

DRY SYSTEMS TECHNOLOGIES®

Technology for a cleaner environment

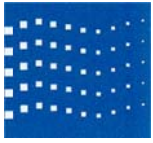
MOSAIC POTASH

DST 18.5T- PH

PRODUCT HANDLER

MACHINE SERIAL #M600013





DRY SYSTEMS TECHNOLOGIES®

Technology for a cleaner environment

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M500847 OUTBY ENGINE KIT

FILTER LIST

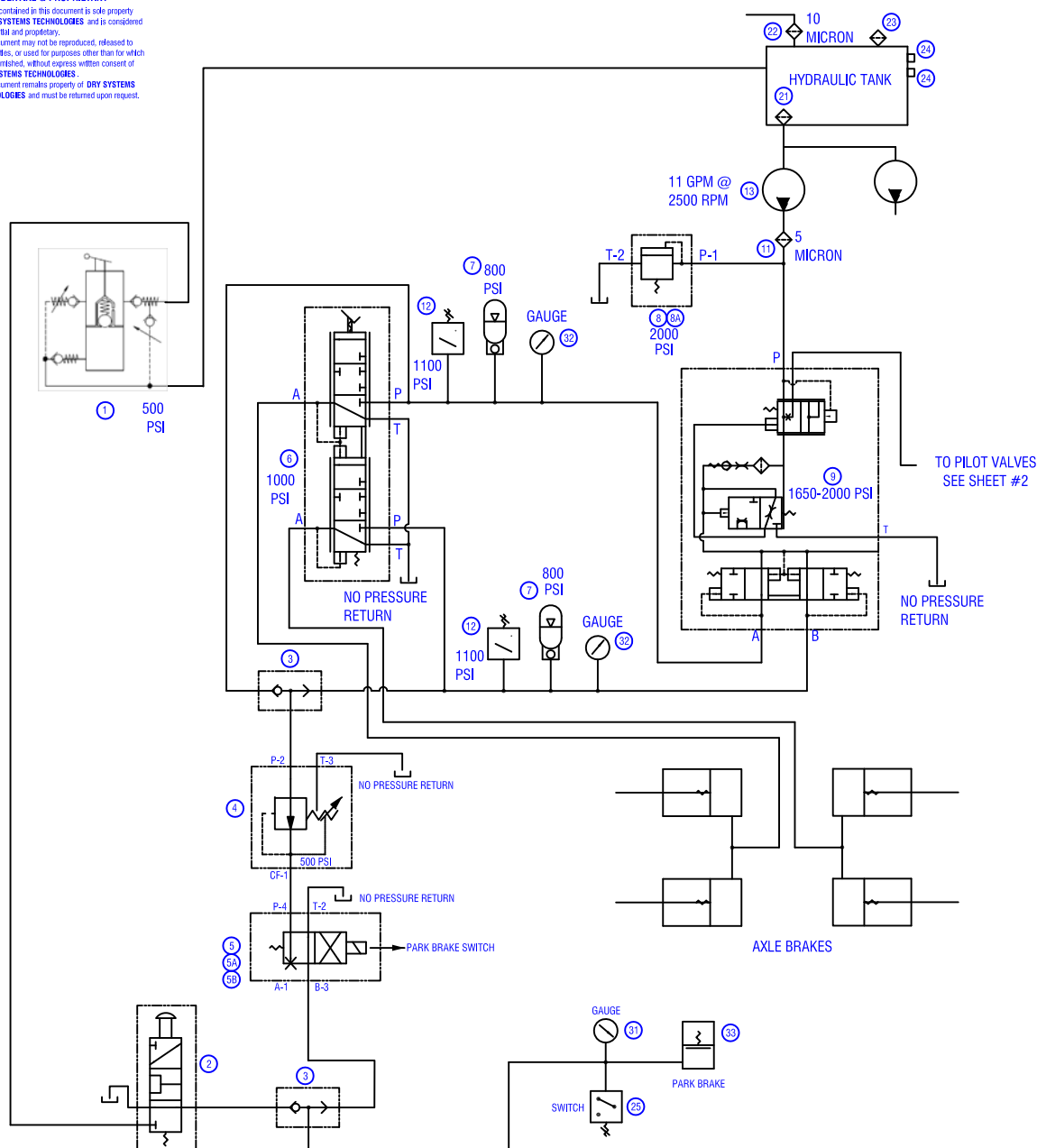
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Item No.	Sheet No.	Qty.	Part No.	Description
1	1	1	M192-524-01	Hand Pump
2	1	1	M348-528-01	Hand Pump Valve
3	1	2	M350-655-01	Shuttle Valve
4	1	2	M192-538-01	Pressure Reducing Valve w/ body
5	1	1	M192-529-01	Park Brake Directional Valve
5a	1	1	M192-530-01	Solenoid for Item 5
5b	1	1	M192-539-01	Body for Item 5
6	1	1	M192-532-01	Tandem Brake Pedal
7	1	2	M192-533-01	Diaphragm 1L Accumulator
8	1	1	M192-534-01	Brake System Relief
8a	1&2	2	M350-643-02	Body for Item 8 and 17
9	1	1	M192-536-02	Accum. Charge Valve
10				
11	1	1	M192-540-01	5 Micron Pressure Filter
12	1	2	M192-541-01	Low Pressure Warning Sw.
13	1	1	M348-530-01	Brake System Pump (6 Bolt Converter Mount)
14	2	1	M348-531-01	Main Pump (6 Bolt Converter Mount)
15	2	1	M348-532-01	Pilot Valve - Single (Steering)
16	2	1	M348-533-01	Pilot Valve - Dual
17	2	1	M350-530-01	Pilot pressure relief valve
18	2	1	M348-534-01	Crossover Relief Valve
19	2	1	M348-535-01	Main Valve
20	1	2	M507-625-01	Flow Control
21	1	1	M350-664-01	Magnetic Suction Strainer
22	1	1	M192-566-01	Return Line Filter
23	1	1	M350-555-01	Filler/Breather
24	1	2	M350-566-01	Sight Glass
25	1	1	M192-558-01	Park Brake Pressure Switch
26	2	1	M348-536-01	10 Micron Pressure Filter
27	2	1	M348-506-01	Pushplate Cylinder
28	2	2	M348-505-01	Material Body Cylinder
29	2	2	M504-528-01	Tailgate Cylinder
30	2	2	M348-504-01	Steer Cylinder
31	1	1	M348-550-01	Pressure Gauge 0-600
32	1	2	M348-549-01	Pressure Gauge 0-3000
33	1	1	M192-512-01	Park Brake
34	2	1	M272-708-01	Oil Cooler
35	2	1	M348-548-01	Check Valve
36	1	1	M348-529-01	Valve Body

HYDRAULIC DIAGRAM
DST 18.5T-PH, JD 1400 AXLES, SAHR PK BR, STICK STEER, 12V

TOLERANCES		DRY SYSTEMS TECHNOLOGIES 8102 LEMONT ROAD, SUITE 700 WOODRIDGE, IL 60517 PHONE: (800) 427-2351 Fax: (800) 427-1036 EMAIL: info@drysystems.com	DESCRIPTION DST 18.5T-PH HYDRAULICS		TO SCALE
Linear unless noted			SCALE	DATE	QUANTITY
Machined: ± 0.005			NONE	SEP 2012	DHR
Fabricated: ± 0.02			ORIGINAL		DIFFERENTIAL
Angular: $\pm 1/2^\circ$					
Surface finish 125					
REV. 001			DESCRIPTION M3488-001-01		SHT 1 OF 2

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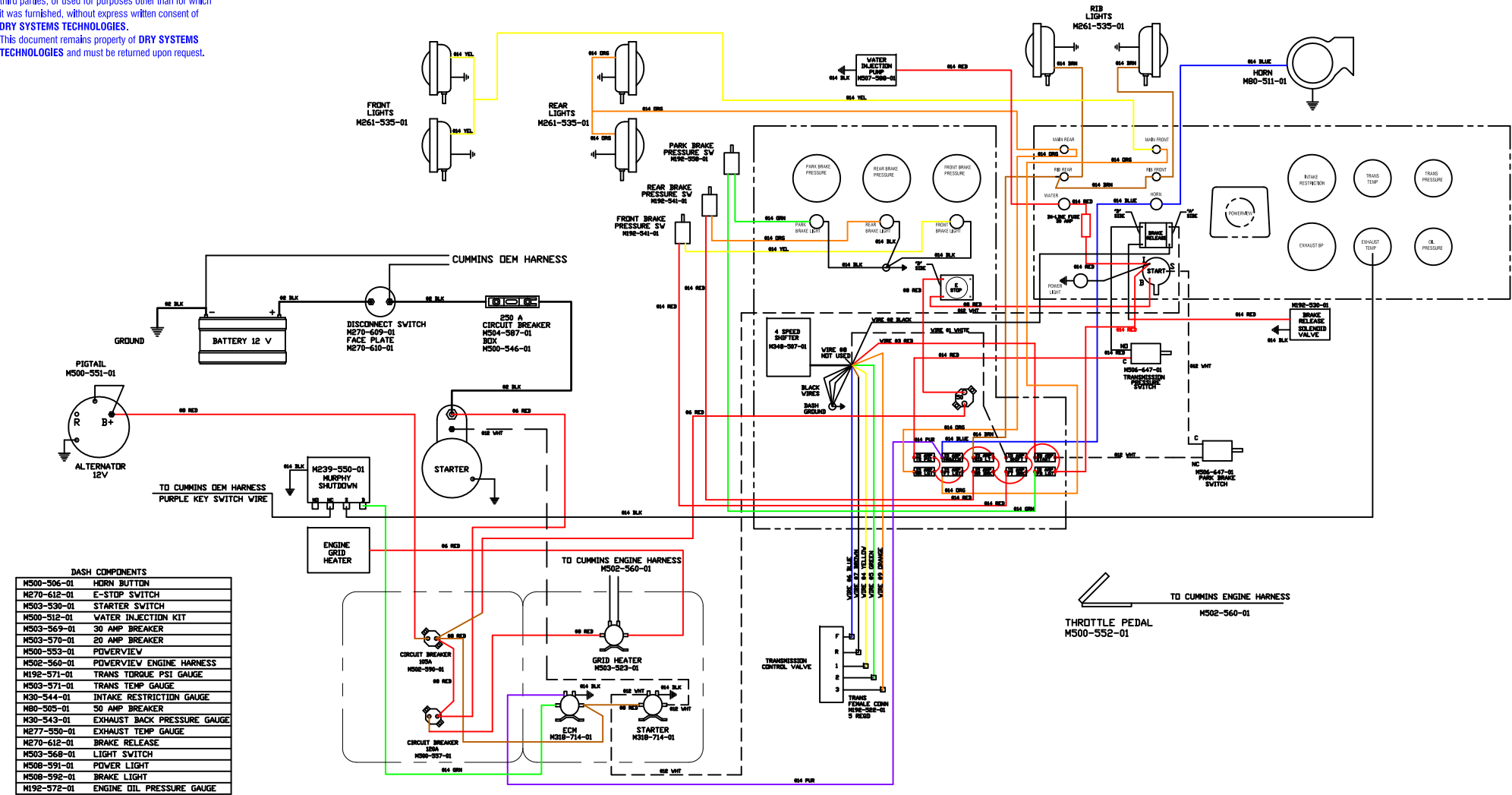
TOLERANCES		DRY SYSTEMS TECHNOLOGIES	DST 18.5T-PH HYDRAULICS		NO REVISIONS
Linear unless noted			NONE	SEP 12	DHR
Machined: ± 0.005					
Fabricated: ± 0.02					
Angular: $\pm 1/2^\circ$		8102 LEMONT ROAD, SUITE 700	REVISED BY		
Surface finish 125		WOODBRIDGE, IL 60517	PROJECT NO.		
		Phone: (800) 427-0351 Fax: (800) 427-1036	M348-001-01		
		FAX: (800) 427-0351	SHT 2 OF 2		

