inside width and inside height of the base boom opening for reference later in this procedure.

2. Install the side wear pads on the fly boom and shim as required to match the corresponding dimension recorded in Step 1 within +0/-1.2 mm. Shims should be divided as evenly as possible between the sides of the boom. The number of shims installed at position #1 must match with position #2, and position #3 must match position #4 as shown below. Take note to how many shims are installed in each position.

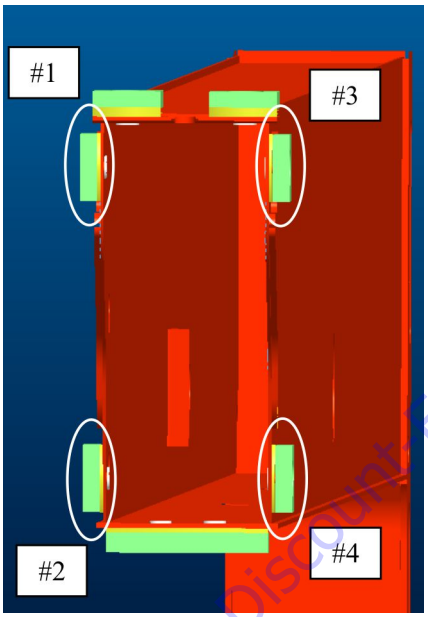


Figure 4-12. Fly Boom Wear Pads

3. Install the top wear pads and shims on the fly boom.

4. Install the bottom wear pads on the fly boom and shim as required to obtain the total base boom dimension within +0/-1.2 mm of the corresponding dimension from Step 1.

5. Slide the fly boom into the base boom, leaving 1 to 2 meters exposed.

6. Install the bottom wear pads and shims into the end of the base boom.

7. Install the side pads and shims into the base boom. Distribute shims to each side to match the distribution noted in Step 2. Positions #5/6 must match positions #1/2. Positions #7/8 must match positions #3/4 (See Figure 4-12. and Figure 4-13.). Verify that no more shims will fit on either side.

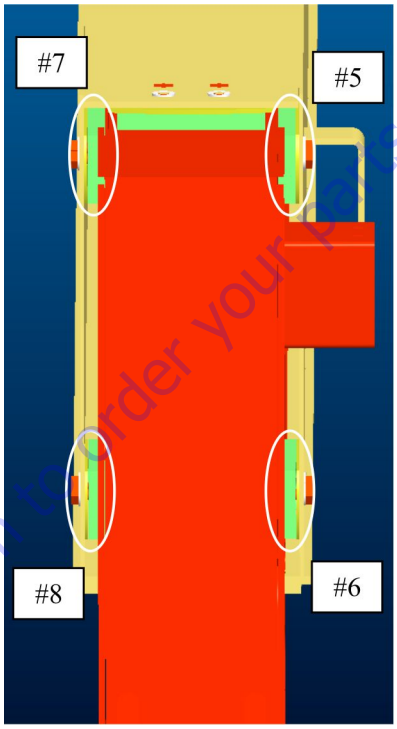


Figure 4-13. Base Boom Wear Pads

NOTE: *Do not use a wedge to install more shims than will fit with the use of a pry bar. This may result in the boom being shimmed too tight. The use of pry bars should only be used to finish installing a shim that can be installed by hand more than half of its length.*

8. Install the top wear pads and shims into the base boom leaving a gap of 0mm to 1.2mm between the top of the fly boom and the inside of the base boom.