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TOLERANCES

Linear unless noted
Machined: ± 0.005
Fabricated: ± 0.02
Angular: $\pm 1/2^\circ$
Surface finish 125

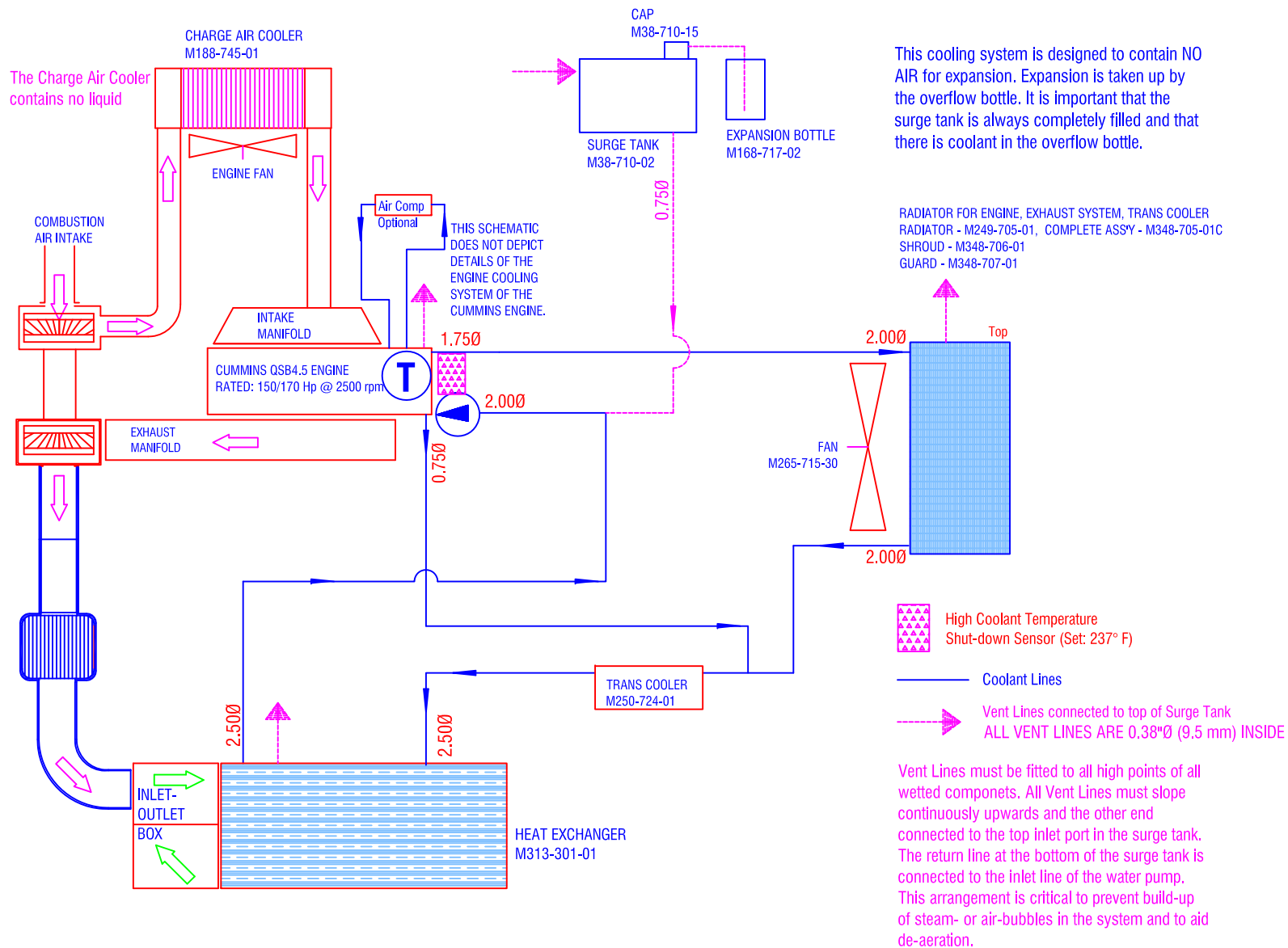
DRY SYSTEMS TECHNOLOGIES

1430 US, HWY 45 NORTH
VIENNA, IL 62995
Phone: 618 658-3000 FAX: 618-658-3002

DESCRIPTION DST 18.5-PH
ELECTRICAL SCHEMATIC

SCALE: NONE DATE: SEP 2012 DRAWN BY: DHR
MATERIAL: APPROVED BY:
CONTAINER NO: M348-002-01

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150/170 Hp Cummins 4.5 Turbo

TOLERANCES

Linear unless noted
Machined: ± 0.005
Fabricated: ± 0.01
Angular: $\pm 1/2^\circ$
Surface finish 125

DRY SYSTEMS TECHNOLOGIES

10420 RISING COURT
WOODRIDGE, IL 60517
Phone: 630-427-2051 Fax: 630-427-1036
E-Mail: eng@drysystemstech.com

DESCRIPTION

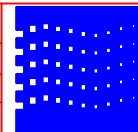
COOLING SYSTEM

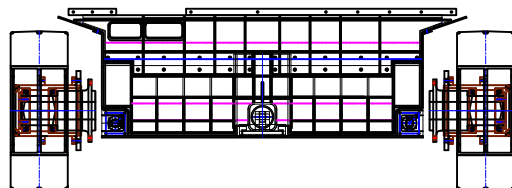
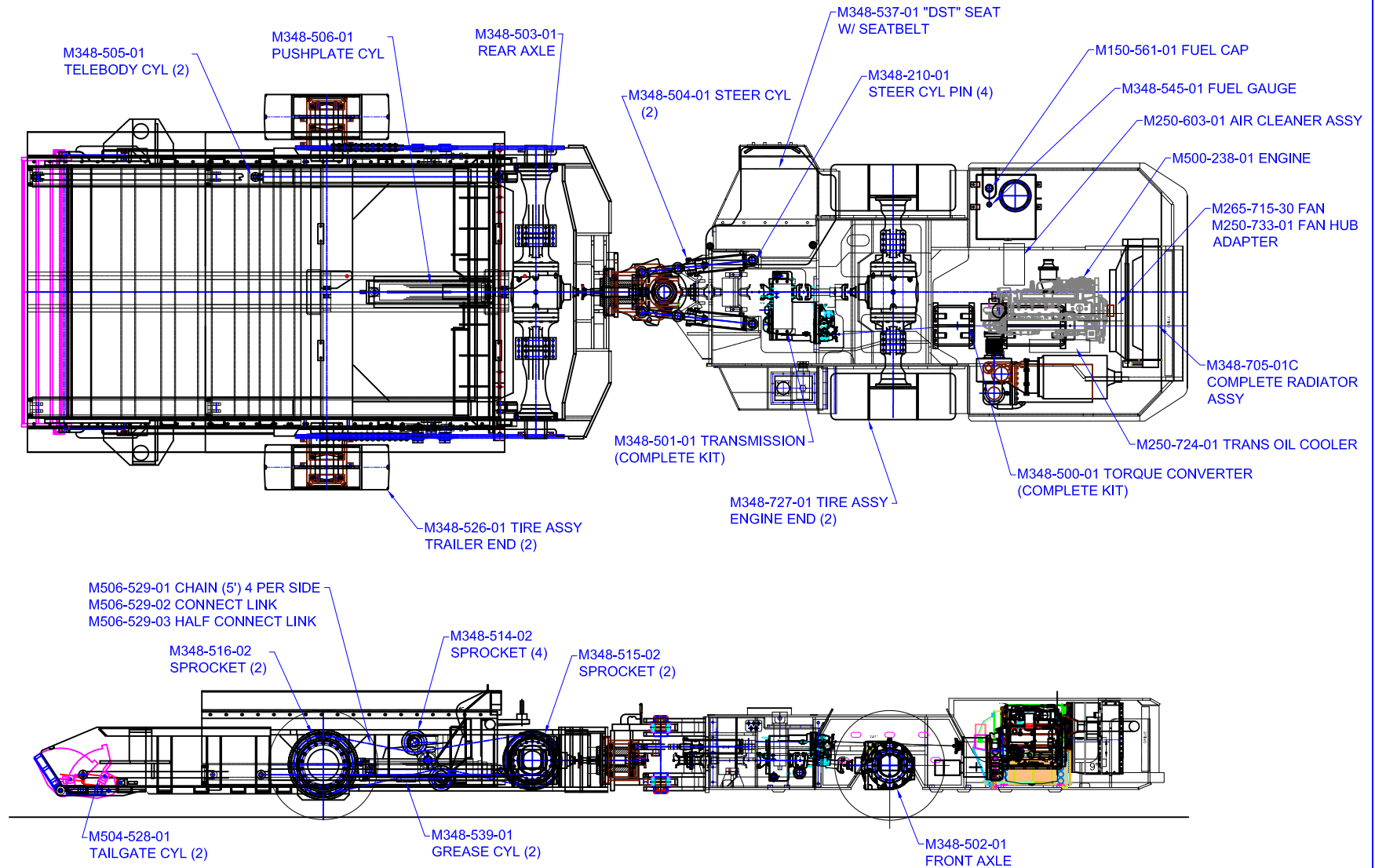
SCALE: FULL
DATE: NOV 15, 2012
DRAWN BY: R Gibbs

MATERIAL: APPROVED BY:

DRAWING NO: **M348-003-01**

NO RECD





TOLERANCES

Linear unless noted
Machined: ± 0.005
Fabricated: ± 0.02
Angular: $\pm 1/2^\circ$
Surface finish 125