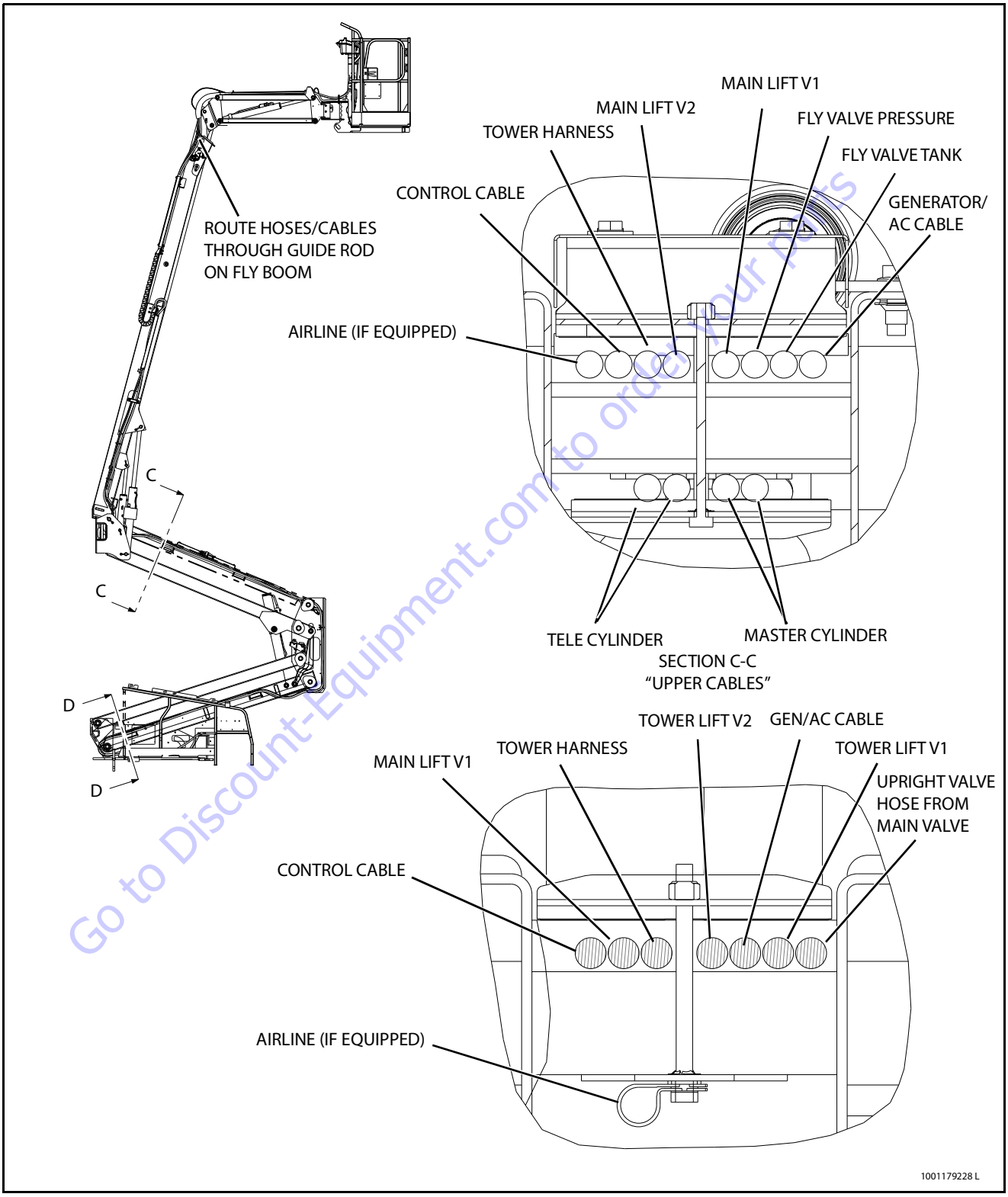


Figure 4-14. Cables and Clamps Installation - Sheet 1 of 8

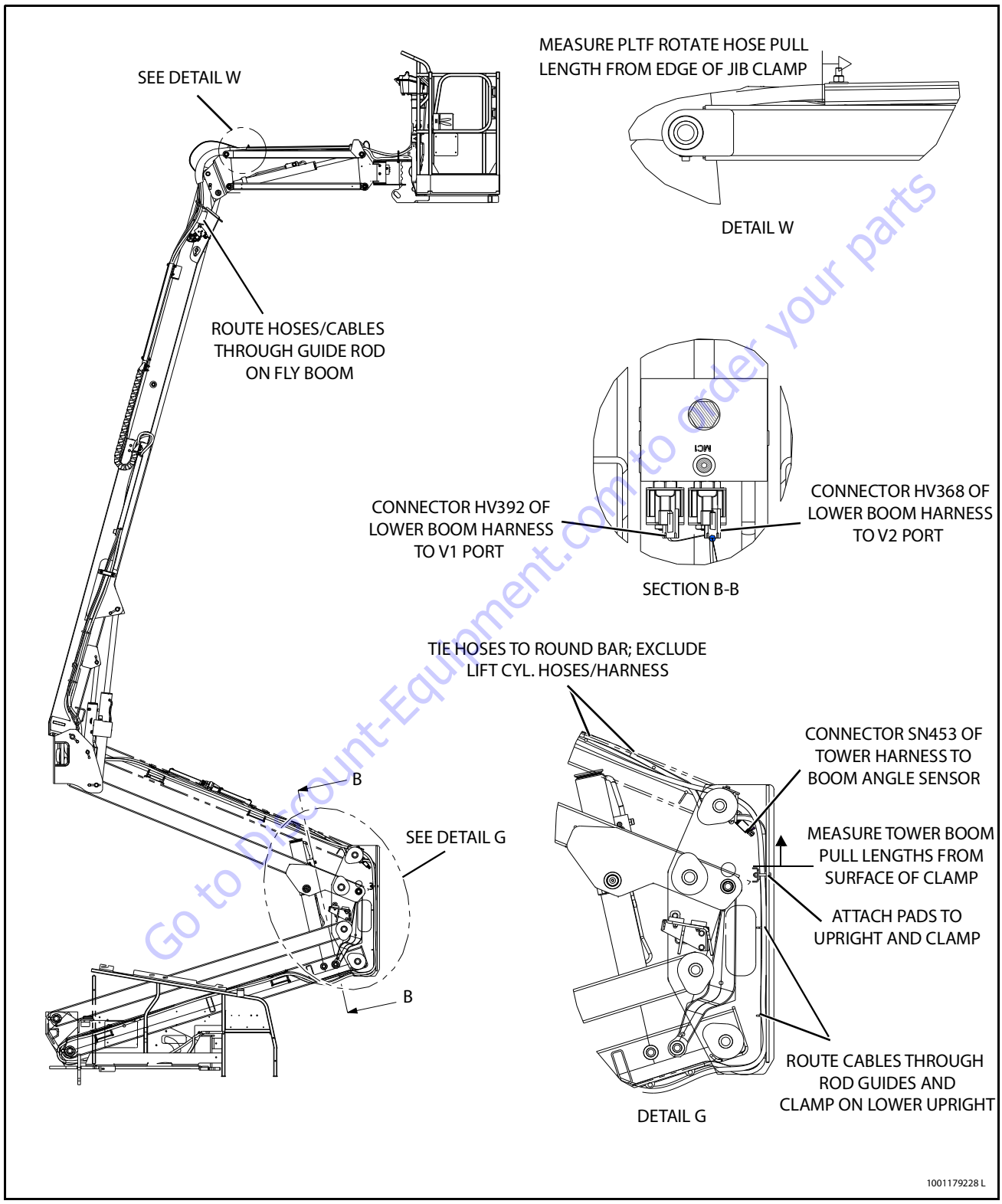


Figure 4-15. Cables and Clamps Installation - Sheet 2 of 8

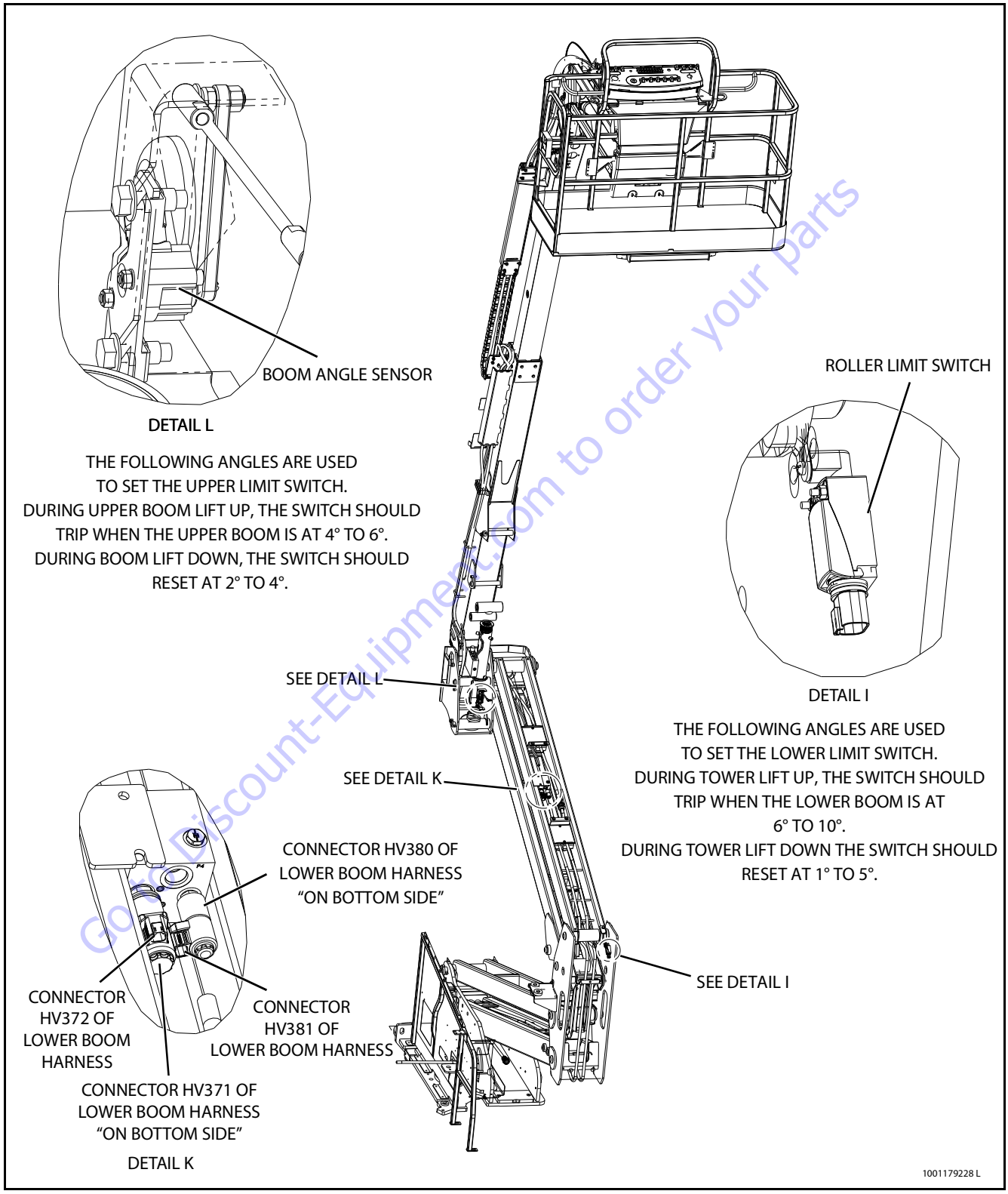


Figure 4-16. Cables and Clamps Installation - Sheet 3 of 8

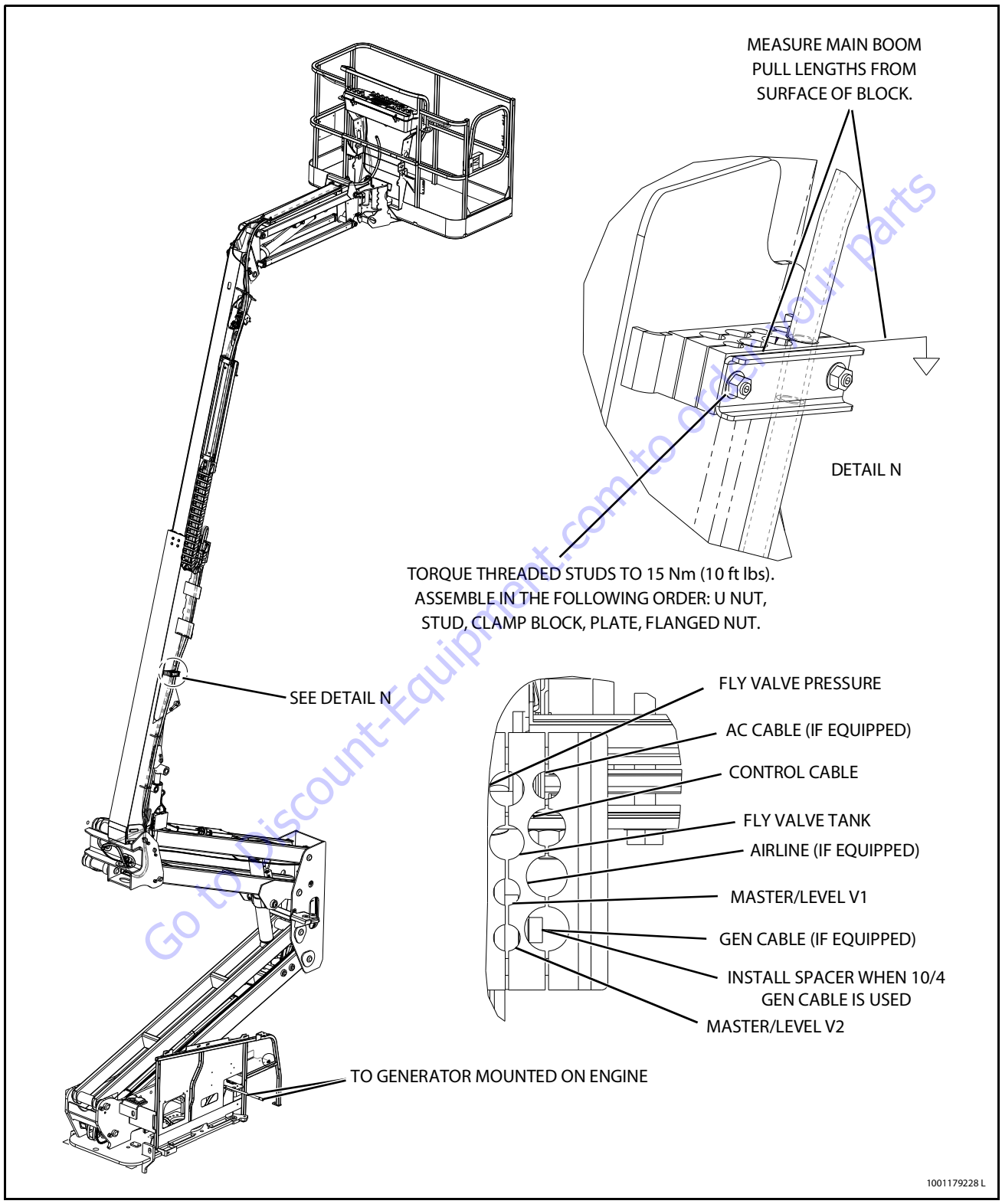


Figure 4-17. Cables and Clamps Installation - Sheet 4 of 8

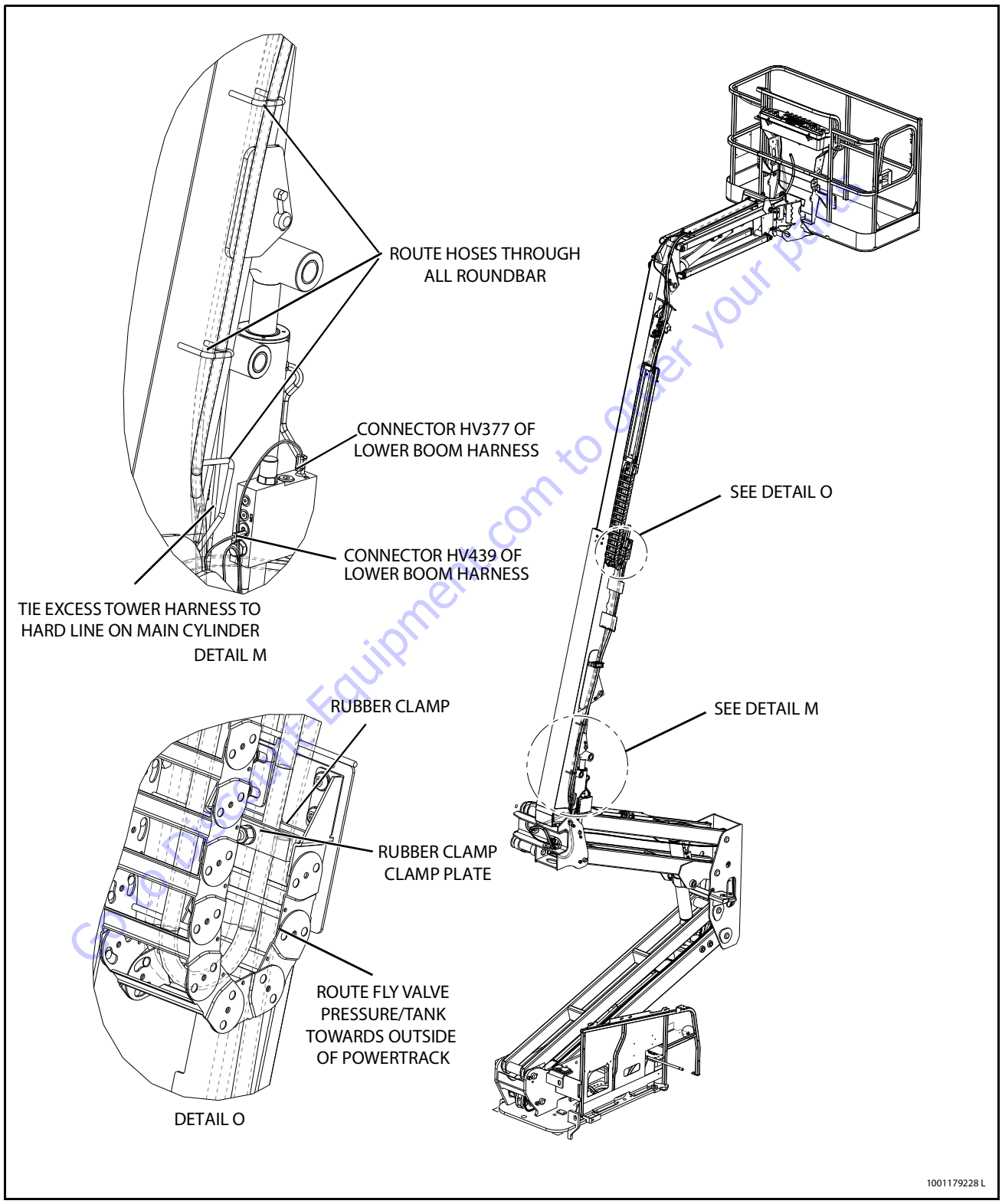


Figure 4-18. Cables and Clamps Installation - Sheet 5 of 8

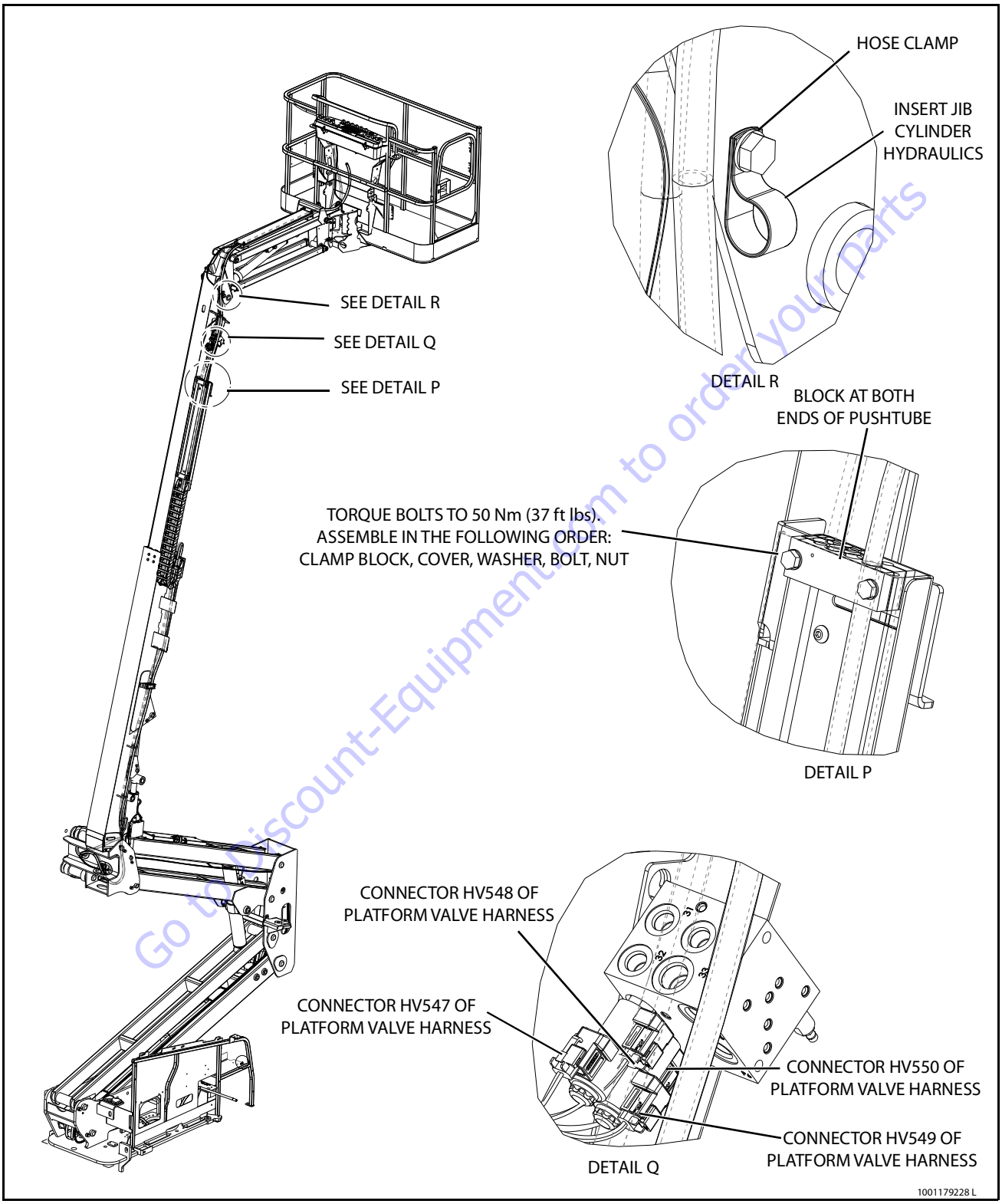


Figure 4-19. Cables and Clamps Installation - Sheet 6 of 8

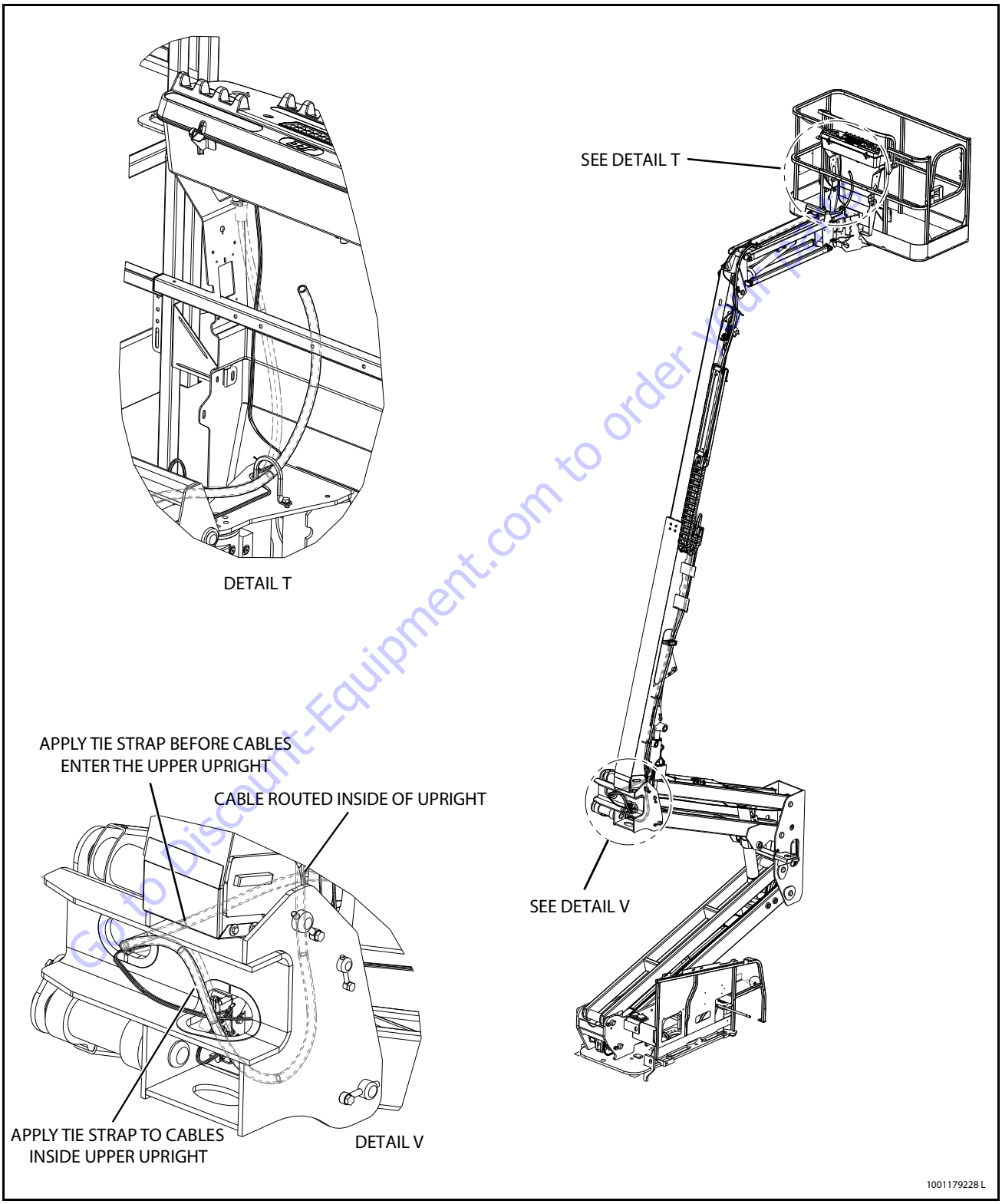


Figure 4-20. Cables and Clamps Installation - Sheet 7 of 8

HOSE & CABLE PULL LENGTHS (TOWER)	
DESCRIPTION	DIMENSION FROM TOP OF CLAMP INSIDE LOWER UPRIGHT (± 25)
AIR LINE	1829
CONTROL CABLE	2197
MAIN LIFT V1	4369
TOWER HARNESS	5213
TOWER LIFT V2	521
GENERATOR/AC CABLE	1626
TOWER LIFT V1	546
UPRIGHT VALVE HOSE FROM MAIN VALVE	1880

HOSE & CABLE PULL LENGTHS 450AJ (MAIN)	
DESCRIPTION	DIMENSION FROM BACK SURFACE OF CLAMP BLOCK ON BASE BOOM (MIN)
CONTROL CABLE	3543
AIRLINE	3658
MASTER/LEVEL V1	2489
MASTER/LEVEL V2	2337
FLY VALVE PRESSURE	3632
FLY VALVE TANK	3683
GENERATOR/AC CABLE	4242
DIMENSION FROM FRONT OF JIB CLAMP. SEE SHT. 1 (DETAIL W) FOR INSTRUCTIONS	
PLATFORM ROTATE	1550

19 PIN BOOM PLUG/ RECEPTACLE LOADING		
SOCKET NUMBER	WIRE COLOR	WIRE SIZE
1	HOLE PLUG SHIELD (ARCTIC)	18 GA.
2	GREEN/J1939 BLACK (ARCTIC)	18 GA.
3	YELLOW/J1939 RED (ARCTIC)	18 GA.
4	ORANGE	18 GA.
5	BLUE	18 GA.
6	YELLOW	18 GA.
7	BROWN	18 GA.
8	HOLE PLUG	N/A
9	RED/BLACK	18 GA.
10	ORANGE 12GA	12 GA.
11	BLUE/BLACK	18 GA.
12	RED 12GA	12 GA.
13	ORANGE/BLACK	18 GA.
14	HOLE PLUG	N/A
15	YELLOW/BLACK	18 GA.
16	BLACK 12GA	12 GA.
17	HOLE PLUG	N/A
18	BLACK/WHITE 12GA	12 GA.
19	HOLE PLUG	N/A

RELATED INSTALLS	
INSTALL #	DESCRIPTION
1001179364	450AJ 7500W
1001179737	450AJ ARCTIC
1001179738	450AJ (4000W 50Hz)
1001179771	450AJ 7500W ARCTIC
1001179776	450AJ (4000W 60Hz)
1001179778	520AJ (4000W 50Hz)
1001179781	520AJ 7500W

GEN CABLE CONNECTOR ROUTING	
Z	BLACK #1
Y	BLACK #2
X	BROWN
WH	BLUE
GRD	GREEN/YELLOW

AC CABLE CONNECTOR LOADING	
GOLD	BLACK/BROWN
SILVER	WHITE/BLUE
GREEN	GREEN/GREEN-YELLOW

1001179228 L

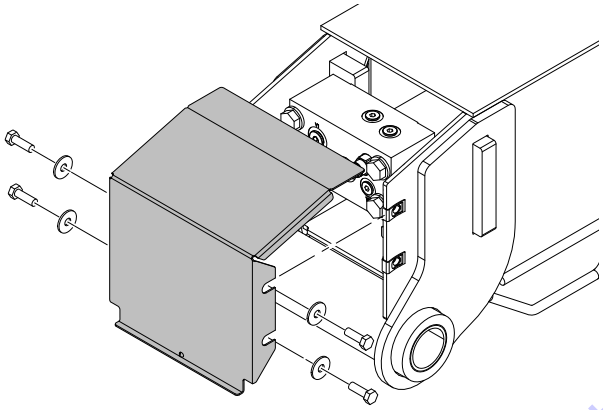
Figure 4-21. Cables and Clamps Installation - Sheet 8 of 8

4.10 BOOM ASSEMBLY

Upper Boom Removal

NOTE: *Prior to removing the upper boom, extend fly boom section out far enough to access telescope cylinder retainer pin, if upper boom needs to be dissembled.*

1. Remove the platform assembly and jib. Refer to Section 4.2, Platform and Section 4.4, Jib.
2. Remove the hardware securing boom end cover to the upper boom. Remove the boom end cover.



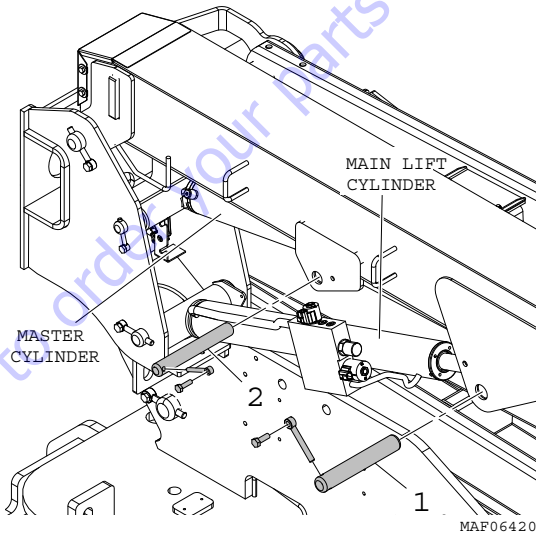
NOTE: *The upper boom assembly weighs approximately 850 lb (385 kg).*

3. Using a suitable lifting device, adequately support upper boom assembly weight along entire length.
4. Tag and disconnect hydraulic lines from telescope cylinder, main lift cylinder and master cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

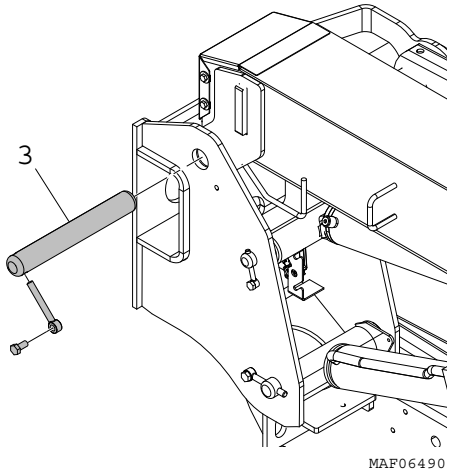
NOTE: *The main lift cylinder weighs approximately 135 lb (61 kg).*

NOTE: *The master cylinder weighs approximately 50 lb (22 kg).*

5. Attach an adequate supporting device to the main lift cylinder and master cylinder to support their weight.
6. Remove bolt and keeper pin from main lift cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin #1 securing main lift cylinder to upper boom.
7. Remove bolt and keeper pin from master cylinder pin #2. Using a suitable brass drift and hammer, remove the cylinder pin #2 securing master cylinder to upper boom.