REV	DATE	DESCRIPTION

DRY SYSTEMS TECHNOLOGIES

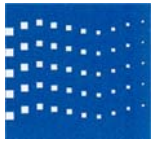
10420 RISING COURT
WOODRIDGE, IL 60517
Phone: 630-427-2051 Fax: 630-427-1036
E-Mail: eng@drysystemstech.com

DESCRIPTION	DST 18.5T-PH	NO REQ
COMPONENTS DRAWING		
SCALE	DATE	DRAWN BY
NONE	JAN 2013	DHR
MATERIAL	APPROVED BY	
DRAWING NO	M348-004-01	SHT 1 OF 2

M500847 Outby Engine Kit

Seq	Component	Item Description	UOM	Quantity
10	M168-717-02	BOTTLE, COOLANT RECOVERY, 2 Gal	EA	1
40	M191-208-02	TURBOCHARGER/COVER PLATE COATING, Cummins QSB4.5	EA	1
50	M191-209-02	MANIFOLD COATING	EA	1
60	M239-551-01	SWITCH, MAGNETIC - 12V,, 30sec Delay	EA	1
70	M265-715-30	FAN 26IN PUSHER	EA	1
80	M270-609-01	SWITCH BATTERY DISCONNECT	EA	1
90	M270-610-01	FACE PLATE, Battery Disconnect	EA	1
100	M270-612-01	SWITCH PUSH/PULL RED KNOB, Double Stack	EA	2
110	M277-550-01	GAUGE EXHAUST TEMPERATURE, w/shutdown switch	EA	1
120	M30-411-01R	FILTER EXHAUST 16,	EA	1
130	M313-301-01	HEAT EXCHANGER	EA	1
140	M318-714-01	SOLENOID SWITCH, 12V	EA	1
150	M320-759-01	HUMP HOSE, 3 CAC	EA	4
160	M320-760-01	HOSE CLAMP 2 3/4 - 3 5/8, Constant Torque	EA	8
170	M38-710-02	SURGE TANK..	EA	1
180	M500-238-01	ENG SPEC. CUMMINS QSB4.5	EA	1
190	M500-506-01	SWITCH, PUSHBUTTON MOMENTARY	EA	1
200	M500-514-01	SNUBBER GAUGE	EA	2
210	M500-551-01	ALTERNATOR PIGTAIL	EA	1
220	M500-552-01	PEDAL, ELECTRONIC ACCELERATOR, Cummins	EA	1
230	M500-553-01	POWerview	EA	1
240	M500-557-01	CIRCUIT BREAKER, 120A, Sealed, Manual Reset	EA	1
250	M502-543-01	HOSE 3/16X7/16 MULTI-PURPOSE, hose	FT	30
260	M502-560-01	HARNESS CUMMINS QSB4.5/QSB6.7	EA	1
270	M502-590-01	CIRCUIT BREAKER, 105 AMP, Sealed, Manual Reset	EA	1
280	M503-523-01	RELAY, GRID HEATER 12V	EA	1
290	M503-530-01	SWITCH, START & IGNITION	EA	1
300	M503-568-01	SWITCH, TWO POSITION	EA	2
310	M503-569-01	CIRCUIT BREAKER, 30 AMP, MANUAL RESET	EA	2
320	M503-570-01	CIRCUIT BREAKER, 20 AMP, MANUAL RESET	EA	3
330	M503-571-01	GAUGE, CONVERTOR TEMP, MECHANICAL	EA	1
340	M503-572-01	GAUGE, TRANS PRESS, R/B M192-571-01	EA	1
350	M504-587-01	CIRCUIT BREAKER, STARTER 250A, With Enclosure and Con	EA	1
360	M506-540-01	ENCLOSURE BOX, 9.5 X 7.2 X 5.1 NEMA 4X	EA	1
370	M59-591-01	KIT, OUTBY RAW EXHAUST PORT	EA	1
380	M80-505-01	CIRCUIT BREAKER, 50A, Sealed, Manual Reset	EA	1
390	M80-511-01	HORN, 12V	EA	1
400	M270-605-01	CABLE #8 RED	FT	50
410	M270-608-01	CABLE #6 RED	FT	50
430	M507-573-01	KIT, WATER INJECTION 12V	EA	1
440	M250-724-01	OIL COOLER, WATER COOLED, 6DIA X 30	EA	1
450	M281-430-01	FILTER HOUSING, 16,, w/lever clamps, inlet flange	EA	1
460	M600-519-01	BRASS PLUG HEX HD 1/8NPT	EA	5
470	M600-521-01	BRASS PLUG HEX HD 1/4NPT	EA	3

480	M600-526-01	BRASS TEE 1/8NPT FXMXF	EA	2
490	M600-563-01	BRASS BARB MALE 3/8 X 1/8NPT	EA	5
500	M600-570-01	BRASS BARB MALE 3/4 X 3/4NPT	EA	2
510	M600-573-01	BRASS BARB MALE 3/4 X 1/2NPT	EA	2
520	M600-576-01	BRASS BARB ELBOW 3/8 X 1/8 NPT	EA	5
530	M600-704-01	HOSE CONNECTOR 1 3/4 X 2	EA	1
540	M600-706-01	HOSE RUBBER 5/8 X 3/4 90DEG	EA	1
550	M600-711-01	HOSE CONNECTOR 2 X 2 1/2	EA	2
560	M600-727-01	HOSE CLAMP 1 1/4 - 2 1/4	EA	8
570	M600-728-01	HOSE CLAMP 2-3IN	EA	30
580	M600-729-01	HOSE CLAMP 1/2 - 13/16IN	EA	15
590	M600-730-01	HOSE CLAMP 7/8 - 1 1/4IN	EA	6
600	M600-735-01	HOSE RUBBER 3/4" ID, 1.06" OD	FT	20
610	M600-738-01	ELBOW RUBBER 2,	EA	4
620	M600-751-01	HOSE, HEATER, 3/8" ID	EA	30
630	M600-716-01	HOSE RUBBER 2X3', 4 PLY	EA	1
640	M320-215-01	TUBING STRAIGHT EXHAUST 3X14GA, Aluminnized, 10' len,	EA	1
650	M30-543-01	GAUGE EXHAUST BACKPRESSURE	EA	1
660	M30-544-01	GAUGE INTAKE VACUUM	EA	1
680	M250-540-01	HOSE CLAMP - T-BOLT, 3" NOM ID	EA	1
690	M201-290-07	HOSE CLAMP - T-BOLT , 4" NOM ID	EA	4
700	M250-538-01	HOSE CLAMP - T-BOLT , 5" NOM ID	EA	1
710	M250-539-01	HOSE CLAMP - T-BOLT, 6" NOM ID	EA	1
720	M250-593-01	HOSE. INTAKE, 5"-4" INSERT	EA	1
730	M250-597-01	REDUCER, RUBBER 6"-5" HUMP	EA	1
740	M270-426-01	ELBOW, SHORT RADIUS, 90DEG, 3,	EA	4
750	M292-218-01	CLAMP, U-BOLT, HEAVY-DUTY, 4,	EA	1
760	M296-716-01	PIPE CONNECTION 2,	EA	1
770	M292-210-02	CATALYST COATED 8.5,	EA	1
790	M506-539-01	3 1/2" FLEX PIPE	EA	1
800	M292-223-01	REDUCER ID-ID 4"-3.5"	EA	1
810	M257-210-01	ADAPTER EXHAUST, 3 1/2 - 3, ID-OD	EA	1
820	M320-203-01	ELBOW, SHORT RADIUS 90DEG 3.5,	EA	2
830	M348-705-01C	RADIATOR ASS'Y	EA	1
840	M250-603-01	AIR CLEANER, VERTICAL MOUNT, PSD12	EA	1
850	M348-003-01	COOLING SCHEMATIC	DW	1
860	M302-003-01	CO SAMPLING SYSTEM	DW	1
870	M292-212-01	FLANGE, OUTLET CATALYST	EA	2
880	M250-733-01	FAN HUB ADAPTER	EA	1

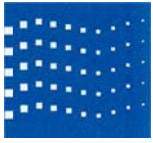


DRY SYSTEMS TECHNOLOGIES®

Technology for a cleaner environment

DST 18.5T-PH FILTER LIST (CUMMINS 4.5)

QUANTITY	PART NUMBER	DESCRIPTION
1	M503-573-01	ENGINE OIL FILTER
1	M503-575-01	FUEL FILTER
1	M503-576-01	FUEL / WATER SEPARATOR
1	M250-592-02	AIR FILTER – PRIMARY ELEMENT
1	M250-592-03	AIR FILTER – SAFETY ELEMENT
1	M30-411-01R	EXHAUST FILTER
1	M350-591-01	TRANSMISSION FILTER
2	M192-566-02	HYDRAULIC RETURN FILTER
1	M192-540-02	BRAKE HYD HIGH PRESSURE FILTER
1	M192-555-02	MAIN HYD HIGH PRESSURE FILTER



DRY SYSTEMS TECHNOLOGIES®

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DST 18.5T-PH SHELL OILS FLUIDS LIST

CUMMINS QSB 4.5 ENGINE OIL.....SHELL ROTELLA 15W-40
DANA POWERSHIFT TRANSMISSION.....SHELL DONAX TC 30
JOHN DEERE AXLES.....SHELL DONAX TD
HYDRAULIC OIL.....SHELL TELLUS 68
CHASSIS GREASE.....SHELL SUPER DUTY GREASE 2
PARK BRAKE..... SHELL DONAX TD

Appendix B. SAE Diagnostic Trouble Codes and Cummins Fault Codes

Fault Code	J1939 SPN	J1939 FMI	Lamp Color	J1939 SPN Description	Cummins Description
111	629	12	Red	Controller #1	Engine Control Module Critical internal failure - Bad intelligent Device or Component
115	612	2	Red	System Diagnostic Code # 2	Engine Speed/Position Sensor Circuit lost both of two signals from the magnetic pickup sensor - Data Erratic, Intermittent, or incorrect
122	102	3	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
123	102	4	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
124	102	16	Amber	Boost Pressure	Intake Manifold 1 Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
131	91	3	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit - Voltage Above Normal, or Shorted to High Source
132	91	4	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
133	974	3	Red	Remote Accelerator	Remote Accelerator Pedal or Lever Position Sensor Circuit - Voltage Above Normal, or Shorted to High Source
134	974	4	Red	Remote Accelerator	Remote Accelerator Pedal or Lever Position Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
135	100	3	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
141	100	4	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
143	100	18	Amber	Engine Oil Pressure	Oil Pressure Low - Data Valid but Below Normal Operational Range - Moderately Severe Level
144	110	3	Amber	Engine Coolant Temperature	Coolant Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
145	110	4	Amber	Engine Coolant Temperature	Coolant Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
146	110	16	Amber	Engine Coolant Temperature	Coolant Temperature High - Data Valid but Above Normal Operational Range - Moderately Severe Level
147	91	1	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit - Abnormal Frequency, Pulse Width, or Period
148	91	0	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit - Abnormal Frequency, Pulse Width, or Period
151	110	0	Red	Engine Coolant Temperature	Coolant Temperature Low - Data Valid but Above Normal Operational Range - Most Severe Level
153	105	3	Amber	Intake Manifold #1 Temp	Intake Manifold Air Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
154	105	4	Amber	Intake Manifold #1 Temp	Intake Manifold Air Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
155	105	0	Red	Intake Manifold #1 Temp	Intake Manifold Air Temperature High - Data Valid but Above Normal Operational Range - Most Severe Level
187	3510	4	Amber	5 Volts DC Supply	Sensor Supply Voltage #2 Circuit - Voltage Below Normal, or Shorted to Low Source

193	520199	3	Amber	Cruise Control	Cruise Control (Resistive) Signal Circuit - Voltage Above Normal, or Shorted to High Source
194	520199	4	Amber	Cruise Control	Cruise Control (Resistive) Signal Circuit - Voltage Below Normal, or Shorted to Low Source
195	111	3	Amber	Coolant Level	Coolant Level Sensor Circuit - Voltage Above Normal, or Shorted to High Source
196	111	4	Amber	Coolant Level	Coolant Level Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
197	111	18	Amber	Coolant Level	Coolant Level - Data Valid but Below Normal Operational Range - Moderately Severe Level
199	1661	4	Amber	Engine Automatic Start Lamp	Engine Automatic Start Lamp Driver Circuit - Voltage Above Normal, or Shorted to High Source
211	1484	31	None	J1939 Error	Additional Auxiliary Diagnostic Codes logged - Condition Exists
212	175	3	Amber	Oil Temperature	Engine Oil Temperature Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
213	175	4	Amber	Oil Temperature	Engine Oil Temperature Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
214	175	0	Red	Oil Temperature	Engine Oil Temperature - Data Valid but Above Normal Operational Range - Most Severe Level
221	108	3	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
222	108	4	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
227	3510	3	Amber	5 Volts DC Supply	Sensor Supply Voltage #2 Circuit - Voltage Above Normal, or Shorted to High Source
231	109	3	Amber	Coolant Pressure	Coolant Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
232	109	4	Amber	Coolant Pressure	Coolant Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
233	109	18	Amber	Coolant Pressure	Coolant Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
234	190	0	Red	Engine Speed	Engine Speed High - Data Valid but Above Normal Operational Range - Most Severe Level
235	111	1	Red	Coolant Level	Coolant Level Low - Data Valid but Below Normal Operational Range - Most Severe Level
237	644	2	Amber	External Speed Input	External Speed Input (Multiple Unit Synchronization) - Data Erratic, Intermittent, or Incorrect
238	3511	4	Amber	System Diagnostic code # 1	Sensor Supply Voltage #3 Circuit - Voltage Below Normal, or Shorted to Low Source
239	3511	3	Amber	System Diagnostic code #2	Sensor Supply Voltage #3 Circuit - Voltage Above Normal, or Shorted to High Source
241	84	2	Amber	Wheel-based Vehicle Speed	Vehicle Speed Sensor Circuit - Data Erratic, Intermittent, or Incorrect
242	84	10	Amber	Wheel-based Vehicle Speed	Vehicle Speed Sensor Circuit tampering has been detected - Abnormal Rate of Change
244	623	4	Amber	Red Stop Lamp	Red Stop Lamp Driver Circuit - Voltage Below Normal, or Shorted to Low Source
245	647	4	Amber	Fan Clutch Output Device Driver	Fan Control Circuit - Voltage Below Normal, or Shorted to Low Source
249	171	3	Amber	Ambient Air Temperature	Ambient Air Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
256	171	4	Amber	Ambient Air Temperature	Ambient Air Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
261	174	16	Amber	Fuel Temperature	Engine Fuel Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level

263	174	3	Amber	Fuel Temperature	Engine Fuel Temperature Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
265	174	4	Amber	Fuel Temperature	Engine Fuel Temperature Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
268	94	2	Amber	Fuel Delivery Pressure	Fuel Pressure Sensor Circuit - Data Erratic, Intermittent, or Incorrect
271	1347	4	Amber	Fuel Pump Pressurizing Assembly #1	High Fuel Pressure Solenoid Valve Circuit - Voltage Below Normal, or Shorted to Low Source
272	1347	3	Amber	Fuel Pump Pressurizing Assembly #1	High Fuel Pressure Solenoid Valve Circuit - Voltage Above Normal, or Shorted to High Source
281	1347	7	Amber	Fuel Pump Pressurizing Assembly #1	High Fuel Pressure Solenoid Valve #1 - Mechanical System Not Responding Properly or Out of Adjustment
284	1043	4	Amber	Internal Sensor Voltage Supply	Engine Speed/Position Sensor (Crankshaft) Supply Voltage Circuit - Voltage Below Normal, or Shorted to Low Source
285	639	9	Amber	SAE J1939 Datalink	SAE J1939 Multiplexing PGN Timeout Error - Abnormal Update Rate
286	639	13	Amber	SAE J1939 Datalink	SAE J1939 Multiplexing Configuration Error - Out of Calibration
287	91	19	Red	Accelerator Pedal Position	SAE J1939 Multiplexing Accelerator Pedal or Lever Sensor System Error - Received Network Data In Error
288	974	19	Red	Remote Accelerator	SAE J1939 Multiplexing Remote Accelerator Pedal or Lever Data Error - Received Network Data In Error
292	441	14	Red	Auxiliary Temperature 1	Auxiliary Temperature Sensor Input 1 - Special Instructions
293	441	3	Amber	OEM Temperature	Auxiliary Temperature Sensor Input # 1 Circuit - Voltage Above Normal, or Shorted to High Source
294	441	4	Amber	OEM Temperature	Auxiliary Temperature Sensor Input # 1 Circuit - Voltage Below Normal, or Shorted to Low Source
295	108	2	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit - Data Erratic, Intermittent, or Incorrect
296	1388	14	Red	Auxiliary Pressure	Auxiliary Pressure Sensor Input 1 - Special Instructions
297	1388	3	Amber	Auxiliary Pressure	Auxiliary Pressure Sensor Input # 2 Circuit - Voltage Above Normal, or Shorted to High Source
298	1388	4	Amber	Auxiliary Pressure	Auxiliary Pressure Sensor Input # 2 Circuit - Voltage Below Normal, or Shorted to Low Source
319	251	2	Maint	Real Time Clock Power	Real Time Clock Power Interrupt - Data Erratic, Intermittent, or Incorrect
322	651	5	Amber	Injector Cylinder #01	Injector Solenoid Cylinder #1 Circuit - Current Below Normal, or Open Circuit
323	655	5	Amber	Injector Cylinder #05	Injector Solenoid Cylinder #5 Circuit - Current Below Normal, or Open Circuit
324	653	5	Amber	Injector Cylinder #03	Injector Solenoid Cylinder #3 Circuit - Current Below Normal, or Open Circuit
325	656	5	Amber	Injector Cylinder #06	Injector Solenoid Cylinder #6 Circuit - Current Below Normal, or Open Circuit
331	652	5	Amber	Injector Cylinder #02	Injector Solenoid Cylinder #2 Circuit - Current Below Normal, or Open Circuit
332	654	5	Amber	Injector Cylinder #04	Injector Solenoid Cylinder #4 Circuit - Current Below Normal, or Open Circuit
334	110	2	Amber	Engine Coolant Temperature	Coolant Temperature Sensor Circuit - Data Erratic, Intermittent, or Incorrect

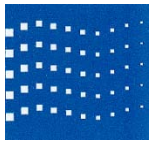
338	1267	3	Amber	Vehicle Accessories Relay Driver	Idle Shutdown Vehicle Accessories Relay Driver Circuit - Voltage Above Normal, or Shorted to High Source
339	1267	4	Amber	Vehicle Accessories Relay Driver	Idle Shutdown Vehicle Accessories Relay Driver Circuit - Voltage Below Normal, or Shorted to Low Source
341	630	2	Amber	Calibration Memory	Engine Control Module data lost - Data Erratic, Intermittent, or Incorrect
342	630	13	Red	Calibration Memory	Electronic Calibration Code Incompatibility - Out of Calibration
343	629	12	Amber	Controller #1	Engine Control Module Warning internal hardware failure - Bad Intelligent Device or Component
349	191	16	Amber	Transmission Output Shaft Speed	Transmission Output Shaft Speed - Data Valid but Above Normal Operational Range - Moderately Severe Level
351	627	12	Amber	Controller #1	Injector Power Supply - Bad Intelligent Device or Component
352	3509	4	Amber	5 Volts DC Supply	Sensor Supply Voltage #1 Circuit - Voltage Below Normal, or Shorted to Low Source
386	3509	3	Amber	5 Volts DC Supply	Sensor Supply Voltage #1 Circuit - Voltage Above Normal, or Shorted to High Source
415	100	1	Red	Engine Oil Pressure	Oil Pressure Low - Data Valid but Below Normal Operational Range - Most Severe Level
418	97	15	Maint.	Water in Fuel Indicator	Water in Fuel Indicator High - Data Valid but Above Normal Operational Range - Least Severe Level
422	111	2	Amber	Coolant Level	Coolant Level - Data Erratic, Intermittent, or Incorrect
425	175	2	Amber	Oil Temperature	Engine Oil Temperature - Data Erratic, Intermittent, or Incorrect
428	97	3	Amber	Water in Fuel Indicator	Water in Fuel Sensor Circuit - Voltage Above Normal, or Shorted to High Source
429	97	4	Amber	Water in Fuel Indicator	Water in Fuel Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
431	558	2	Amber	Accelerator Pedal Low Idle Switch	Accelerator Pedal or Lever Idle Validation Circuit - Data Erratic, Intermittent, or Incorrect
432	558	13	Red	Accelerator Pedal Low Idle Switch	Accelerator Pedal or Lever Idle Validation Circuit - Out of Calibration
435	100	2	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit - Data Erratic, Intermittent, or Incorrect
441	168	18	Amber	Electrical Potential (Voltage)	Battery #1 Voltage Low - Data Valid but Below Normal Operational Range - Moderately Severe Level
442	168	16	Amber	Electrical Potential (Voltage)	Battery #1 Voltage High - Data Valid but Above Normal Operational Range - Moderately Severe Level
449	157	0	Red	Injector Metering Rail 1 Pressure	Fuel Pressure High - Data Valid but Above Normal Operational Range - Moderately Severe Level
451	157	3	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
452	157	4	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
488	105	16	Amber	Intake Manifold	Intake Manifold 1 Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
489	191	18	Amber	Transmission Output Shaft Speed	Transmission Output Shaft Speed - Data Valid but Below Normal Operational Range - Moderately Severe Level