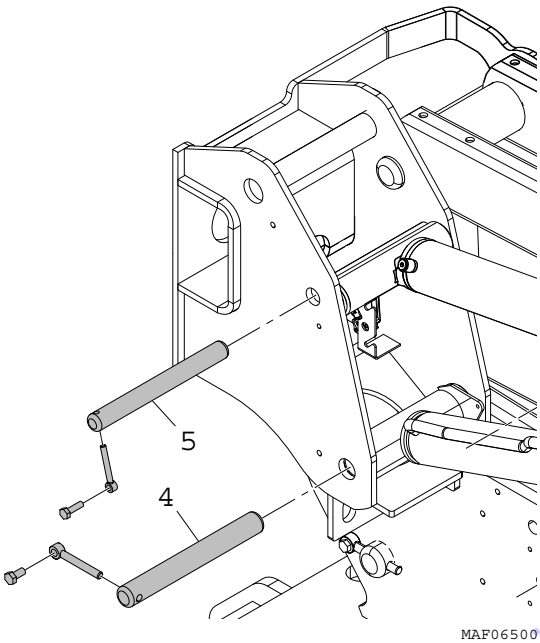
8. Remove Engine side hood to gain access to keeper pins on upper upright, if necessary.
9. Remove bolt and keeper pin #3 securing the upper boom to the upper upright. Using a suitable brass drift and hammer, remove the pin #3 from upper boom.



10. Using all applicable safety precautions, carefully lift upper boom assembly clear of upper upright and lower to ground or suitably supported work surface.

11. If necessary remove bolt and keeper pin from main lift cylinder pin #4. Using a suitable brass drift and hammer, remove the cylinder pin #4 from upper upright. Carefully remove the main lift cylinder.

12. If necessary remove bolt and keeper pin #5 from master cylinder pin. Using a suitable brass drift and hammer, remove the cylinder pin #5 from upper upright. Carefully remove the master cylinder.



Mid Boom Removal

1. Using a suitable lifting equipment, adequately support mid boom assembly weight.

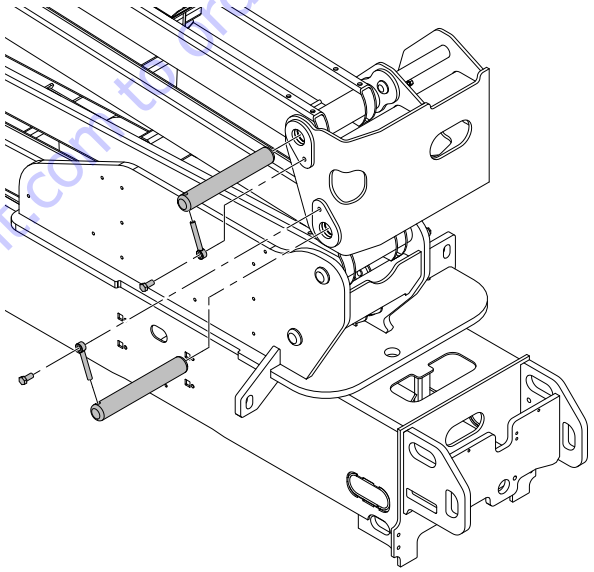
2. Tag and disconnect hydraulic lines from tower lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap and plug all openings of hydraulic lines and ports.

3. Remove Hydraulic tank side hood to gain access to keeper pins on upper upright, if necessary.

NOTE: *The upper upright weighs approximately 210 lb (95 kg).*

4. Attach an adequate supporting device to the upper upright to support its weight.

5. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from upper upright.



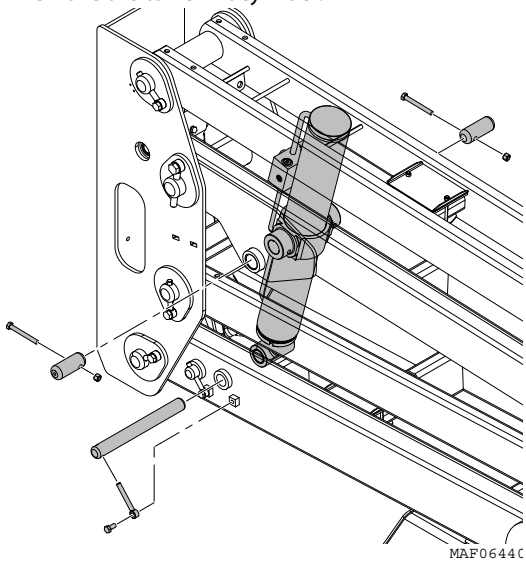
6. Using all applicable safety precautions, carefully lift upper upright and lower to ground or suitably supported work surface.

NOTE: *The tower lift cylinder weighs approximately 140 lb (65 kg).*

7. Using a suitable lifting equipment, adequately support tower lift cylinder to supper its weight.

8. Remove mounting hardware from pins securing tower lift cylinder to the mid boom. Using a suitable brass drift and hammer, remove the pin from tower lift cylinder securing to mid boom.

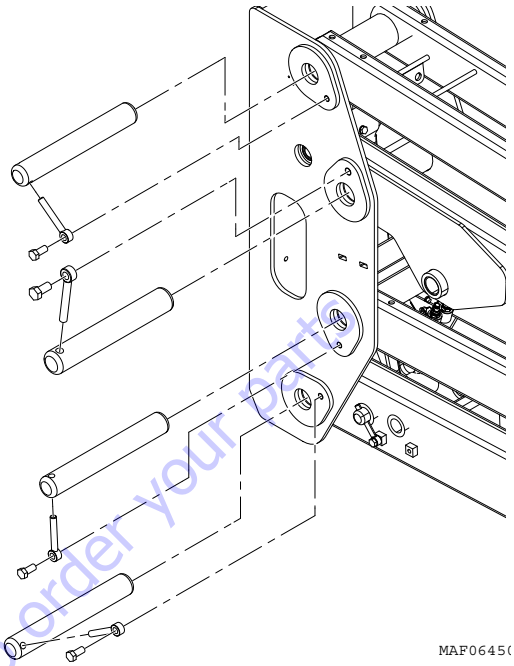
9. If necessary remove bolt and keeper pin from tower lift cylinder pin. Using a suitable brass drift and hammer, remove the cylinder pin from lower boom. Carefully remove the tower lift cylinder.



NOTE: *The lower upright weighs approximately 295 lb (135 kg).*

10. Attach an adequate supporting device to the lower upright to support its weight.

11. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from lower upright.

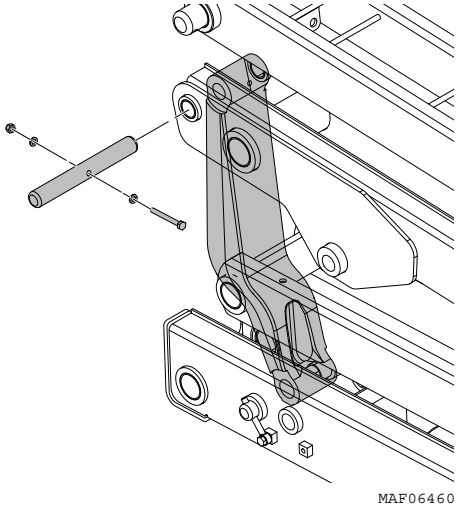


12. Using all applicable safety precautions, carefully lift lower upright and lower to ground or suitably supported work surface.

NOTE: *The timing link weighs approximately 110 lb (50 kg).*

13. Attach an adequate supporting device to the timing link to support its weight.

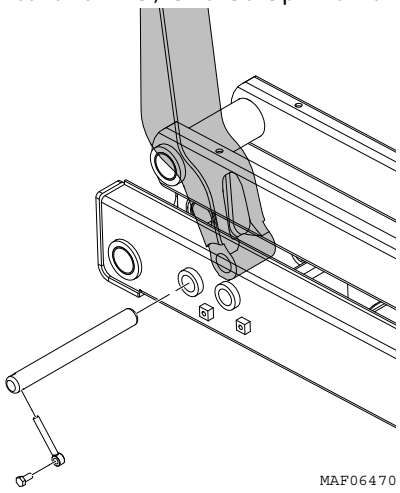
14. Remove mounting hardware from pin. Using a suitable brass drift and hammer, remove the pin from timing link.



15. Using all applicable safety precautions, carefully lift mid boom assembly and lower to ground or suitably supported work surface.

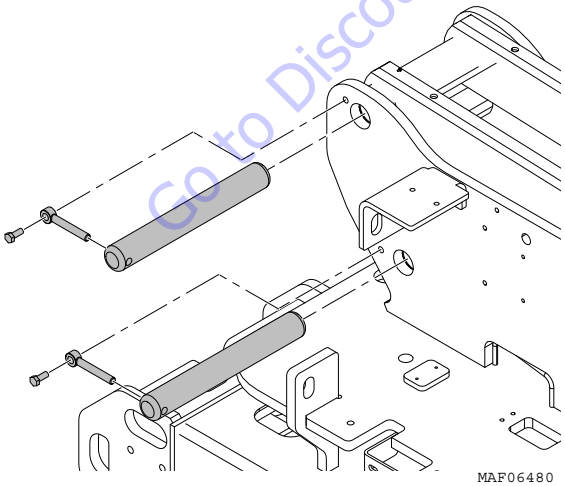
Lower Boom Removal

1. Using a suitable lifting device, adequately support lower boom assembly weight.
2. Remove mounting hardware from pin. Using a suitable brass drift and hammer, remove the pin from timing link.



NOTE: *The timing link weighs approximately 110 lb (50 kg).*

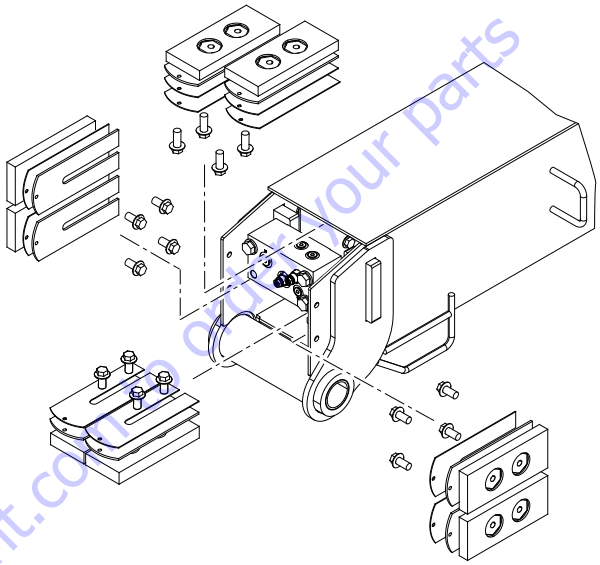
3. Using all applicable safety precautions, carefully lift lower timing link to ground or suitably supported work surface.
4. Remove front hood and counterweight to gain access to keeper pins on turntable, if necessary.
5. Remove mounting hardware from pins. Using a suitable brass drift and hammer, remove the pins from lower boom securing to turntable.



6. Using all applicable safety precautions, carefully lift lower boom assembly and lower to ground or suitably supported work surface.

Upper Boom Disassembly

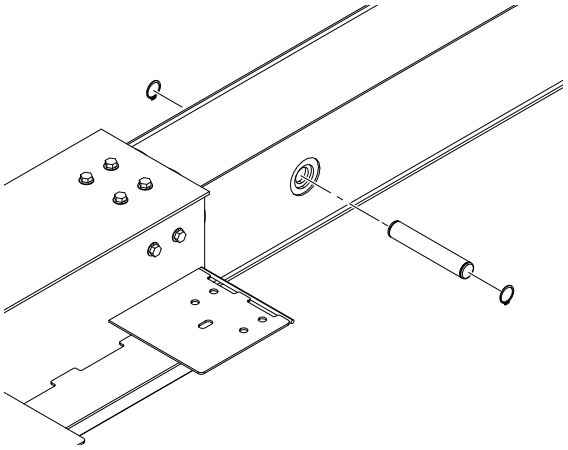
1. Loosen jam nuts on aft end of fly boom wear pad adjustment and loosen adjustments.
2. Loosen the wear pad retaining bolts at the rear of fly boom section and remove the shims and wear pads noting the location and number of shims to aid in reassembly.



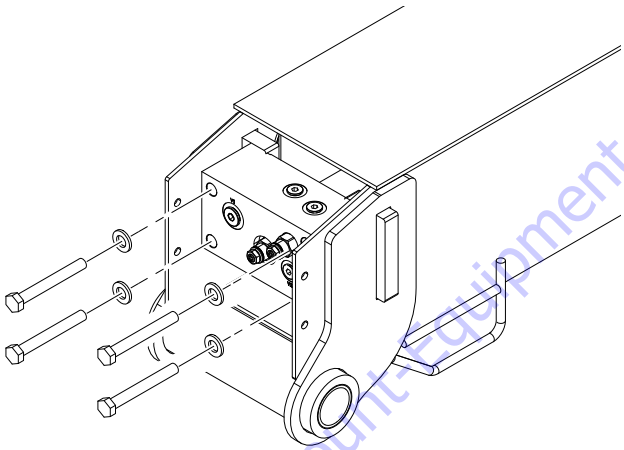
3. If necessary, using a portable power source, attach hose to telescope cylinder port block. Using all applicable safety precautions, activate hydraulic system and extend cylinder to gain access to cylinder rod retaining pin. Shut down the portable power source.
4. Carefully disconnect hydraulic hose from retract port of cylinder. There will be initial weeping of hydraulic fluid which can be caught in a suitable container. After initial discharge, there should be no further leakage from the retract port. Cap or plug all openings.

NOTE: *When removing the retaining pin from the rod end of the telescope cylinder, make sure the cylinder is properly supported.*

5. Remove the retaining ring and pin securing the telescope cylinder rod end to the fly boom section.

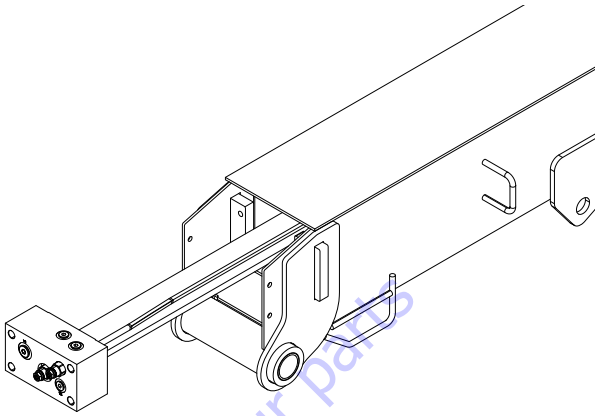


6. Remove the bolts and washers securing telescope cylinder to the rear of the base boom section.

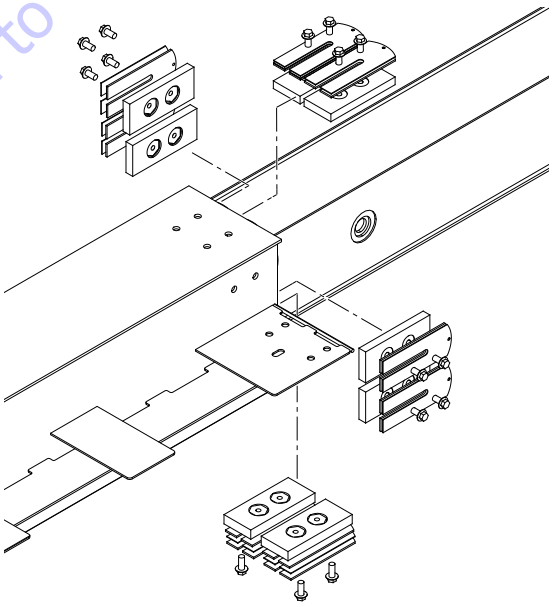


NOTE: *The telescope cylinder weighs approximately 120 lb (55 kg).*

7. Using a suitable lifting device, remove telescope cylinder from the rear of the boom sections.



8. Remove hardware securing the front wear pads on base boom section, remove wear pads and shims, noting the location and number of shims to aid in reassembly.



NOTE: *The fly boom section weighs approximately 200 lb (90 kg).*

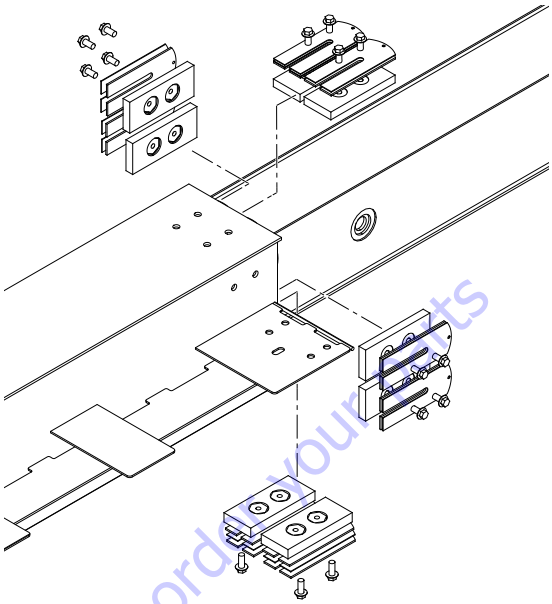
9. Using a suitable lifting device, remove fly boom from boom section.