497	1377	2	Amber	Switch Circuit	Multiple Unit Synchronization Switch Circuit - Data Erratic, Intermittent, or Incorrect
523	611	2	Amber	System Diagnostic code # 1	OEM Intermediate (PTO) Speed switch Validation - Data Erratic, Intermittent, or Incorrect
527	702	3	Amber	Circuit - Voltage	Auxiliary Input/Output 2 Circuit - Voltage Above Normal, or Shorted to High Source
528	93	2	Amber	Switch - Data	Auxiliary Alternate Torque Validation Switch - Data Erratic, Intermittent, or Incorrect
529	703	3	Amber	Circuit - Voltage	Auxiliary Input/Output 3 Circuit - Voltage Above Normal, or Shorted to High Source
546	94	3	Amber	Fuel Delivery Pressure	Fuel Delivery Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
547	94	4	Amber	Fuel Delivery Pressure	Fuel Delivery Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
551	558	4	Amber	Accelerator Pedal Low Idle Switch	Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal, or Shorted to Low Source
553	157	16	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure High - Data Valid but Above Normal Operational Range - Moderately Severe Level
554	157	2	Amber	Injector Metering Rail 1 Pressure	Fuel Pressure Sensor Error - Data Erratic, Intermittent, or Incorrect
559	157	18	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure Low - Data Valid but Below Normal Operational Range - Moderately Severe Level
584	677	3	Amber	Starter Solenoid Lockout Relay Driver Circuit	Starter Relay Circuit - Voltage Above Normal, or Shorted to High Source
585	677	4	Amber	Starter Solenoid Lockout Relay Driver Circuit	Starter Relay Circuit - Voltage Below Normal, or Shorted to Low Source
595	103	16	Amber	Turbocharger 1 Speed	Turbocharger #1 Speed High - Data Valid but Above Normal Operational Range - Moderately Severe Level
596	167	16	Amber	Alternate Potential (voltage)	Electrical Charging System Voltage High - Data Valid but Above Normal Operational Range - Moderately Severe Level
597	167	18	Amber	Alternate Potential (voltage)	Electrical Charging System Voltage Low - Data Valid but Below Normal Operational Range - Moderately Severe Level
598	167	1	Red	Alternate Potential (voltage)	Electrical Charging System Voltage Low - Data Valid but Below Normal Operational Range - Most Severe Level
599	640	14	Red	Engine External Protection Input	Auxiliary Commanded Dual Output Shutdown - Special Instructions
649	1378	31	Maint	Engine Oil Change Interval	Change Lubricating Oil and Filter - Condition Exists
687	103	18	Amber	Turbocharger 1 Speed	Turbocharger #1 Speed Low - Data Valid but Below Normal Operational Range - Moderately Severe Level
689	190	2	Amber	Engine Speed	Primary Engine Speed Sensor Error - Data Erratic, Intermittent, or Incorrect
691	1172	3	Amber	Turbocharger #1 Compressor Inlet Temperature	Turbocharger #1 Compressor Inlet Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
692	1172	4	Amber	Turbocharger #1 Compressor Inlet Temperature	Turbocharger #1 Compressor Inlet Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
697	1136	3	Amber	Sensor Circuit - Voltage	ECM Internal Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
698	1136	4	Amber	Sensor Circuit - Voltage	ECM Internal Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source

719	22	3	Amber	Crankcase Pressure	Extended Crankcase Blow-by Pressure Circuit - Voltage Above Normal, or Shorted to High Source
729	22	4	Amber	Crankcase Pressure	Extended Crankcase Blow-by Pressure Circuit - Voltage Below Normal, or Shorted to Low Source
731	723	7	Amber	Engine Speed Sensor #2	Engine Speed/Position #2 mechanical misalignment between camshaft and crankshaft sensors - Mechanical System Not Responding Properly or Out of Adjustment
757	2802	31	Amber	Electronic Control Module	Electronic Control Module data lost - Condition Exists
778	723	2	Amber	Engine Speed Sensor #2	Engine Speed Sensor (Camshaft) Error - Data Erratic, Intermittent, or Incorrect
779	703	11	Amber	Auxiliary Equipment Sensor Input	Warning Auxiliary Equipment Sensor Input # 3 (OEM Switch) - Root Cause Not Known
951	166	2	None	Cylinder Power	Cylinder Power Imbalance Between Cylinders - Data Erratic, Intermittent, or Incorrect
1117	627	2	None	Power Supply	Power Lost With Ignition On - Data Erratic, Intermittent, or Incorrect
1139	651	7	Amber	Injector Cylinder # 01	Injector Cylinder #1 - Mechanical System Not Responding Properly or Out of Adjustment
1141	652	7	Amber	Injector Cylinder # 02	Injector Cylinder #2 - Mechanical System Not Responding Properly or Out of Adjustment
1142	653	7	Amber	Injector Cylinder # 03	Injector Cylinder #3 - Mechanical System Not Responding Properly or Out of Adjustment
1143	654	7	Amber	Injector Cylinder # 04	Injector Cylinder #4 - Mechanical System Not Responding Properly or Out of Adjustment
1144	655	7	Amber	Injector Cylinder # 05	Injector Cylinder #5 - Mechanical System Not Responding Properly or Out of Adjustment
1145	656	7	Amber	Injector Cylinder # 06	Injector Cylinder #6 - Mechanical System Not Responding Properly or Out of Adjustment
1239	2623	3	Amber	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Above Normal, or Shorted to High Source
1241	2623	4	Amber	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Below Normal, or Shorted to Low Source
1242	91	2	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor 1 and 2 - Data Erratic, Intermittent, or Incorrect
1256	1563	2	Amber	Control Module Identification Input State	Control Module Identification Input State Error - Data Erratic, Intermittent, or Incorrect
1257	1563	2	Red	Control Module Identification Input State	Control Module Identification Input State Error - Data Erratic, Intermittent, or Incorrect
1852	97	16	Amber	Water in Fuel Indicator	Water in Fuel Indicator - Data Valid but Above Normal Operational Range - Moderately Severe Level
1911	157	0	Amber	Injector Metering Rail	Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operational Range - Most Severe Level
2111	52	3	Amber	Coolant Temperature	Coolant Temperature 2 Sensor Circuit - Voltage Above Normal, or Shorted to High Source
2112	52	4	Amber	Coolant Temperature	Coolant Temperature 2 Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2113	52	16	Amber	Coolant Temperature	Coolant Temperature 2 - Data Valid but Above Normal Operational Range - Moderately Severe Level
2114	52	0	Red	Coolant Temperature	Coolant Temperature 2 - Data Valid but Above Normal Operational Range - Most Severe Level
2115	2981	3	Amber	Coolant Pressure	Coolant Pressure 2 Circuit - Voltage Above Normal, or Shorted to High Source

2116	2981	4	Amber	Coolant Pressure	Coolant Pressure 2 Circuit - Voltage Below Normal, or Shorted to Low Source
2117	2981	18	Amber	Coolant Pressure	Coolant Pressure 2 - Data Valid but Below Normal Operational Range - Moderately Severe Level
2182	1072	3	Amber	Engine Brake Output # 1	Engine Brake Actuator Driver 1 Circuit - Voltage Above Normal, or Shorted to High Source
2183	1072	4	Amber	Engine Brake Output # 1	Engine Brake Actuator Driver 1 Circuit - Voltage Below Normal, or Shorted to Low Source
2185	3512	3	Amber	System Diagnostic code # 1	Sensor Supply Voltage #4 Circuit - Voltage Above Normal, or Shorted to High Source
2186	3512	4	Amber	System Diagnostic code # 1	Sensor Supply Voltage #4 Circuit - Voltage Below Normal, or Shorted to Low Source
2195	703	14	Red	Auxiliary Equipment Sensor	Auxiliary Equipment Sensor Input 3 Engine Protection Critical - Special Instructions
2215	94	18	Amber	Fuel Delivery Pressure	Fuel Pump Delivery Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
2216	94	1	Amber	Fuel Delivery Pressure	Fuel Pump Delivery Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2217	630	31	Amber	Calibration Memory	ECM Program Memory (RAM) Corruption - Condition Exists
2249	157	1	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail 1 Pressure - Data Valid but Below Normal Operational Range - Most Severe Level
2261	94	15	Maint	Fuel Delivery Pressure	Fuel Pump Delivery Pressure - Data Valid but Above Normal Operational Range - Least Severe Level
2262	94	17	Maint	Fuel Delivery Pressure	Fuel Pump Delivery Pressure - Data Valid but Below Normal Operational Range - Least Severe Level
2263	1800	16	Amber	Battery Temperature	Battery Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
2264	1800	18	Amber	Battery Temperature	Battery Temperature - Data Valid but Below Normal Operational Range - Moderately Severe Level
2265	1075	3	Amber	Electric Lift Pump for Engine Fuel	Fuel Priming Pump Control Signal Circuit - Voltage Above Normal, or Shorted to High Source
2266	1075	4	Amber	Electric Lift Pump for Engine Fuel	Fuel Priming Pump Control Signal Circuit - Voltage Below Normal, or Shorted to Low Source
2292	611	16	Amber	Fuel Inlet Meter Device	Fuel Inlet Meter Device - Data Valid but Above Normal Operational Range - Moderately Severe Level
2293	611	18	Amber	Fuel Inlet Meter Device	Fuel Inlet Meter Device flow demand lower than expected - Data Valid but Below Normal Operational Range - Moderately Severe Level
2311	633	31	Amber	Fuel Control Valve #1	Fueling Actuator #1 Circuit Error - Condition Exists
2321	190	2	None	Engine Speed	Engine Speed / Position Sensor #1 - Data Erratic, Intermittent, or Incorrect
2322	723	2	None	Engine Speed Sensor #2	Engine Speed / Position Sensor #2 - Data Erratic, Intermittent, or Incorrect
2345	103	10	Amber	Turbocharger 1 Speed	Turbocharger speed invalid rate of change detected - Abnormal Rate of Change
2346	2789	15	None	System Diagnostic Code #1	Turbocharger Turbine Inlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level
2347	2790	15	None	System Diagnostic Code #1	Turbocharger Compressor Outlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level