Inspection

1. Inspect all boom pivot pins for wear, scoring or other damage, and for tapering or ovality. Replace pins as necessary.
2. Inspect lift cylinder pins for wear, scoring or other damage, and for tapering or ovality. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
3. Inspect telescope cylinder rod attach pin for wear, scoring or other damage. Replace pin as necessary.
4. Inspect inner diameter of boom pivot bushings for scoring, distortion, wear or other damage. Replace bushings as necessary.
5. Inspect wear pads for wear.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Upper Boom Assembly

1. Using Medium Strength Threadlocking Compound or equivalent, install the bottom wear pads and shims as noted during disassembly on the rear of the fly section. Torque the retaining bolts to 40 ft. lbs. (55 Nm). Install the rest of the wear pads on the rear of the fly section but do not install the shims or torque them at this time.
2. Using an adequate lifting device, slide the fly boom section into the base boom section. Install the remaining shims on the rear of the fly section as noted during disassembly and torque the retaining bolts to 40 ft. lbs. (55 Nm). Pull the fly section out of the base section enough to install the pin that secures the telescope cylinder rod to the fly boom section.
3. Using Medium Strength Threadlocking Compound or equivalent, install the front wear pads and shims as noted during disassembly on the base boom section. Torque the retaining bolts to 40 ft. lbs. (55 Nm).

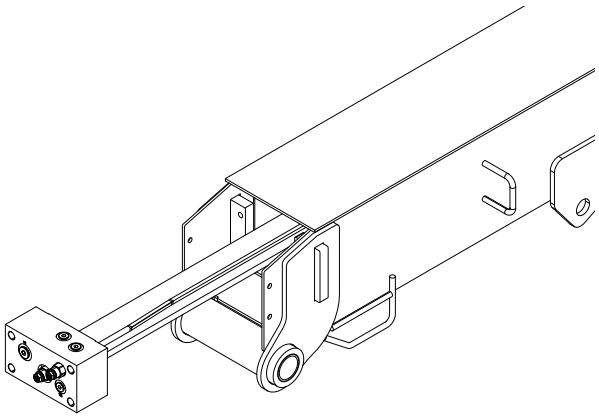


NOTICE

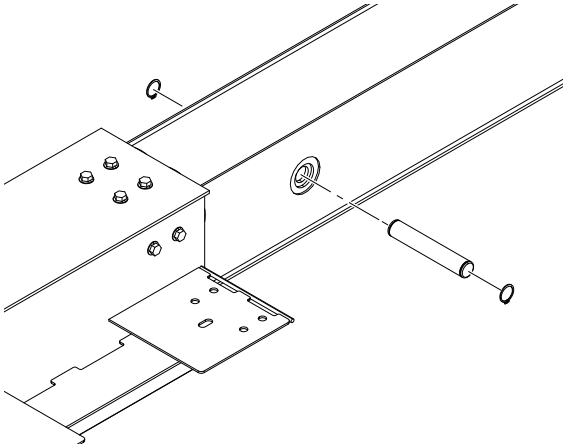
WHEN INSERTING TELESCOPE CYLINDER INTO BOOM, CARE MUST BE TAKEN NOT TO DAMAGE POWER TRACK ASSEMBLY.

NOTE: *The telescope cylinder weighs approximately 120 lb (55 kg).*

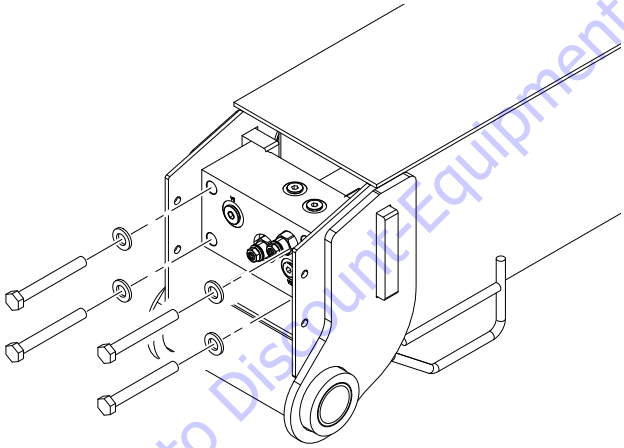
4. Using an adequate lifting device, install the telescope cylinder into the boom assembly. It will aid assembly if the cylinder is extended to enable connection to the fly boom section.



5. Align the telescope cylinder rod end with the corresponding hole in the fly boom section. If necessary, attach a portable power supply to the cylinder to extend or retract the cylinder for alignment. Install the retaining pin and secure it in place with the retaining ring.



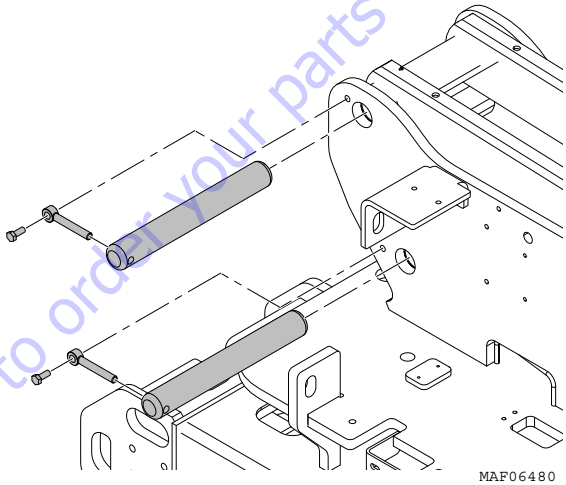
6. Using Medium Strength Threadlocking Compound or equivalent, secure the rear of the telescope cylinder to the base boom section with the attaching bolts and washers. Torque the bolts 85 ft. lbs. (115 Nm).



7. Retract boom section fully. Using shims, adjust wear pads at aft end of boom section to zero clearance. Adjust pads alternately side to side, so fly boom section is centered in base boom section.

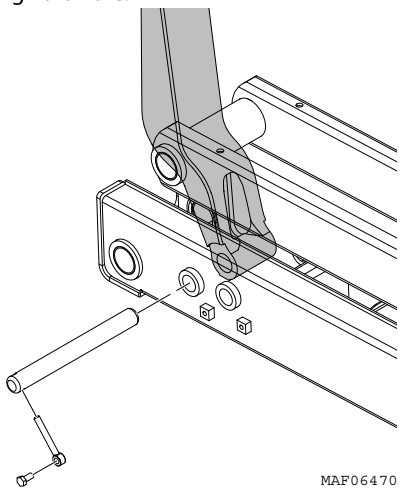
Lower Boom Installation

1. Remove front hood and counterweight to gain access to keeper pins on turntable, if necessary.
2. Using all applicable safety precautions, carefully lift lower boom assembly to align the pivot holes in the lower boom with those of the turntable.
3. Using a soft head mallet, install pins into turntable and secure with mounting hardware.



NOTE: *The timing link weighs approximately 110 lb (50 kg).*

4. Using all applicable safety precautions, carefully lift and align timing link with lower boom assembly. Using a soft head mallet, install pins into timing link and secure with mounting hardware.



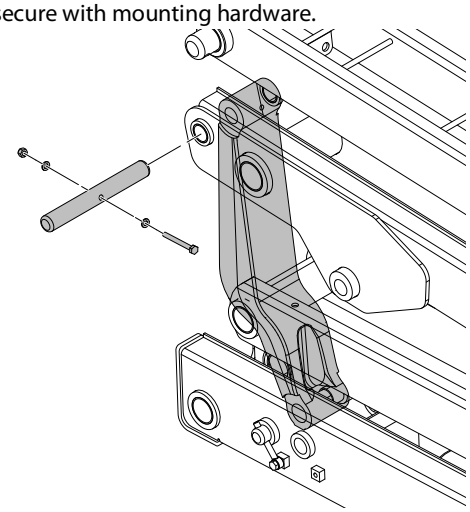
Mid Boom Installation

1. Attach an adequate supporting device to the Mid Boom to support its weight.

NOTE: *The timing link weighs approximately 110 lb (50 kg).*

2. Using all applicable safety precautions, carefully lift timing link and mid boom to align the pivot hole in the timing link with holes of the Mid boom.

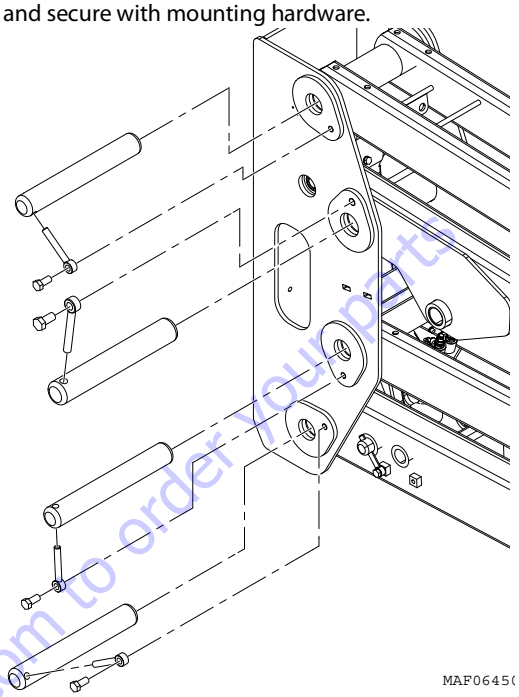
3. Using a soft head mallet, install pin into lower boom and secure with mounting hardware.



NOTE: *The lower upright weighs approximately 295 lb (135 kg).*

4. Attach an adequate supporting device to the lower upright to support its weight.

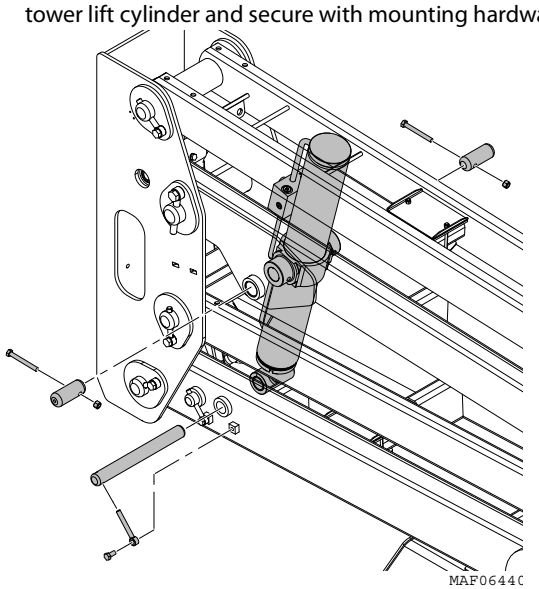
5. Using all applicable safety precautions, carefully lift and align lower upright with lower boom and mid boom. Using a soft head mallet, install pins into lower upright and secure with mounting hardware.



NOTE: *The tower lift cylinder weighs approximately 140 lb (65 kg).*

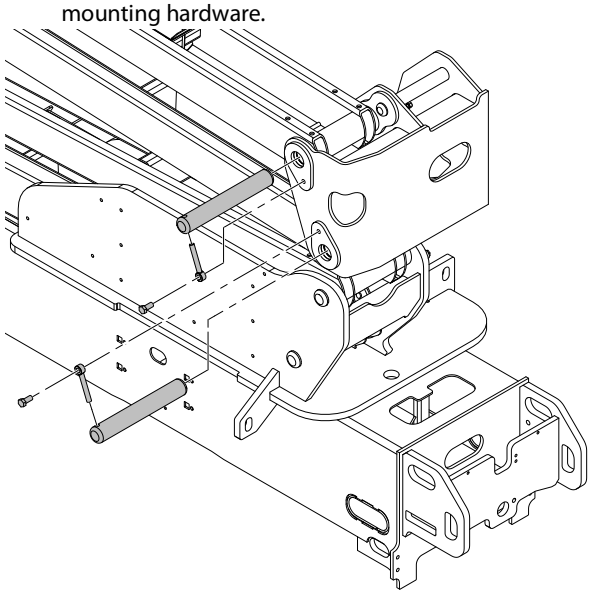
6. Using a suitable lifting equipment, adequately support tower lift cylinder to supper its weight.

7. Using all applicable safety precautions, carefully lift and align tower lift cylinder assembly with lower boom and mid boom. Using a soft head mallet, install pins into tower lift cylinder and secure with mounting hardware.



NOTE: *The upper upright weighs approximately 210 lb (95 kg).*

8. Attach an adequate supporting device to the upper upright to support its weight.
9. Using all applicable safety precautions, carefully lift and align upper upright with mid boom. Using a soft head mallet, install pins into lower upright and secure with mounting hardware.



MAF0643(

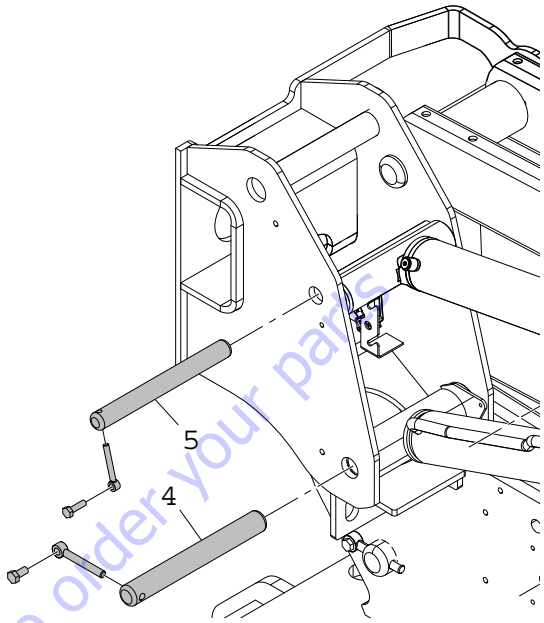
10. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the tower lift cylinder as tagged during removal.

Upper Boom Installation

NOTE: *The main lift cylinder weighs approximately 135 lb (61 kg).*

NOTE: *The master cylinder weighs approximately 50 lb (22 kg).*

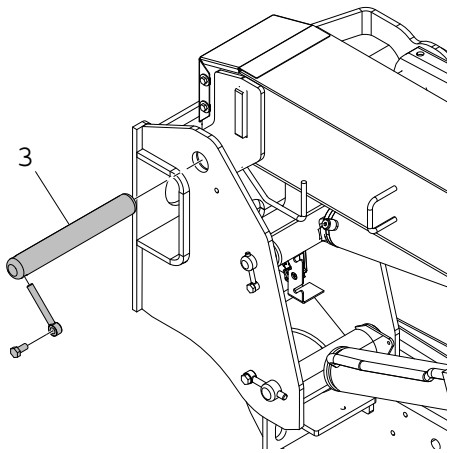
1. Using a suitable lifting device, align the master cylinder with the upper upright. Using a soft head mallet install pin #5 in the upper upright. Install the hardware for pin #5.
2. Using a suitable lifting device, align the main lift cylinder with the upper upright. Using a soft head mallet install pin #4 in the upper upright. Install the hardware for pin #4



MAF06500

NOTE: *The upper boom assembly weighs approximately 850 lb (385 kg).*

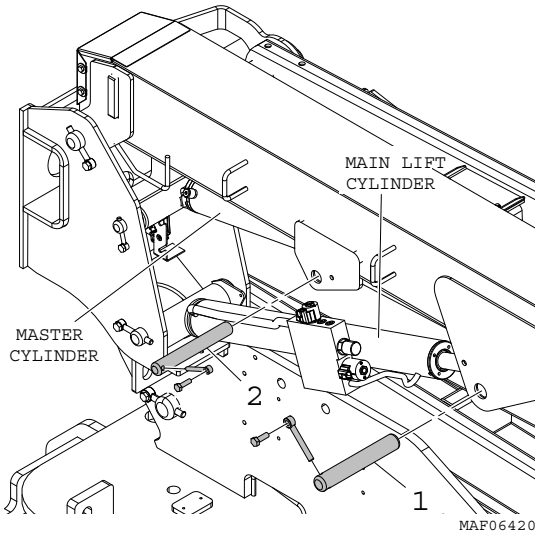
3. Attach an adequate lifting device to support the entire length of the upper boom.
4. Using all applicable safety precautions, carefully lift and align upper boom with upper upright. Using a soft head mallet, install pin3 into upper upright and secure with mounting hardware.



MAF06490

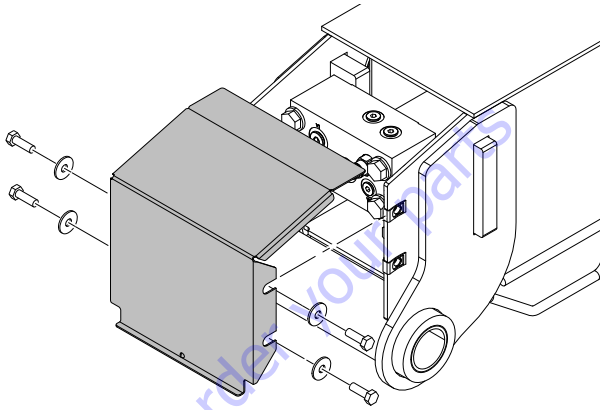
5. Using all applicable safety precautions, carefully lift and align master cylinder with upper boom. Using a soft head mallet, install pin #2 into master cylinder and secure with mounting hardware.

6. Using all applicable safety precautions, carefully lift and align main lift cylinder with upper boom. Using a soft head mallet, install pin #1 into main lift cylinder and secure with mounting hardware.



7. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to the master cylinder, main lift cylinder and telescope cylinder as tagged during removal.

8. Install boom end cover on the upper boom.



9. Install the jib and platform assembly. Refer to Section 4.4, Jib and Section 4.2, Platform.

10. Start machine and check all hydraulic functions for proper operation. Check for any hydraulic oil leaks

4.11 ROTATOR ASSEMBLY

Theory of Operation

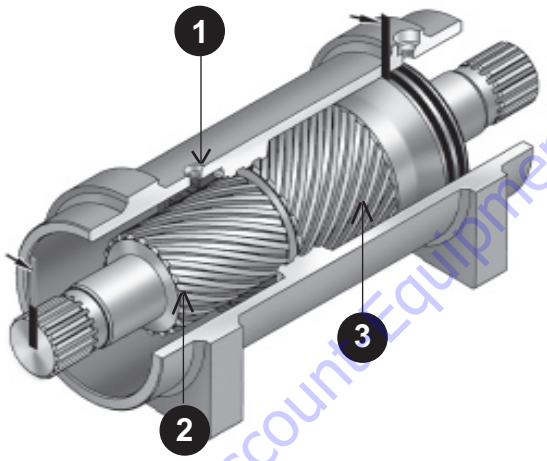
The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). Helical spline teeth machined on the shaft engage matching splines on the inside diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing similar to the operation of a hydraulic cylinder while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the housing, preventing piston movement and locking the shaft in position.

The shaft is supported radially by the large main radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the main and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

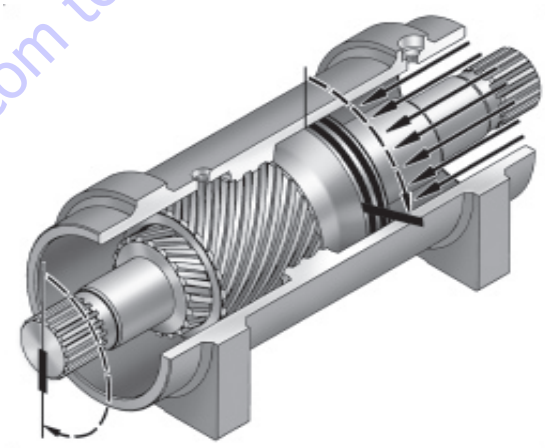
The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- Protects the actuator in the event of overload.
- Enables the actuator to hold position without drifting when external loads are applied.
- Reduces hydraulic backlash by pressuring the hydraulic fluid.

Provides a constant controlled rate of rotation in over-center load conditions.



Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.



Applying fluid pressure will displace the piston axially while the helical gearing causes the piston and shaft to rotate simultaneously.

The double helix design compounds rotation: shaft rotation is about twice that of the piston. Applying pressure to the opposite port will return the piston and shaft

Required Tools

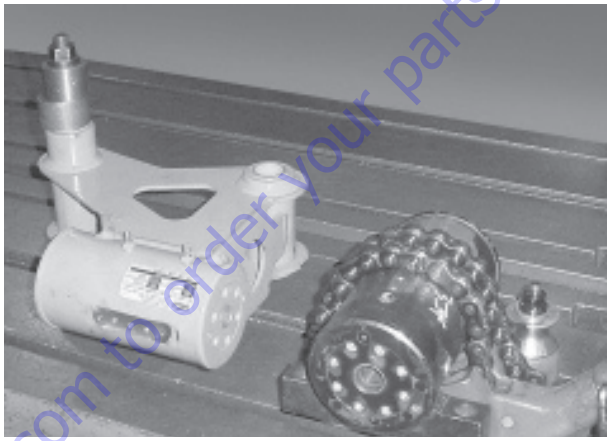
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:

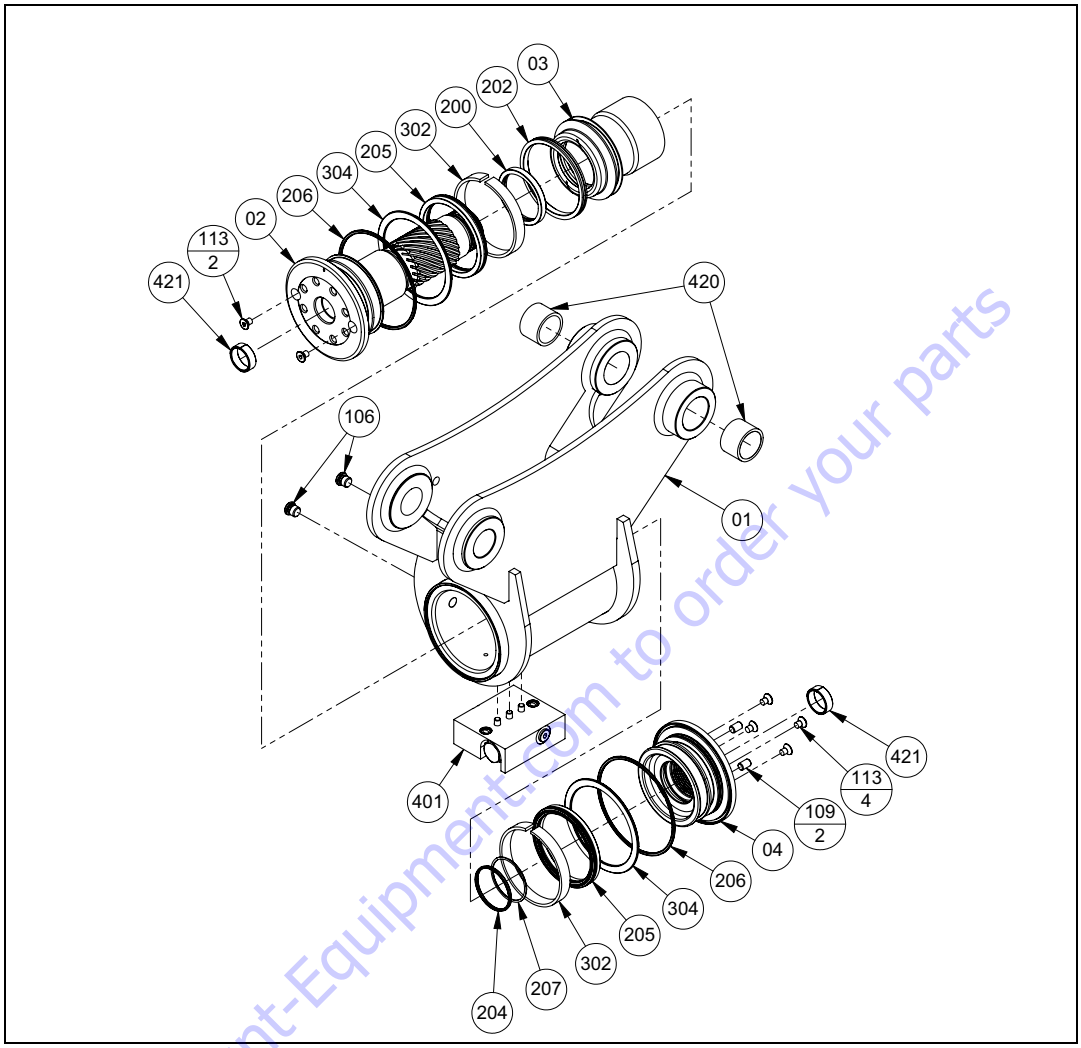
1. PIPE VISE
2. HEX WRENCH - Removal and replacement of port plugs and setscrews.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS (provided with Helac seal kit).
6. DRILL
7. FLASHLIGHT - Helps to locate and examine timing marks, component failure and overall condition.
8. RUBBER MALLET - Removal and installation of shaft and piston sleeve assembly.
9. PLASTIC MANDREL
10. PRY BAR - Removal of end cap and manual rotation of shaft.
11. FELT MARKER - Highlights the timing marks and outline troubled areas.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET - Removal and replacement of port plugs and setscrews (106 &110).
14. SEAL TOOLS - Removal and installation of seals and wear guides.
15. PUNCH
16. DOWEL PINS - Removal and installation of end cap.

Before Disassembly

Inspect the actuator for corrosion prior to disassembly. Severe corrosion can make it difficult to remove the lock pins (109) and unthread the end cap (04). If corrosion is evident, soak the lock pins and end cap with penetrating oil for several hours before disassembly.

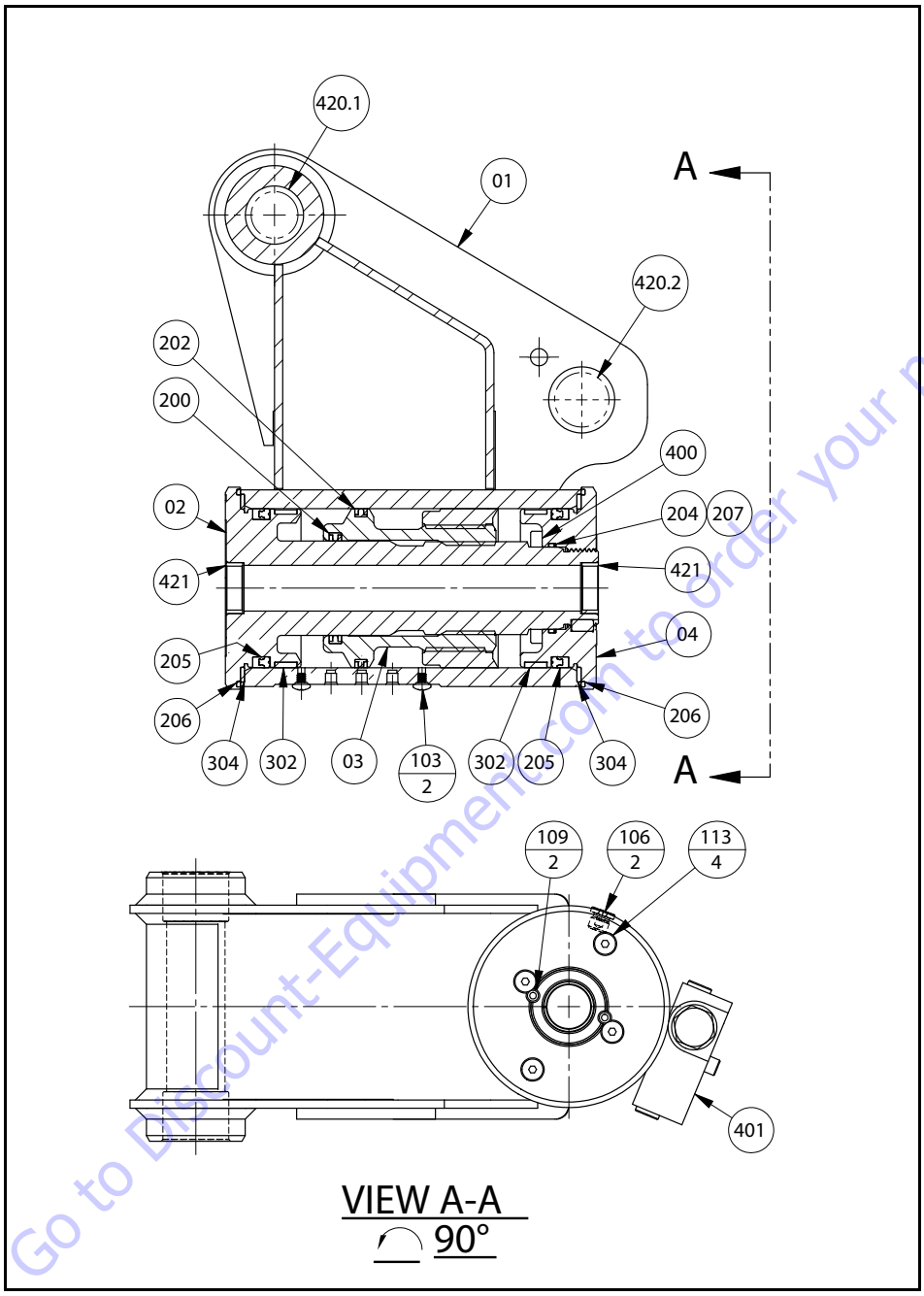
Disassembly is considerably easier if the actuator is firmly secured to the work bench. A pipe vise or mounting fixture work well.





PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	106. Port Plug	202. T-Seal	304. Thrust Washer	401. Counterbalance Valve
3. Piston Sleeve	109. Lock Pin	204. O-ring		403. Motion Control Valve
4. End Cap	113. Capscrew	205. Cup Seal		420. Bushing
		206. Exclusion Seal		421 Bushing
		207. Backup Ring		

Figure 4-22. Rotator - Exploded View



PARTS
1. Housing
2. Shaft
3. Piston Sleeve
4. End Cap

HARDWARE
103. Screw
106. Port Plug
109. Lock Pin
113. Capscrew

SEALS
200. T-Seal
202. T-Seal
204. O-ring
205. Cup Seal
206. Exclusion Seal
207. Backup Ring

BEARINGS
302. Wear Guide
304. Thrust Washer

ACCESSORIES
400. Stop Tube
401. Counterbalance Valve
403. Motion Control Valve
420.1 Bushing
420.2 Bushing
421 Bushing

Figure 4-23. Rotator - Assembly Drawing

Disassembly

⚠ CAUTION

SECURE PRODUCT TO SLOTTED TABLE OR VISE.

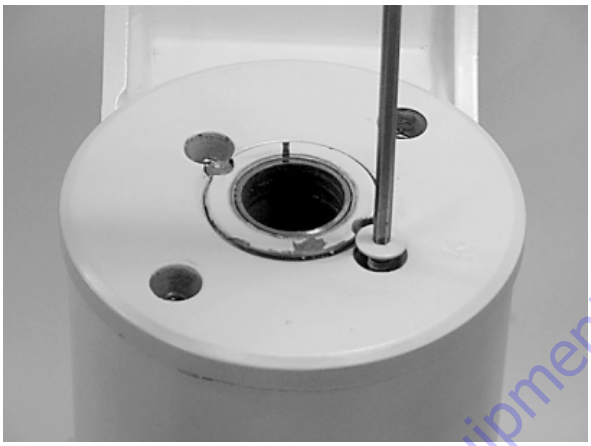
⚠ CAUTION

CONTENTS UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

NOTICE

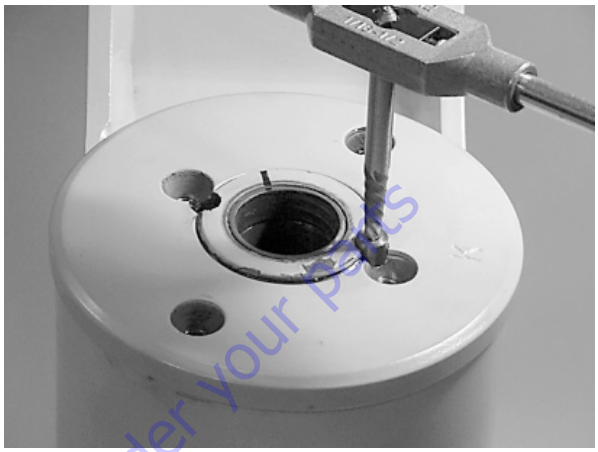
MAKE SURE WORK AREA IS CLEAN.

1. Remove the capscrews (113) over end cap lock pins (109).



2. Using a 1/8 in. (3.18 mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16 in. (4.76 mm).

3. Remove the lock pins using an "Easy Out" (a size #2 is shown). If the pin will not come out with the "Easy Out", use 5/16 in. drill bit to a depth of 1/2 in. (12.7 mm) to drill out the entire pin.



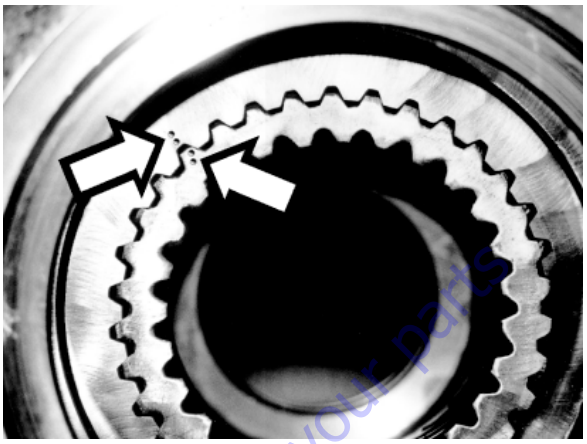
4. Install the end cap (4) removal tools provided with the Helac seal kit.

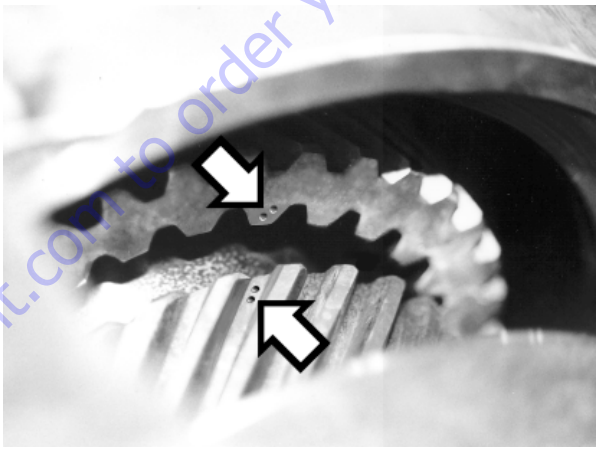
5. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counterclockwise.

6. Remove the end cap (4) and set aside for later inspection.

7. Remove the stop tube if equipped. The stop tube is an available option to limit the rotation of the actuator.

8. Every actuator has timing marks for proper engagement.



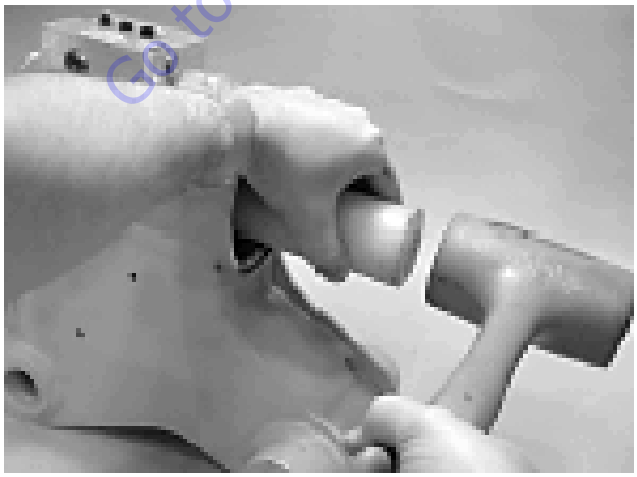


9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.