2363	1073	4	Amber	Engine Compression Brake Output # 2	Engine Brake Actuator Circuit #2 – Voltage Below Normal, or Shorted to Low Source
2365	1112	4	Amber	Engine Brake Output # 3	Engine Brake Actuator Driver Output 3 Circuit - Voltage Below Normal, or Shorted to Low Source
2367	1073	3	Amber	Engine Compression Brake Output # 2	Engine Brake Actuator Circuit #2 – Voltage Above Normal, or Shorted to High Source
2368	1112	3	Amber	Engine Brake Output # 3	Engine Brake Actuator Driver 3 Circuit - Voltage Above Normal, or Shorted to High Source
2372	95	16	Amber	Engine Fuel Filter Differential Pressure	Fuel Filter Differential Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2373	1209	3	Amber	Exhaust Gas Pressure	Exhaust Gas Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
2374	1209	4	Amber	Exhaust Gas Pressure	Exhaust Gas Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2375	412	3	Amber	Exhaust Gas Recirculation Temperature	Exhaust Gas Recirculation Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
2376	412	4	Amber	Exhaust Gas Recirculation Temperature	Exhaust Gas Recirculation Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2377	647	3	Amber	Fan Clutch Output Device Driver	Fan Control Circuit - Voltage Above Normal, or Shorted to High Source
2425	730	4		Intake Air Heater # 2	Intake Air Heater 2 Circuit - Voltage Below Normal, or Shorted to Low Source
2426	730	3		Intake Air Heater # 2	Intake Air Heater 2 Circuit - Voltage Above Normal, or Shorted to High Source
2555	729	3	Amber	Inlet Air Heater Driver #1	Intake Air Heater #1 Circuit - Voltage Above Normal, or Shorted to High Source
2556	729	4	Amber	Inlet Air Heater Driver #1	Intake Air Heater #1 Circuit - Voltage Below Normal, or Shorted to Low Source
2557	697	3	Amber	Auxiliary PWM Driver #1	Auxiliary PWM Driver #1 - Voltage Above Normal, or Shorted to High Source
2558	697	4	Amber	Auxiliary PWM Driver #1	Auxiliary PWM Driver #1 - Voltage Below Normal, or Shorted to Low Source
2963	110	15	None	Engine Coolant Temperature	Engine Coolant Temperature High - Data Valid but Above Normal Operational Range - Least Severe Level
2973	102	2	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit - Data Erratic, Intermittent, or Incorrect



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Technology for a cleaner environment

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DRY SYSTEMS TECHNOLOGIES®

OPERATION AND MAINTENANCE MANUAL

DST DRY SYSTEM®

**SECTION A
ON BOARD CLEANING SYSTEM
FOR OUTBY MACHINE**

M301-016-11

DRY SYSTEMS TECHNOLOGIES®

8102 Lemont Road, Suite 700
WOODRIDGE, IL 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036
E-mail: eng@drysystemstech.com

DRY SYSTEMS TECHNOLOGIES®

8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART A, M301-016-11

INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

Background:

The Dry System™ supplied by Dry Systems Technologies® consists of a unique patented arrangement of components that provide a diesel power package and superior emissions reduction from diesel engines. The system can operate at very minimal maintenance, but requires some attention by the operator to maintain its permissibility and clean exhaust.

The Dry System™ is fitted with a tube-and-shell heat exchanger. It reduces the exhaust temperature from about 950-1150° F in the manifold to a safe temperature of less than 300° F before exhausting to the atmosphere.

Because of the rapid cooling of the exhaust gases inside the heat exchanger, the airborne sub-micron diesel particles agglomerate (cling to each other) and form larger particles. However, some of these particles attach themselves to the cold tube walls, where they accumulate over time. This process is completely normal as part of the operation of the Dry System™, or any system that cools the exhaust gases.

After the particle accumulation has reached a certain thickness, the tubes become partially restricted, and both exhaust backpressure and temperature increase. The exhaust backpressure and the exhaust gas temperature can be monitored on the exhaust-backpressure gauge and the exhaust-temperature gauge which are conveniently mounted in the operator's compartment.

It is the responsibility of the operator to monitor the exhaust backpressure and exhaust temperature gauges frequently while operating the diesel machine.

Activating the On-board Cleaning System

Once the exhaust backpressure increases, the removal of these internal deposits is necessary to maintain a clean and safe exhaust system. The Dry System™ is equipped with a patented **On-board Cleaning System™** that allows removal of the soot deposits while operating the machine. The **On-board Cleaning System™** consists of a small water supply bottle, a metered actuator and an injection nozzle. The 1 quart (1 liter) water bottle is located inside the engine compartment, contains several shifts supply and must be filled with clean water (such as bottled water or drinking water) only. The injection nozzle is located near the inlet of the heat exchanger. A cab mounted push button or valve is all the operator needs to perform the cleaning process while operating the machine.

When activated (for five seconds) by the operator with the cab-mounted push button, a very small metered amount of water is injected into the hot exhaust inlet of the heat exchanger. The water flashes into steam and expands to more than 200 times of its original volume. This sudden pressure rise (and not the water itself) causes the soot deposit to dislodge from the tube walls to be carried downstream by the exhaust gas to the particulate filter where it is trapped.

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA

Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

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INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

This procedure is the most important action the operator has to take. Neglect of this operation will cause high exhaust backpressure which will inevitably lead to reduced filter life and triggering of the safety shut-down system. Using the On-board Cleaning System™ properly is the responsibility of the machine operator.

There will be no visible water vapor or smoke emitted from the exhaust system while the on-board cleaning system is activated. The only indication to verify proper injection is to monitor the exhaust gauges. Initially, the exhaust backpressure will rise, followed by a drop to below its starting point. There should also be a small simultaneous reduction in exhaust gas temperature.

The most effective time to activate the On-board Cleaning System™ is when the engine is hot and under load. At a minimum, the On-board Cleaning System™ should be activated **twice** each operating shift, and while the engine is hot and working hard. There is no harm done if the On-board Cleaning System is used more often, except that the water supply gets depleted quicker.

The On-board Cleaning System™ will not function on a cold engine or at idle. Using the on-board cleaning system on a cold engine and without load on the engine is ineffective. **Do not activate the On-board Cleaning System™ on a cold engine.**

Frequent use of the on-board cleaning system is a very important step to keep the DST Management System operating efficiently and safely. The amount of water that is injected is metered by the five seconds that the button is held. The On-board Cleaning System is ready for use immediately after release of the electric push button that is located in the operator's compartment.

It is the responsibility of the operator to activate the On-board Cleaning System at least twice a shift with the engine hot and under load, more often if judged necessary. It is safe to activate the On-board Cleaning System in any part of the mine where diesel equipment may be operated.

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART A, M301-016-11

INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

Diagnosing High Exhaust Backpressure

The typical life cycle of the Disposable Exhaust Particulate Filter (DPM Filter) can range from 40-100 hours, depending on the operating cycle of the machine. Once the exhaust system backpressure can no longer be reduced by the On-board Cleaning System™, the DPM Filter may be loaded to its capacity. Before changing the filter, a quick diagnostic test should be performed to determine if the filter is fully loaded, or if the heat exchanger is fouled and needs flushing. An optional diagnostic gauge that measures the differential pressure across the heat exchanger is installed inside the engine compartment. The reading of this gauge, together with the backpressure gauge, taken under full engine speed and no load (high idle), can be used to determine the next action.

- A reading of the backpressure gauge at or near the maximum, combined with a pressure differential across the heat exchanger (diagnostic gauge) in the range of 8-12" WG is an indication of a loaded filter. The next step should be to exchange the loaded exhaust particulate filter with a clean exhaust particulate filter.
- A reading of the backpressure gauge at or near the maximum combined with a pressure differential across the heat exchanger (diagnostic gauge) greater than 20" WG is an indication of excessive soot deposit in the heat exchanger. The higher the reading on the diagnostic gauge, the more soot has built up inside the heat exchanger. THIS MAY BE AN INDICATION THAT THE ON-BOARD CLEANING SYSTEM HAS NOT BEEN USED PROPERLY OR FREQUENTLY ENOUGH. As a first step, the On-board Cleaning System should be used (with the engine hot and under load) to see if the pressure across the heat exchanger can be reduced.
- If the backpressure in the heat exchanger can not be reduced significantly, the next step should be to schedule the machine for flushing of the exhaust system by a trained and qualified mechanic.
- **REF:** MWM 916, The maximum allowable exhaust backpressure is 40" WG.
Caterpillar 3300 PCNA The maximum allowable exhaust backpressure is 34" WG.
Caterpillar 3300 PCTA , C-10 The maximum allowable exhaust backpressure is 27" WG.
Cummins C8.3 The maximum allowable exhaust backpressure is 41" WG.
Isuzu 6BG1, The maximum allowable exhaust backpressure is 41" WG.

It is the responsibility of the operator to perform the initial diagnostic test. It is safe to activate the on-board cleaning system in any part of the mine where diesel equipment may be operated. Any flushing operation must be scheduled through maintenance.

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART A, M301-016-11

INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

Flushing of the System

If the On-board Cleaning System™ is used as described above, and if engine operation under light load and excessive idling are minimized, flushing of the exhaust system should seldom become necessary.

Flushing of the exhaust system must be performed by a trained and qualified mechanic and at an approved location. Should flushing become necessary, keep in mind that this not the same as on-board cleaning.

Flushing of the DST Dry System™ is performed by attaching an external water supply hose to the connecting port. Unlike during On-board Cleaning™ that uses only a few ounces of water, significant amounts (several gallons) of water are passed through the exhaust system during flushing operation. This will remove the soot deposited inside the heat exchanger that is not removed during On-board Cleaning™. Flushing may be performed during any time of the operating cycle, but only at a suitable location, as follows:

- The machine MUST be located at an outby area of the mine or a shop.
- Ventilation in the area should be into the return air.
- Water must be available at the area.
- Remove the exhaust filter according to the "Particulate Filter replacing procedure" and make provisions to capture water from the filter housing.
- Attach the external water hook-up to the system.
- Start the engine; make sure it is up to operating temperature.
- Run the engine at high idle speed and record the heat exchanger differential pressure.
- At high idle speed, open the water valve to allow continuous water-flow through the water injector for about 1- 2 minutes.
- Close the water valve and continue running the engine for 3-5 minutes to allow the exhaust system to dry out. Check for the change in the heat exchanger differential pressure gauge. A normal reading would be 8-14" WG. A higher reading indicates that there still are soot deposits inside the system.
- If needed, repeat the flushing as described above.
- If successful, install a new exhaust filter according to the "Exhaust Filter replacing procedure".

Do not perform the flushing procedure underground without a filter in place, or if there are indications that the filter has become damaged during the flushing.

Flushing without a particulate filter installed must be performed as follows:

- Remove the particulate filter and provide for some means to capture the water from the exhaust system.
- Re-install the lid to the filter housing.
- Make sure there is proper ventilation to remove the unfiltered diesel exhaust from the work area.