10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.

11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).

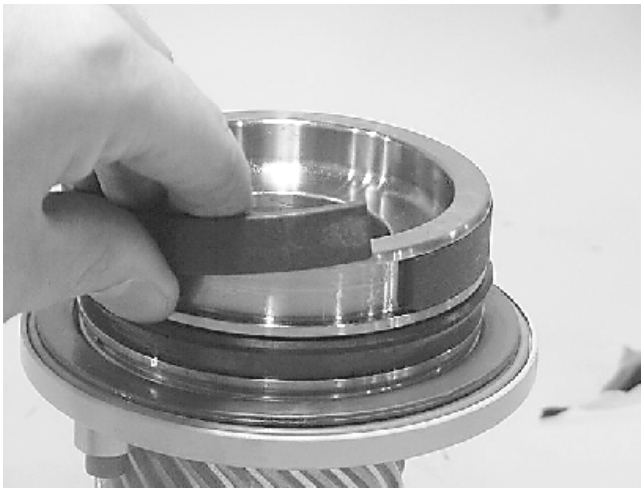
12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.



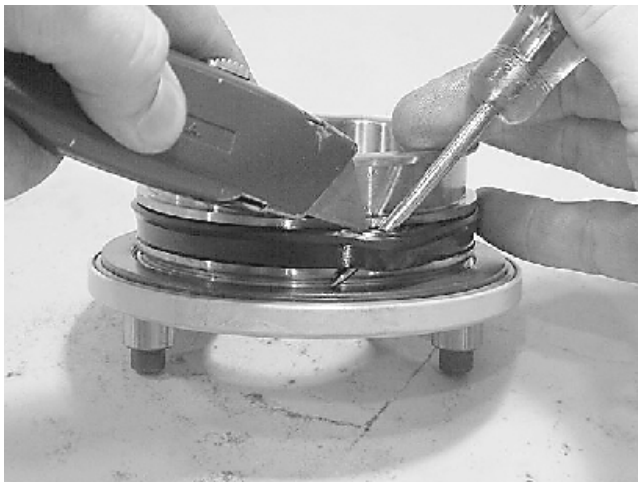
13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.

14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

15. Remove the wear guides (302) from the end cap (4) and shaft (2).



16. To remove the main pressure seals (205), it is easiest to cut them using a sharp razor blade being careful not to damage the seal groove.



17. Remove the thrust washers (304), from the end cap (4) and shaft (2).

18. Remove the wiper seal (304.1) from its groove in the end cap (4) and shaft (2).

19. Remove the piston O.D. seal (202) from the piston.

20. Remove the piston I.D. seal (200). You may now proceed to the inspection process.

Inspection

NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

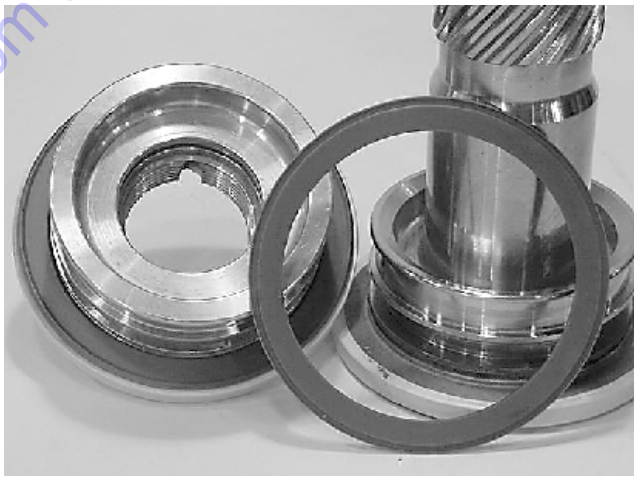
1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.

2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092 in. or 2.34 mm).

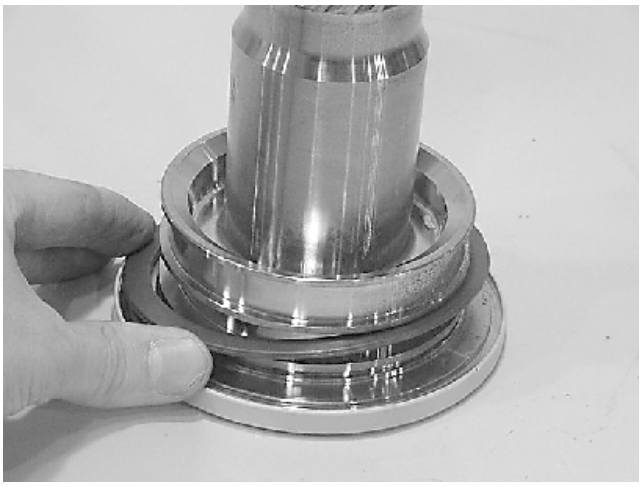
3. Inspect the wear guide condition and measure thickness (not less than 0.123 in. or 3.12 mm).

Assembly

1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.

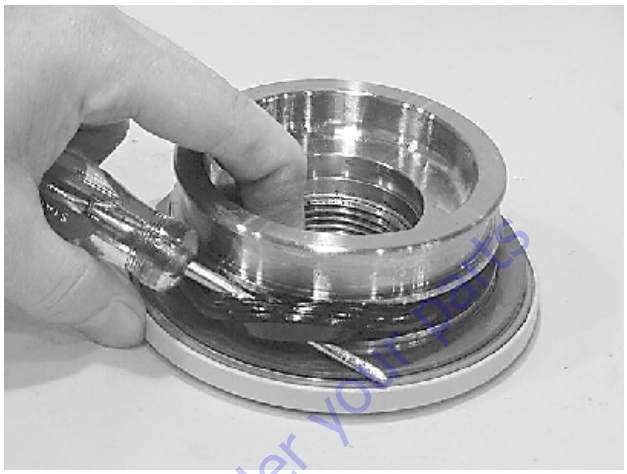


2. Install the thrust washer (304) onto shaft (2) and end cap (4).

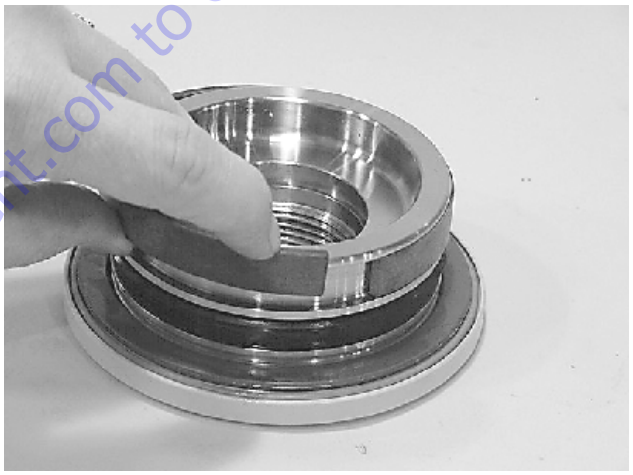


3. Install the wiper seal (304.1/green o-ring) into the groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).

4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.



5. Install the wear guide (302) on the end cap (4) and shaft (2).



6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

7. Install the inner T-seal (200) into the piston (3) using a circular motion.

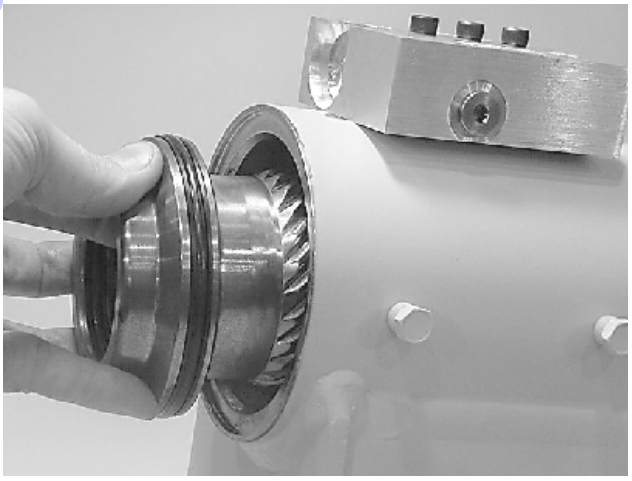
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

   Each T-seal has 2 backup rings (see drawing for orientation).

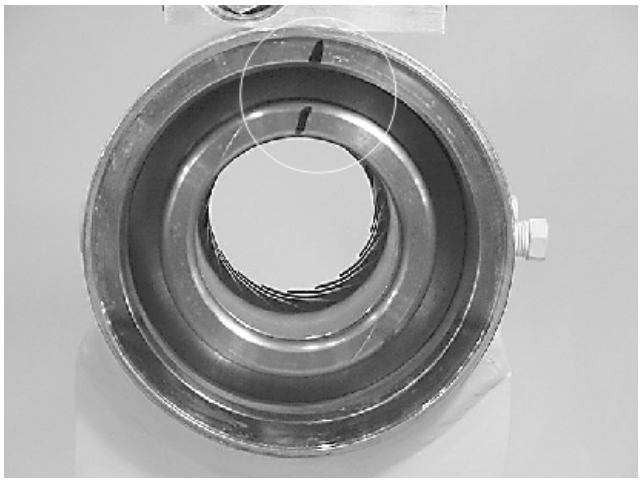
8. Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

   Repeat this step for the outer seal (202).

9. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.

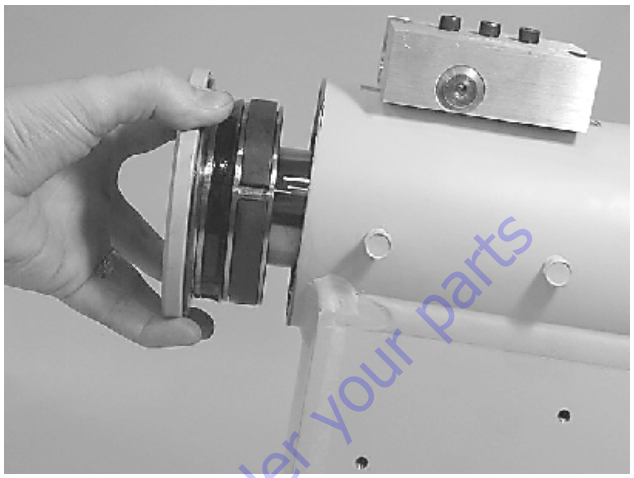


10. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



11. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.

12. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.

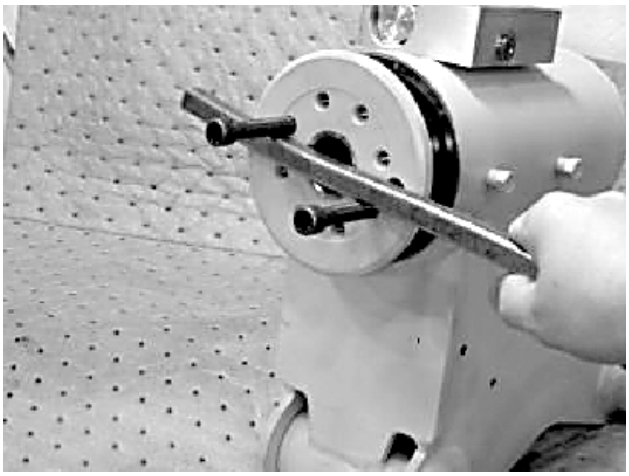


13. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

14. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.

NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSE GEARING.

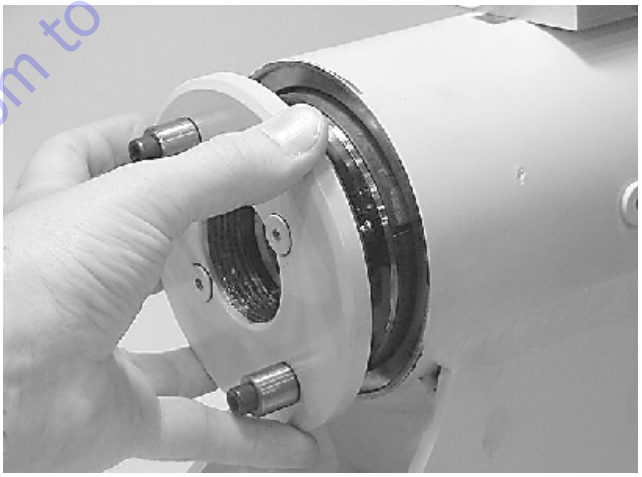


15. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

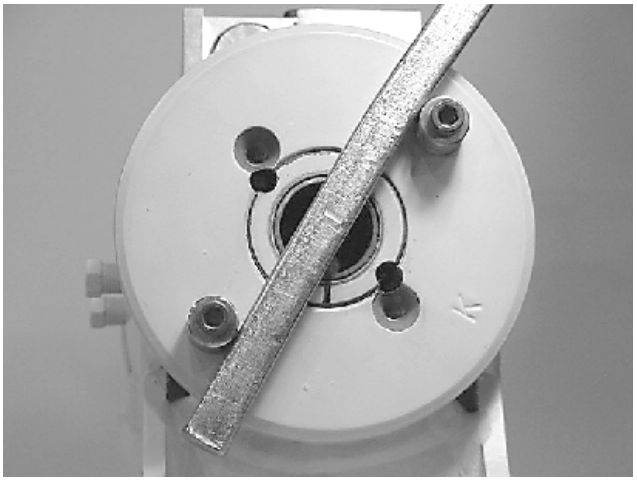
16. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.

17. Install the 0-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

18. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).

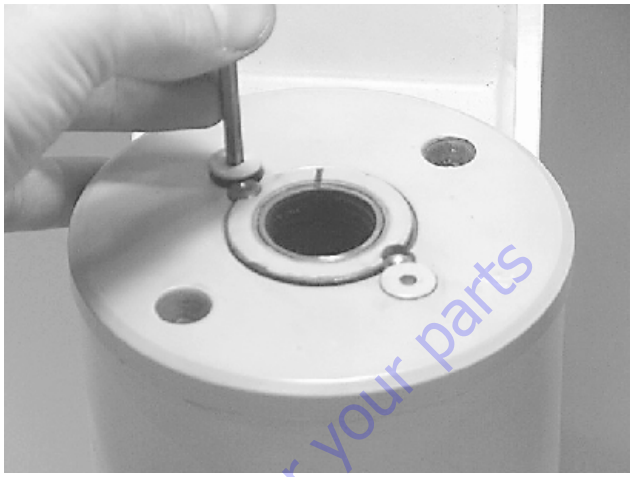


19. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



20. Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.

21. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-24., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Medium Strength Threadlocking Compound.
2. Make sure the new valve has the o-rings in the counter-bores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Medium Strength Threadlocking Compound should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4 in. bolts 110 to 120 in. lbs. (12.4 to 13.5 Nm). Do not torque over 125 in. lbs. (14.1 Nm). Torque the 5/16 in. bolts 140 in. lbs. (15.8 Nm). Do not torque over 145 in. lbs. (16.3 Nm).
5. Make sure the valve is seated against the housing valve flat. If it is raised up on any side or corner, remove the valve to determine what the obstruction is. If possible, test this using a hydraulic hand pump or electric test.

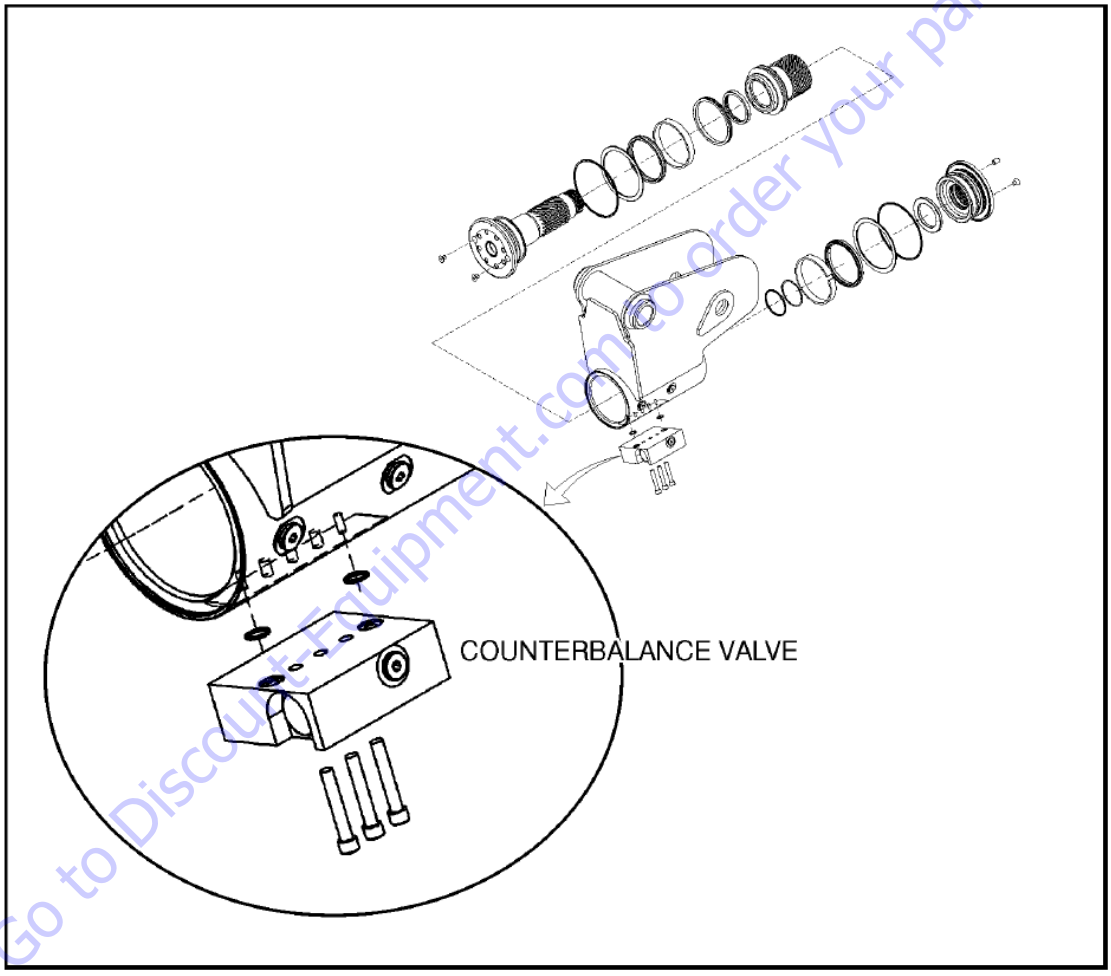


Figure 4-24. Rotator Counterbalance Valve

Greasing Thrust Washers

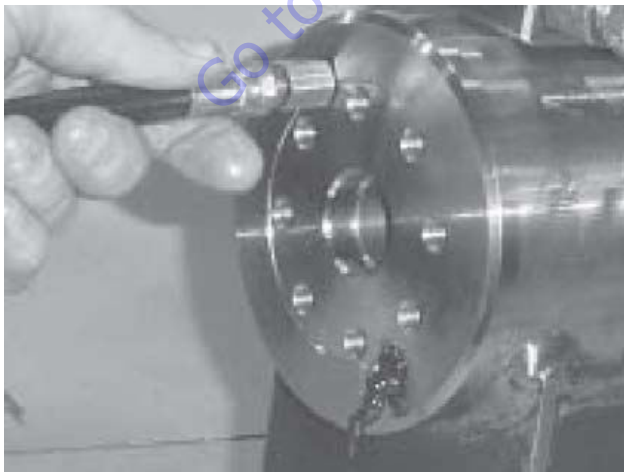
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)

NOTICE

IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAPSCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.

3. Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the capscrews into the grease ports and tighten to 25 in. lbs. (2.8 Nm).



Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

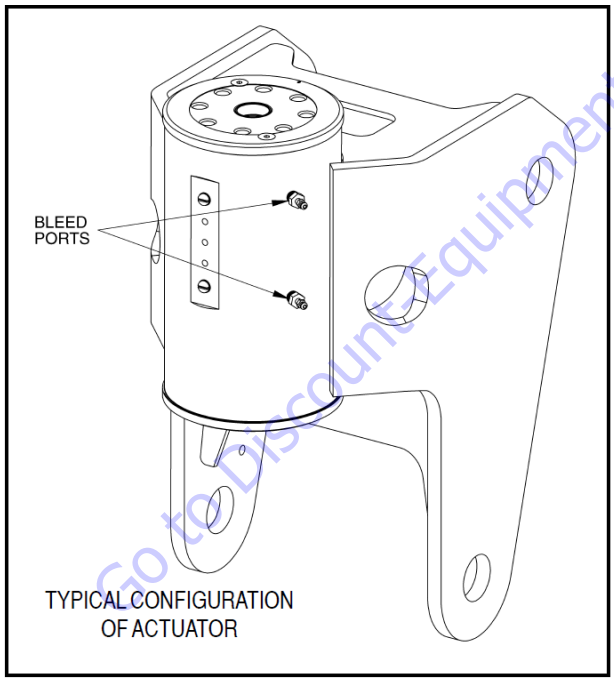
Installation and Bleeding

After installation of the actuator on the equipment, it is important that all safety devices such as tie rods or safety cables are properly reattached.

To purge air from the hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review the hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of the hydraulic supply lines together with pump capacity will determine the amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after the actuator is connected to the hydraulic system. The following steps are recommended when a minimum of two gallons (8 liters) is purged.

1. Connect a 3/16 in. inside diameter x 5/16 in. outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



TYPICAL CONFIGURATION
OF ACTUATOR

2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.
3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

4.12 FOOT SWITCH ADJUSTMENT

Adjust so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 in. (6.35 mm) of travel, top or bottom, it should be adjusted.

Troubleshooting

Table 4-1. Troubleshooting

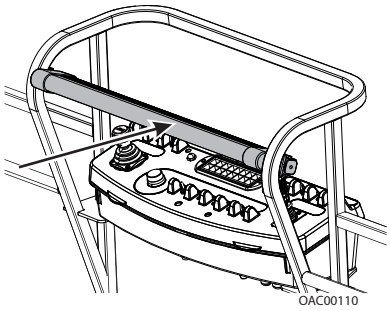
Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.
	c. Control or counterbalance valve has internal leak	c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	d. Piston and/or shaft seal leak	d. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	e. Corrosion build-up on the thrust surfaces	e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.
	f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	f. Re-build the actuator. Use fluid that is compatible with seals and bearings.
2. Operation is erratic or not responsive	a. Air in actuator	a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	a. Twisted or chipped gear teeth	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	b. Piston and/or shaft seal leak	b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures.

4.13 SKYGUARD

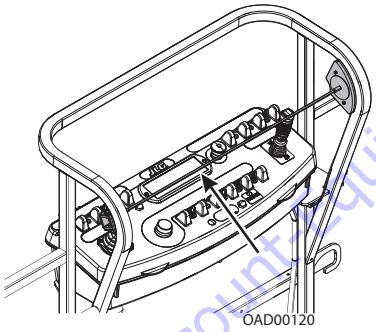
Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

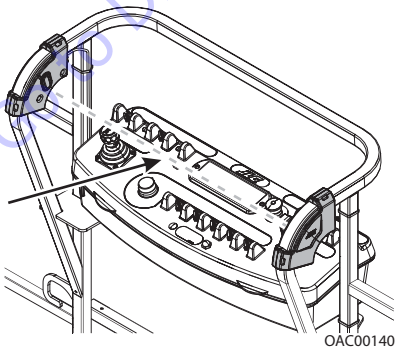
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

Operation is allowed regardless of SkyGuard activation.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SKYGUARD NOT SELECTED IN MACHINE SETUP

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostics & Troubleshooting

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the
MACHINE SETUP: SKYGUARD OPTION menu using the handheld Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

FAULT CODES

Refer to Table 6-2 for more fault code information

- **0039 -** SkyGuard switch activation fault
- **2563 -** switch disagreement fault

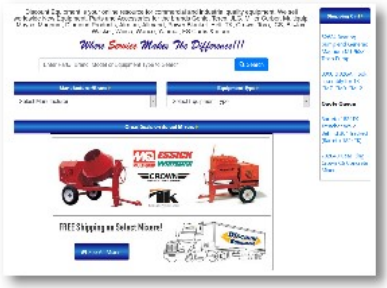
Table 4-2. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Tower Lift Up	Tower Lift Down	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated												
C = Indicates Cutout is Activated												
* DOS Enabled												
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active												

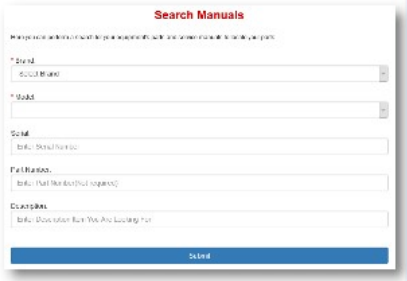
PARTS FINDER

Search Website by Part Number

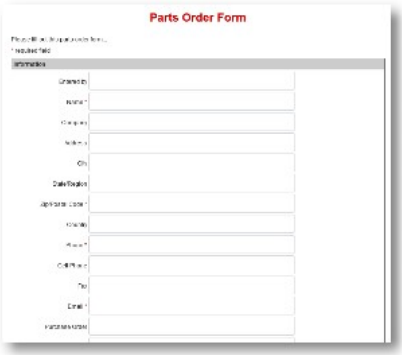
Discount Equipment



Search Manual Library For Parts Manual & Lookup Part Numbers – Purchase or Request Quote



Can't Find Part or Manual? Request Help by Manufacturer, Model & Description



Discount-Equipment.com is your online resource for quality parts & equipment.
Florida: 561-964-4949 Outside Florida TOLL FREE: 877-690-3101

Need parts?

Click on this link: http://www.discount-equipment.com/category/5443-parts/ and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on once of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

NOTE: *All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.*

Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- A small container for hydraulic oil
- Small paint brush

1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.

2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.

3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.

Dip Method

NOTE: *This method works best with Face Seal o-rings, but will work for all o-ring fitting types.*

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
- Sponge cut to fit inside the container
- A small amount of hydraulic oil to saturate the sponge.

1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.

3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.

Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over a suitable catch can.
3. Spray the entire o-ring surface with a medium coat of oil.

Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.

5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

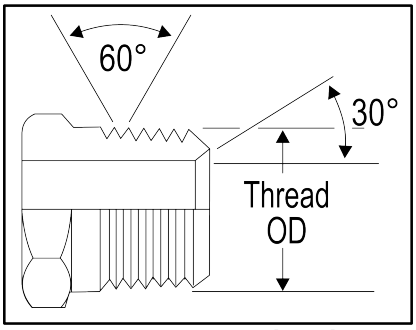


Figure 5-1. NPTF thread

BSPT = British standard pipe tapered per ISO7-1

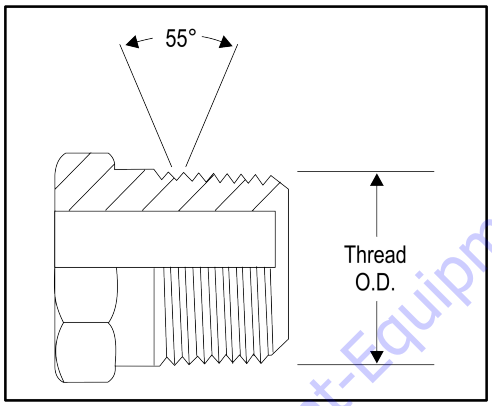


Figure 5-2. BSPT thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

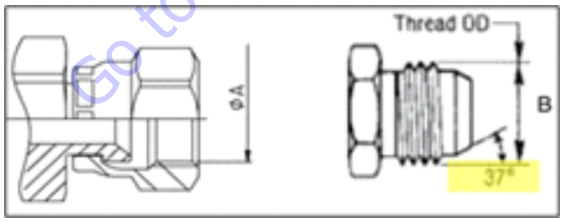


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

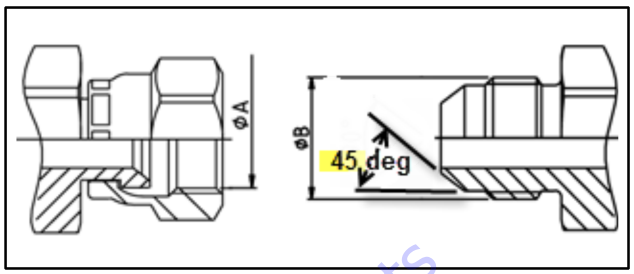


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

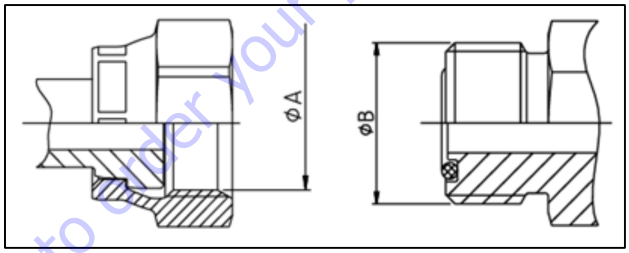


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

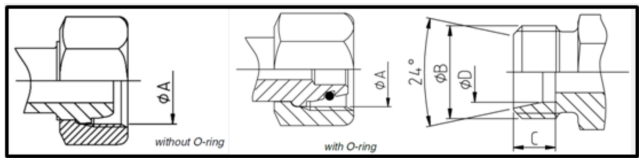


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

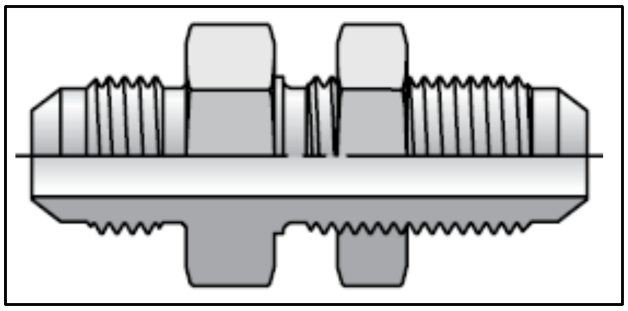
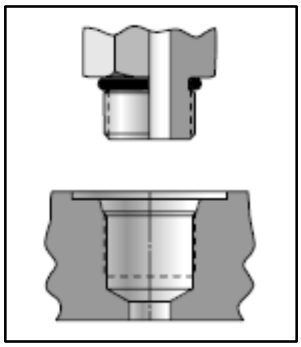


Figure 5-7. Bulkhead Thread

Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852



MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

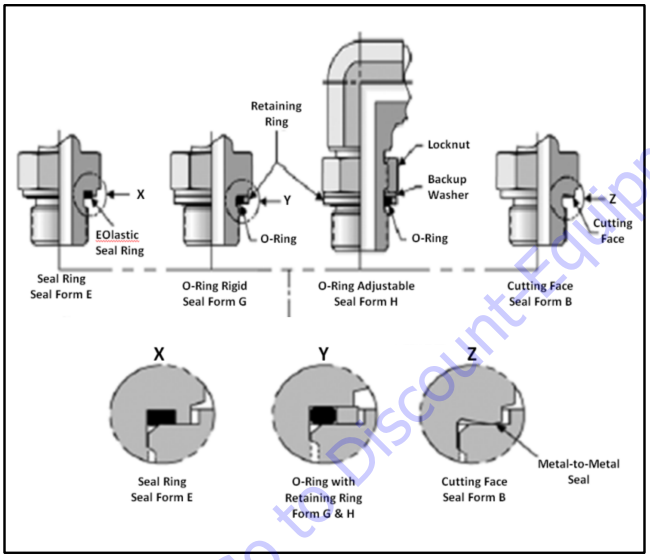


Figure 5-8. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

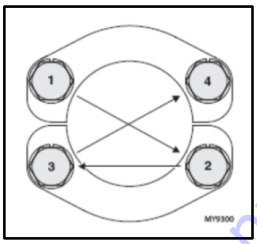


Figure 5-9. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft. lbs. (4 Nm). Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats From Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly And Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   - **a.** Avoid using dirty or oily rags when handling fittings.
   - **b.** If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
   - **c.** Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   - **d.** Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   - **e.** Sealant should only be applied to the male threads.
   - **f.** Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   - **g.** When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
   - **h.** When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
   - **a.** Verify the material designation in the table headings.
   - **b.** If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the upper limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

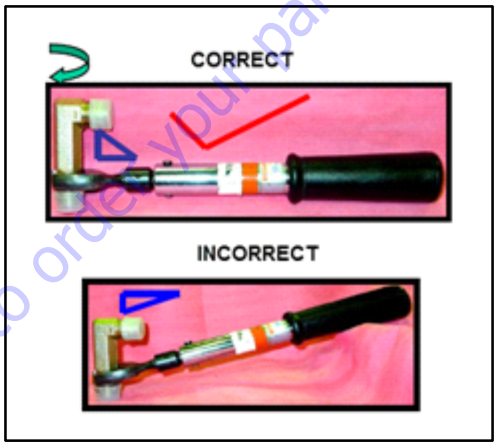


Figure 5-10. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection.

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Low Strength Threadlocking Compound, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

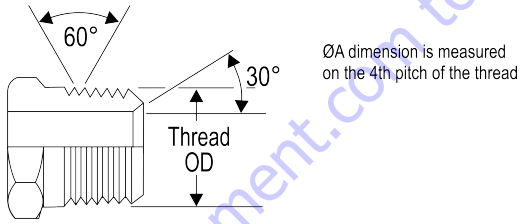
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH **STEEL, ALUMINUM, OR BRASS** MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

*ØA thread dimension for reference only.

**See FFWR and TFFT Methods subsection for TFFT procedure requirements.

Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Low Strength Threadlocking Compound, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

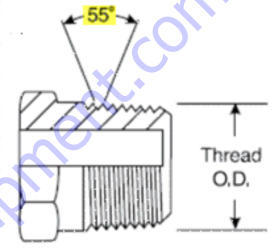
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size (BSPT)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH **STEEL, ALUMINUM, OR BRASS** MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
	32	2-11	2.35	59.61	1.5 to 2.5

* ØA thread dimension for reference only.

** See Appendix B for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

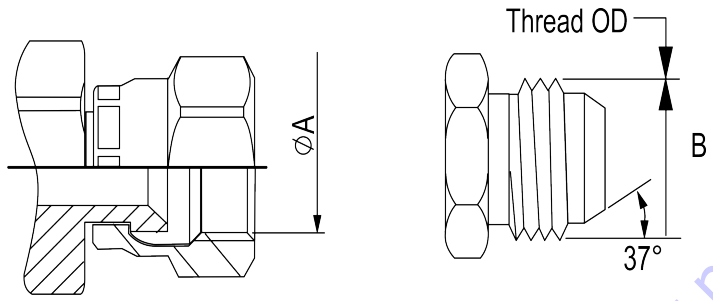
3. Torque assembly to value listed in Table 5-3, 37° Flare (JIC)Thread - Steel or Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC)Thread - Steel

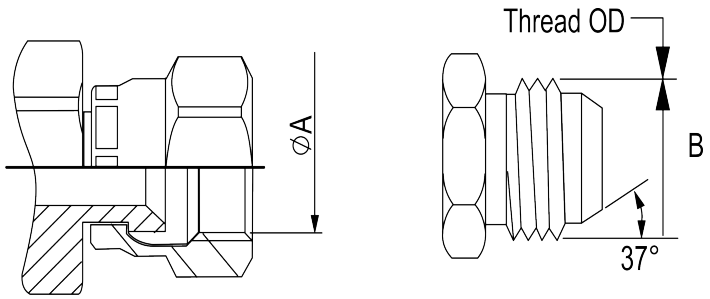


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	11/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	15/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	21/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Table 5-4. 37° Flare (JIC)Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

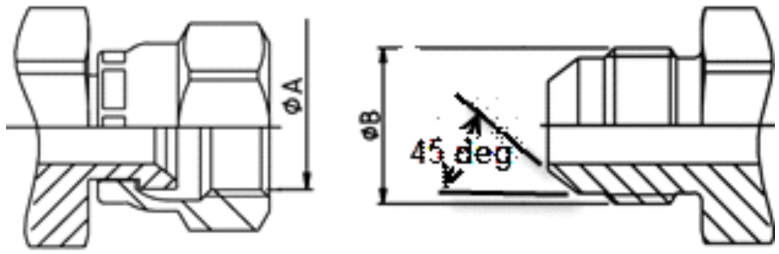
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS

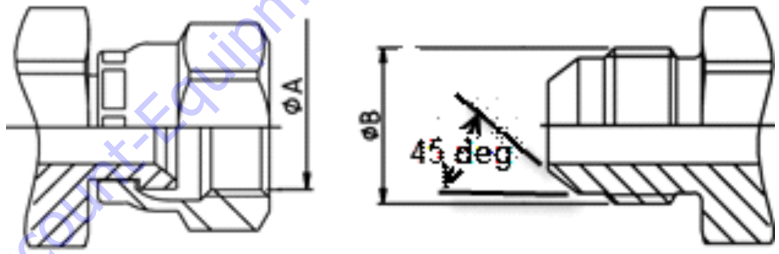
mating components.