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: drysystemstech.com

OPERATION AND MAINTENANCE MANUAL PART A, M301-016-11

INSTRUCTIONS FOR USING THE ON-BOARD CLEANING SYSTEM AND FOR REPLACING THE EXHAUST PARTICULATE FILTER

- Install the external water hook-up to the system.
- Set the brakes and start the engine; make sure it is up to operating temperature.
- Run the engine at high idle speed and record the heat exchanger differential pressure.
- At high idle speed, open the water valve to allow continuous water-flow through the water injector until the water out of the exhaust system is clear. (Typically 10-15 minutes)
- Close the water valve and continue running the engine for 5 minutes to allow the exhaust system to dry out. Check for the change in the heat exchanger differential pressure gauge. A normal reading is 8-12".
- If successful, install a new particulate filter according to the "Particulate Filter replacing procedure".

Do not perform the flushing procedure without proper ventilation and without a provision to capture the soot and water from the exhaust.

Procedure to replacing the Particulate Filter

Replacing the DST particulate filter may be performed in any part of the mine where diesel equipment can be operated. **The diesel engine must be stopped during the entire time while the exhaust filter is being replaced.** Proceed as follows:

- Open the lid to the exhaust particulate filter housing.
- Release the manual clamp or clamping cylinders with the valve at the end of the filter housing.
- Remove the new exhaust filter from its shipping box and inspect for damage from shipping and handling.
- Remove the loaded exhaust filter from the filter housing, inspect for obvious damage or leaks and place into the empty shipping box and mark the box with "Used" or "Dirty". Do not grip on the inside of the filter where the soot is deposited. Gloves should be worn while handling the dirty filter.
- Check the inside of the exhaust filter housing. Report any soot deposits to the Maintenance Department.
- Inspect the seal groove inside the filter housing. Make sure there are no remains of seal material or other matter in the seal groove. If necessary, remove any remains with a screwdriver or similar tool.
- Insert the clean exhaust filter, after visual inspections for damage, and seal.
- Set the manual clamp or clamping cylinders with the valve at the end of the filter housing
- Close the lid to the exhaust filter housing.
- Remove the box with the used filter according to disposal procedures at the mine.
- Start the engine and check the exhaust backpressure at high idle to be in the normal range.

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OPERATION AND MAINTENANCE MANUAL

DST DRY SYSTEM®

**SECTION C
CO SAMPLING PROCEDURE**

To be performed by a trained and qualified mechanic

M301-018-01

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WOODRIDGE, IL 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036
E-mail: eng@drysystemstech.com

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART C, M301-018-01

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

Background:

MSHA requires that the engine-out untreated Carbon Monoxide of all Inby and heavy-duty Outby engines be checked weekly. The following is the applicable text (excerpts) that may be found in the **MSHA 30 CFR, Part 75.1914 (g) Regulations**. The test for untreated (engine out) CO emissions is mandatory and will also provide excellent feedback to the mechanic on the engine condition.

§75.1914 Maintenance of diesel-powered Equipment

(a) Diesel-powered equipment shall be maintained in approved and safe condition or removed from service.

(b) Maintenance and repairs of approved features and those features required by Sections 75.1909 and 75.1910 on diesel-powered equipment shall be made only by a person qualified under Section 75.1915.

(c)

(d)

(e)

(f)

(g) Undiluted exhaust emissions of diesel engines in diesel-powered equipment approved under part 36 and heavy-duty non-permissible diesel-powered equipment as defined in Section 75.1908(a) in use in underground coal mines shall be tested and evaluated weekly by a person who is trained to perform this task. The mine operator shall develop and implement written standard operating procedures for such testing and evaluation that specify the following:

- (1) The method of achieving a repeatable loaded engine operating condition for each type of equipment;*
- (2) Sampling and analytical methods (including calibration of instrumentation) that are capable of accurately detecting carbon monoxide in the expected concentrations;*
- (3) The method of evaluation and interpretation of the results;*
- (4) The concentration or changes in concentration of carbon monoxide that will indicate a change in engine performance. Carbon monoxide concentration shall not exceed 2,500 parts per million;*
- (5) The maintenance of records necessary to track engine performance.*

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8102 Lemont Road, Suite 700, Woodridge, Illinois 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART C

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

The reasons for monitoring Engine-out CO Emissions

CO sampling became a mandatory procedure when MSHA released the new Part 75 regulations. It was introduced to ensure that diesel engines are operated in “as-approved” condition and settings. In most instances when a diesel engine develops a problem, the CO output will increase. Other emissions do not necessarily follow the same trend. Under normal operating conditions (at torque stall), CO output ranging from 200-300 ppm should be expected from a MWM D916-6 engine, 300-400 ppm for a Caterpillar 3300 engine. Whenever abnormally high CO is observed, an engine problem should be suspected, because CO increases when an engine develops a fault. Increased CO will not pinpoint to a specific problem, but based on past experience, the following may have happened: (In order of probability):

- The Intake Air Cleaner is plugged, causing too high an intake air restriction and air starvation of the engine. This makes the engine run too rich. (A plugged intake air cleaner is the cause in more than ¾ of all cases)
- Fuel injector problems, which could be a bad spray pattern of an injector and cause incomplete combustion.
- Improper fuel pump adjustment by having the fuel pump adjusted too rich or not properly de-rated for the operating altitude. This makes the engine run too rich.
- Mechanical problems with the engine, such as bad valve seals, leaking piston rings, low compression or similar problems. (Not frequent cause)
- The exhaust system is restricted, causing too high a backpressure.

CO (Carbon Monoxide) is an excellent diagnostic tool for the maintenance department to detect engine problems before they lead to failures. It has been used successfully by many mines in a similar way as oil analysis. The main purpose of CO sampling is to minimize exposure of the operator and other personnel to diesel exhaust.

The reasons for monitoring treated CO Emissions (after catalyst) (Optional)

The DST Dry System™ is fitted with a catalyst that will reduce CO by up to 90% at exhaust temperatures above 300°F. A typical treated CO level in the exhaust is 20-40 ppm. If the catalyst would develop a problem, the treated CO levels will increase significantly. Therefore, whenever there is higher than normal CO, a problem with the catalyst should be suspected. If the treated CO levels are continuously greater than 100 ppm, the catalyst must be removed and checked for fouling.

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OPERATION AND MAINTENANCE MANUAL PART C, M301-018-01

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

Permanently Installed CO Sampling Ports

To simplify this mandatory procedure, Dry Systems Technologies® developed and offers a permanently installed and MSHA Certified (31/D126) Flameproof Port™ assembly. All hardware remains permanently mounted in the exhaust system and on the machine. Drawn through a flameproof port, a cooling tube and a connecting hose, the exhaust gas portion for sampling is routed to the operator's cab. There, a soot filter and a water separator condition the exhaust gas to be suitable for **CO sampling with simple hand held instruments**.

A quick connect coupling is permanently mounted inside the operator's cab and allows the sampling from the safe location inside the operator's cab. The mating coupler is attached to the CO sampling instrument. **Only one person is required to sample the CO.** An optional Catalyst – out sampler may also be provided.

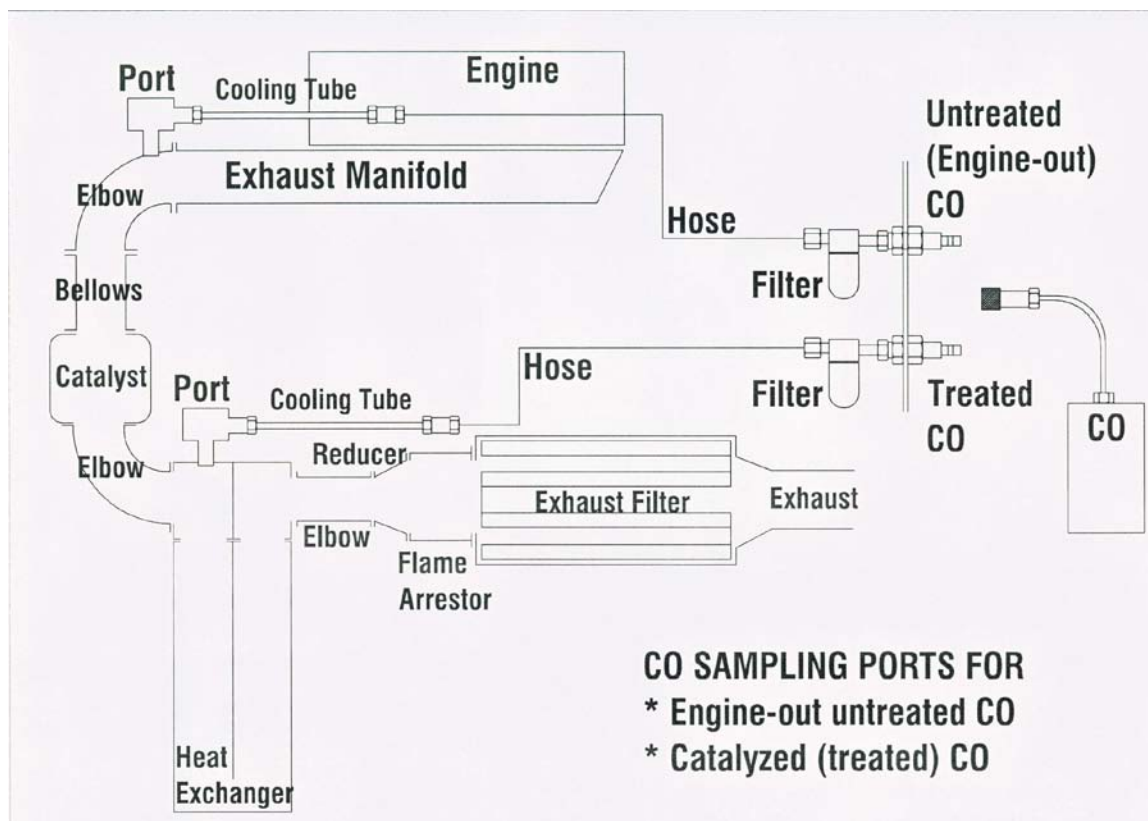


Figure 1: Sampling Schematic for untreated and (Optional) treated CO

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OPERATION AND MAINTENANCE MANUAL PART C, M301-018-01

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

CO Sampling Procedure

The following is the standard procedure to obtain an accurate and repeatable CO sample.