Table 5-5. 45° Flare (SAE) - Steel



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	11/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125
* ØA and ØB thread dimensions for reference only.												
** See FFWR and TFFT Methodsfor FFWR procedure requirements.												

Table 5-6. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	11/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83
* ØA and ØB thread dimensions for reference only.												
** See FFWR and TFFT Methods for TFFT procedure requirements.												

Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

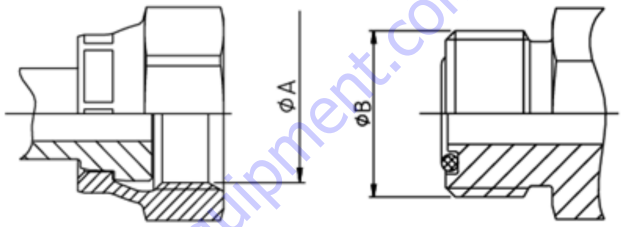
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or

BRASS mating components

Table 5-7. O-ring Face Seal (ORFS) - Steel

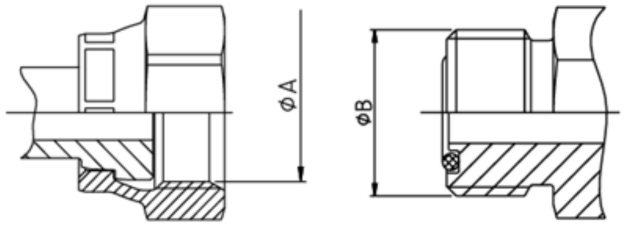


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	111/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	21/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	1 3/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	1 7/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

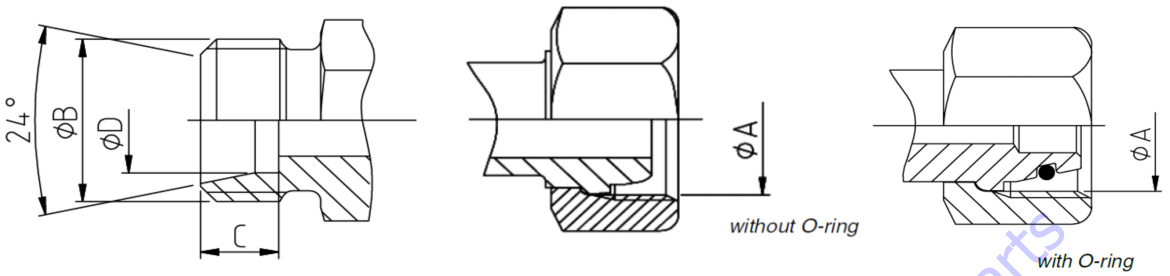
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table 5-9, DIN 24° Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

Table 5-9. DIN 24° Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**
								[Ft-Lb]			[N-m]			
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in this Service Manual						1.5 to 1.75
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75
	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**
								[Ft-Lb]			[N-m]			
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	Max	Min	Nom	Max	
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in this Service Manual						1.5 to 1.75
		8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36x2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42x2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52x2	49.90	52.00	16.00	38.30							1.5 to 1.75

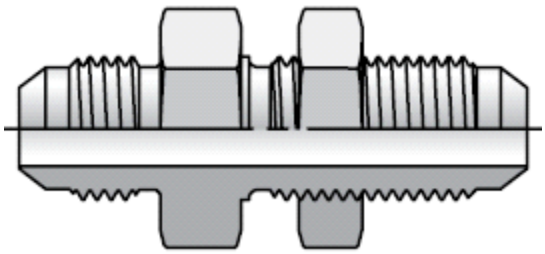
*ØA, ØB, C, & ØD thread dimensions for reference only.

**See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

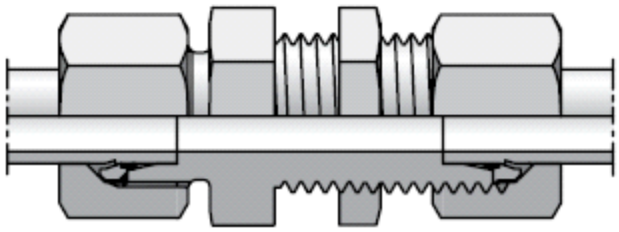
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	1 3/16-12	135	142	149	183	193	202
		14	1 5/16-12	170	179	187	230	243	254
		16	1 7/16-12	200	210	220	271	285	298
		20	1 11/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	1 1/16-12	135	142	149	183	193	202
		14	1 3/16-12	170	179	187	230	243	254
		16	1 5/16-12	200	210	220	271	285	298
		20	1 5/8-12	245	258	270	332	350	366
		24	1 7/8-12	270	284	297	366	385	403
		32	2 1/2-12	310	326	341	420	442	462

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
		25	M36x2	150	157	164	203	213	222
		30	M42x2	155	162	169	210	220	229
		38	M52x2	220	230	240	298	312	325

Assembly Instructions for O-Ring Boss (ORB) Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

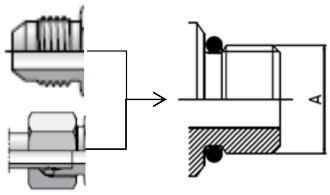
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 through Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 through Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



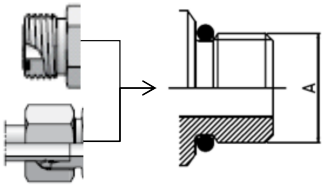
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. O-ring Boss (ORB) - Table 2 of 6

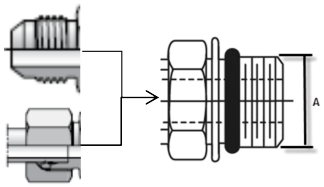


TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6



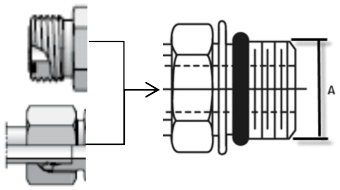
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

*ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

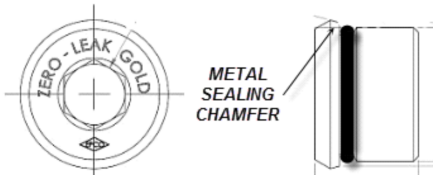
Table 5-16. O-ring Boss (ORB) - Table 5 of 6

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

*ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

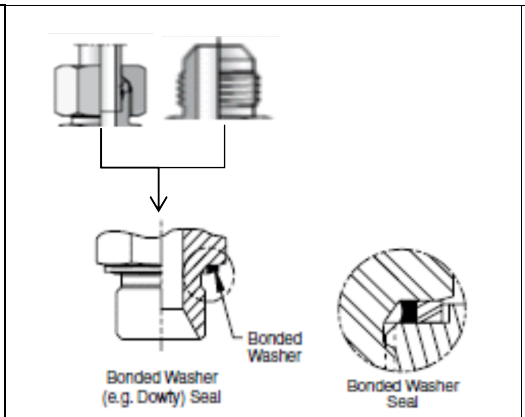
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

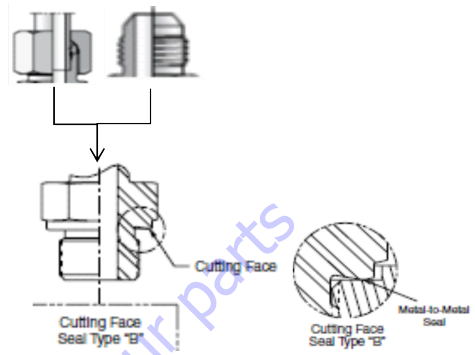
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

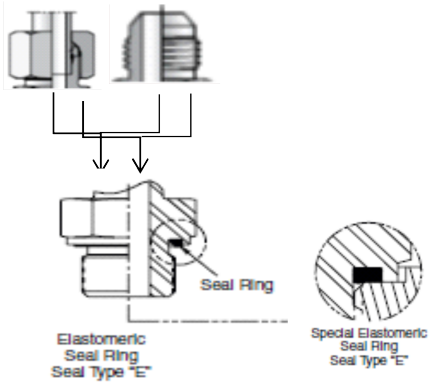
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

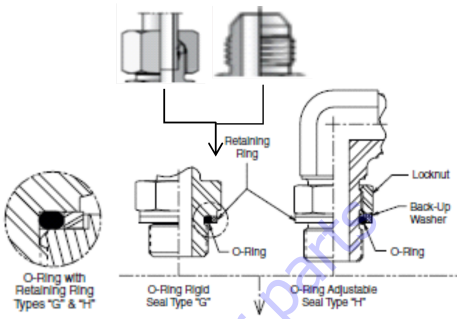




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque [Ft-Lb]			Torque [N-m]			Torque [Ft-Lb]			Torque [N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

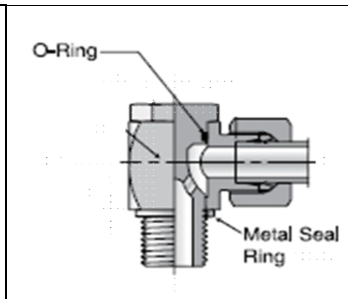
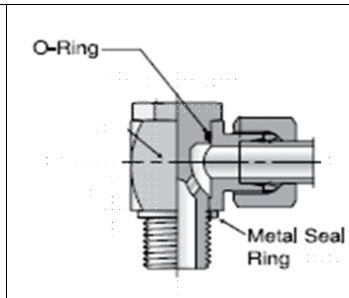
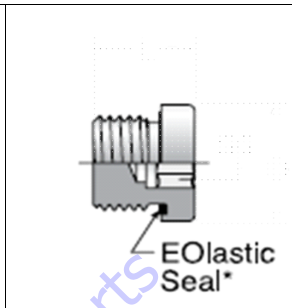
																				
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS							
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque							
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]				
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14		
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27		
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39		
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61		
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72		
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99		
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149		
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248		
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397		
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397		
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque							
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]				
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9		
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18		
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26		
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39		
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46		
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64		
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98		
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161		
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258		
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258		

Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

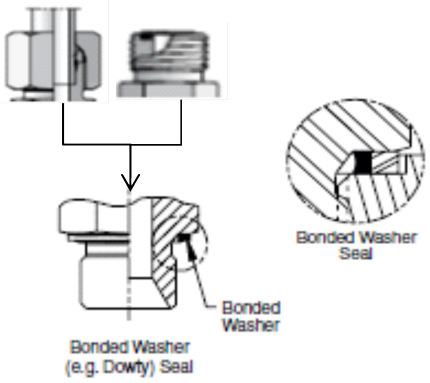
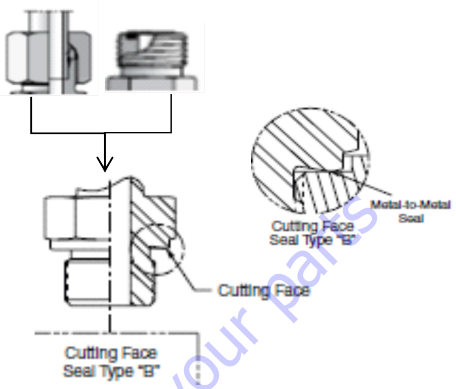
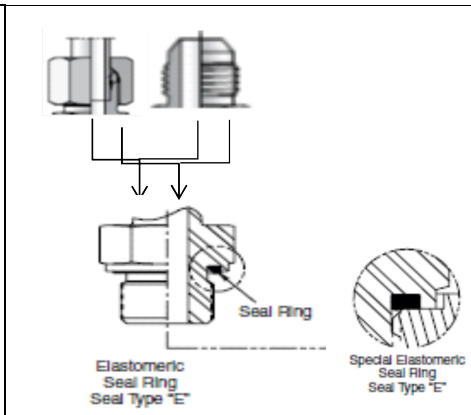
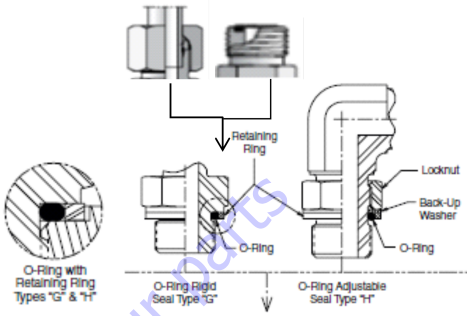
														
TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

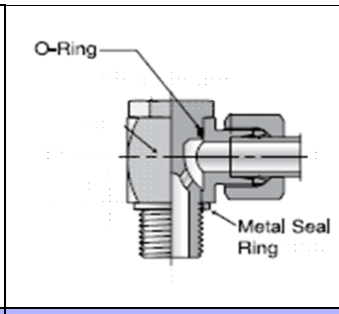
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3

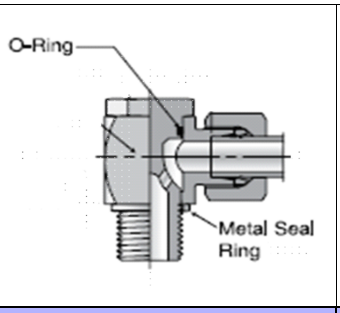


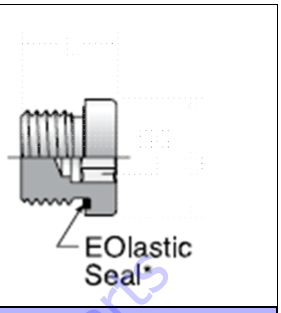


TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-23. Metric Flat Face Port (MFF) - S Series - Table 3 of 3







TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

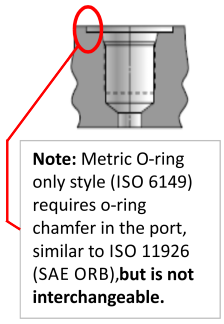
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

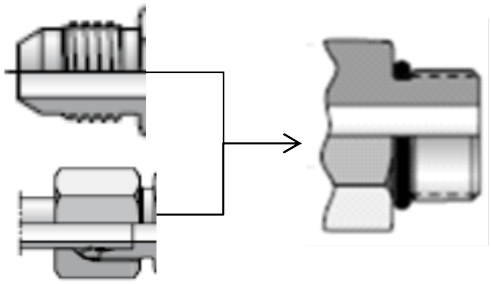
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

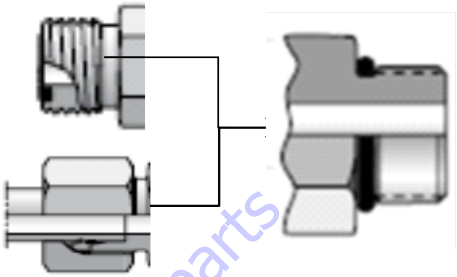
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



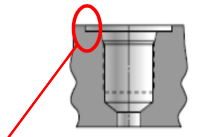
Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**



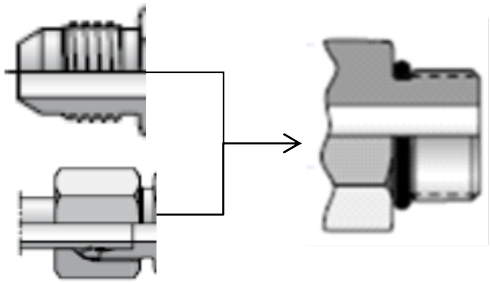


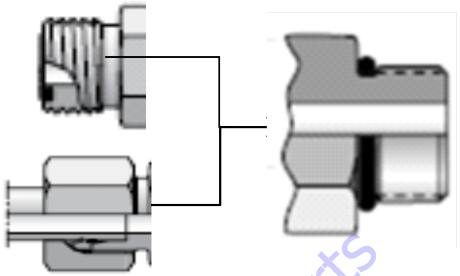
TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**





TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

Assembly instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

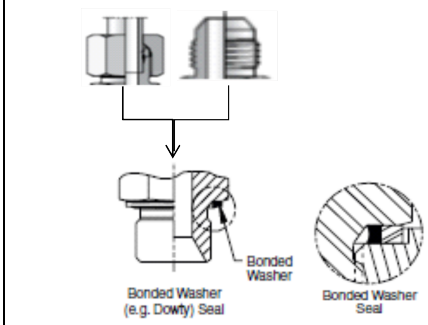
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

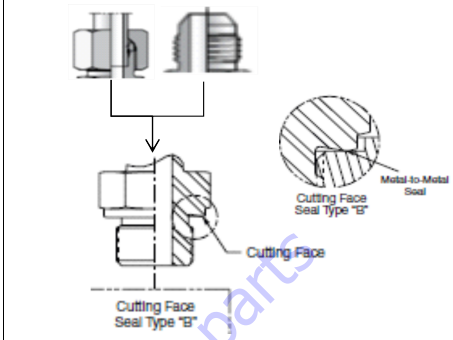
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3





TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

*Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

***Typical for JLG Adjustable Fittings