- Place the machine in a safe location, make sure the area in front of the machine is clear and there is sufficient ventilation air. Sampling can be conducted in any area of the mine.
- Set the brakes and start the engine as outlined in the Operation and Maintenance Manual.
- Allow the engine to warm up to normal operating temperature. Taking the CO samples on a cold engine would provide incorrect results.
- Check all operating gauges to be in the normal operating range. The coolant temperature must be no lower than 170°F. If the intake restriction is greater than 25" WG or the exhaust backpressure is greater than 35" WG, perform the necessary maintenance before proceeding.
- Attach the CO Sampling Device to the quick connect port labeled "**Engine Out**" in the operator's cab.
- Re-check that the areas in front and behind of the machine are clear and that the parking brakes are set.
- Put the transmission into the **highest** gear and apply full throttle.
- Monitor the reading on CO Sampling Device. After about 45-90 seconds, the CO indication starts rising. Allow this to continue until the CO indication stabilizes.
- Start recording (5) separate sequential readings in one-minute intervals. Monitor the torque converter temperature while taking the samples. The intervals between the samples may have to be shortened to prevent overheating during the test. Do not allow the torque converter temperature to exceed the safe range.
- Stop sampling after (5) readings, or before if the torque converter fluid gets too hot.
- Slow the engine to low idle, put the transmission into neutral, then put the engine into high idle (without load) for about one minute to cool down the torque converter and the engine coolant.
- Remove the instrument and enter the CO readings on the report.
- Attach the CO Sampling Device to the Optional quick connect port labeled "**Catalyzed**" in the operator's cab.
- Re-check that the areas in front and behind of the machine are clear and that the parking brakes are set.
- Put the transmission into the **highest** gear and apply full throttle.
- Monitor the reading on CO Sampling Device. After about 45-90 seconds, the CO indication starts rising. Allow this to continue until the CO indication stabilizes.
- Start recording (5) separate sequential readings in one-minute intervals. Monitor the torque converter temperature while taking the samples. The intervals between the samples may have to be shortened to prevent overheating during the test. Do not allow the torque converter temperature to exceed the safe range.
- Stop sampling after (5) readings, or before if the torque converter fluid gets too hot.
- Slow the engine to low idle, put the transmission into neutral, then put into high idle for about one minute to cool the torque converter and the engine coolant.
- Remove the instrument and record the CO readings on the report.

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OPERATION AND MAINTENANCE MANUAL PART C, M301-018-01

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

CO Sampling Instruments

One of the advantages of the permanently installed CO sampling port system is that it conditions the exhaust gas where it can be monitored with inexpensive handheld instruments. The gas is cooled and filter for this purpose. There are three single gas (CO only) instruments that are readily available, relatively inexpensive and have acceptable accuracy and reliability:

- ECOM EM
- Industrial Scientific CO 260
- Industrial Scientific CO 262

More expensive instruments can be used if they are available to the mine, but provide not advantage. Handheld multi-gas instruments have been evaluated and did not have the necessary accuracy and reliability to be recommended. Handheld multi-gas instrument are fitted with very small sensors that tend to foul up in a very short period of time. The above listed handheld single gas instruments are fitted with larger sensors that hold up better.

Keep in mind that ALL instruments require periodic re-calibration. The calibration date is usually stated on a label attached to the instrument. Unless stated otherwise, we recommend calibration at least twice a year, or whenever inaccuracy is suspected.

Maintenance of the Flameproof Ports

When hot exhaust gas is drawn through small internal passages of the flameproof port and the cooling tube, it is cooled down and some soot will deposit inside the ports and the tubes. This is unavoidable.

When there is excessive soot inside the port, it will plug. As result no sample can be drawn and there is no indication on the CO instrument. As first corrective step, rotate the stem at the end of the flameproof port. If this does not clear the passage, the flameproof port must be removed, disassembled and both port and cooling tube cleaned with solvent. Make sure all solvent is cleaned off and the components are dry before reinstallation.

The filter and water separator remove soot and water that would otherwise damage the sampling head inside the CO sampling instrument. Periodically, the filter cartridge should be replaced. We recommend twice a year when the machine is in normal use. Failure to replace the filter will result in shorter sampler head life.

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OPERATION AND MAINTENANCE MANUAL PART C, M301-018-01

CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™



Figure 2: Components of Flameproof Port Installation

Top left:	Intake restriction gauge and flameproof port for intake restriction
Top right:	Port for exhaust backpressure and CO sampling, Cooling tube (May be coiled or straight tube)
Center:	Exhaust backpressure gauge, water separator/filter (sample conditioner) and Quick Coupler
Bottom:	Matching quick coupler for CO instrument

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CO (Carbon Monoxide) SAMPLING INSTRUCTIONS FOR THE DST DRY SYSTEM™

Record Keeping (Sample Form)

The following is a sample form to record the CO readings:

Mine Name								
Engine Model								
Engine Serial No								
Machine Model								
Machine Serial Number								
Mine Machine ID								
Mechanic								
Date								
Engine hours								
		Baseline for reference	#1 Sample	#2 Sample	#3 Sample	#4 Sample	#5 Sample	Average
CO Engine-out	ppm							
Coolant	°F							
Exhaust	°F							
Torque Converter	°F							
Engine Speed	rpm							
CO Catalyzed	ppm							
Coolant	°F							
Exhaust	°F							
Torque Converter	°F							
Engine Speed	rpm							

Signature:

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OPERATION AND MAINTENANCE MANUAL

DST DRY SYSTEM®

SECTION D PRE-OP INSPECTIONS

To be performed by the machine operator

M301-019-01

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WOODRIDGE, IL 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036
E-mail: eng@drysystemstech.com

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Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART D, M301-019-01

PRE-OPERATING INSPECTION FOR THE DST DRY SYSTEM™

MSHA Requirements

The Part 75 MSHA regulations require that the machine operator performs a walk-around inspection of the machine before it is operated. The following is the text from the MSHA 30 CFR, Part 75.1914(e) regulations pertinent to this pre-op inspection.

MSHA 30 CFR Part 75.1914 Maintenance of diesel-powered equipment.

(a) Diesel-powered equipment shall be maintained in approved and safe condition or removed from service.

(b) Maintenance and repairs of approved features and those features required by Sections 75.1909 and 75.1910 on diesel-powered equipment shall be made only by a person qualified under Section 75.1915.

(c)

(d)

(e) Mobile diesel-powered equipment that is to be used during a shift shall be visually examined by the equipment operator before being placed in operation. Equipment defects affecting safety shall be reported promptly to the mine operator.

Note: MSHA text is provided for reference only. Refer to the official MSHA published regulations.

DST Dry System™ Inspection Requirements

The DST Dry System™ requires very little maintenance, when compared with water scrubbers. The pre-op inspection is required by MSHA to ensure there is no damage to the DST Dry System™ and all components are properly in place. It is not necessary to perform flushing and refilling of the DST Dry System™, as necessary with water scrubbers. There are no floats or water level sensors that must be checked.

The following form is intended to guide the operator through the walk-around inspection. Please refer also to any machine inspection procedures in the OEM manual, as the following page refers ONLY to the DST Dry System™.

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Phone: 630-427-2051 * Fax: 630-427-1036 * E-mail: eng@drysystechnology.com

OPERATION AND MAINTENANCE MANUAL PART D, M301-019-01

PRE-OPERATING INSPECTION FOR THE DST DRY SYSTEM™

Dry System™ Pre-operation Checklist

OPERATOR'S PRE-OP CHECKLIST FOR THE DST SYSTEM		
DE-ENERGIZED WALK-AROUND INSPECTION PERFORMED BEFORE EACH SHIFT		
ITEM	DESCRIPTION	COMPLETED
1	Make certain equipment is in a safe condition and in a safe area prior to the inspection.	
2	Make sure the machine is clean and free of accumulations of combustibles.	
3	Check the DST Dry System™ for external damage and to determine that all components are in place and not damaged.	
4	Look for loose or missing DST components and loose or missing hardware.	
5	Look for gas leakage at each flange connection of the DST Dry System™.	
6	Inspect the bellows assembly for external damage or leakage.	
7	Check for damaged coolant hoses, vent hoses and coolant leaks.	
8	The surge tank must be completely full. DO NOT OPEN RADIATOR CAP IF HOT.	
9	Check the coolant overflow bottle. Coolant must be between upper and lower marks. Add coolant mix if needed.	
10	Check the radiator cap on top of the surge tank to be in place and tightened.	
11	Check the radiator core for obstructions, plugging, damage and leaks.	
12	Check the fan for broken or missing blades.	
13	Check all belts to be properly tightened and in good condition.	
14	Check the water level in the tank for the on-board cleaning system and top off with clean bottled water if necessary.	
15	Check all gauges for external damage.	
16	Replace all lids and secure all access doors as needed.	
17	Complete this form and place in operator's cab	
18	Report all damage or problems to Maintenance for further action.	

Name: Date:

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OPERATION AND MAINTENANCE MANUAL

DST DRY SYSTEM®

**SECTION F
COOLING SYSTEM FILLING
PROCEDURE**

To be performed by the machine operator

M301-021-01

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WOODRIDGE, IL 60517, USA
Phone: 630-427-2051 * Fax: 630-427-1036
E-mail: eng@drysystemstech.com

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8102 Lemont Road, Woodridge, Illinois 60517, USA

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OPERATION AND MAINTENANCE MANUAL PART F, M301-021-01

COOLING SYSTEM FILLING PROCEDURE FOR THE DST DRY SYSTEM™

The DST Dry System™ is fitted with a cooling system that incorporates a surge tank, a recovery bottle, and several vent lines to assure that the system has no trapped air. The system is self purging, once it is filled initially. As with all cooling systems, a mixture of 50% ethylene glycol and 50% treated (clean) water should be used for best performance. Never add untreated mine water to the cooling system. The following is the filling procedure for the system.

COOLING SYSTEM FILLING PROCEDURE

- Carefully open the pressure cap on the surge tank, after the system has cooled down and is not under pressure. (There is no radiator cap on the radiator itself) CAUTION: DO NOT ATTEMPT TO OPEN PRESSURE CAP WHEN COOLANT IS STILL HOT OR UNDER PRESSURE. INJURY OR BURNS COULD RESULT.
- Fill a mixture of 50% Ethylene Glycol and 50% filtered water into the surge tank, until the tank is completely full and the vent lines (3/8" clear hoses) are filled with coolant.
- Replace the pressure cap firmly and start the engine. Idle for 1-2 minutes to purge the remaining air from the system. Check for leaks.
- Carefully open the pressure cap on the surge tank and top off the surge tank with a mixture of 50% Ethylene Glycol and 50% filtered water.
- Repeat steps 3 and 4 if necessary.
- Replace the pressure cap firmly. Fill the overflow bottle half way with a mixture of 50% Ethylene Glycol and 50% filtered water
- Check the coolant level after about one hour of operation. If coolant is significantly lower, the cause for the coolant loss must be investigated. A normal loss in coolant due to temperature changes will be compensated by a rise or drop of the coolant in the overflow bottle. The surge tank should never contain air.

CAUTION: DO NOT ATTEMPT TO OPEN PRESSURE CAP WHEN COOLANT IS STILL HOT OR UNDER PRESSURE. INJURY OR BURNS COULD RESULT. DO NOT OPERATE SYSTEM WITH LOW COOLANT. ENGINE DAMAGE MAY RESULT. USE ONLY A MIXTURE OF 50% ETHYLENE GLYCOL AND 50% CLEAN (FILTERED) WATER AS COOLANT. NEVER ADD MINE WATER TO THE COOLING SYSTEM.