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BUREAU OF DEEP MINE SAFETY

November 14, 2003

Bill Brookshire
Bureau of Deep Mine Safety
Fayette County Health Center
100 New Salem Road, Room 167
Uniontown, PA 15401

Eugene Davis
UMWA
1146 Palmer Road
Adah, PA 15410

Robert DuBreucq
142 Hemlock Drive
Portage, PA 15946

Subject: Brookville Equipment Corporation
Request to the Technical Advisory Committee

Dear Sirs:

Brookville Equipment Corporation has applied for an approval of a Brookville Model 20T240D with the Pennsylvania Deep Mine Safety, and is requesting that the Technical Advisory Committee review the enclosed information and make a determination that it meets the requirements of Section 203A(1), (2), and (3).

Also, Brookville Equipment Corporation is requesting the alternative test procedure be used for CO sampling, instead of the 5 minute testing under 217-A and 218-A of the Pennsylvania Diesel Law. The alternative sampling method consists of samples taken at 60, 75, and 90 seconds.
Please review this request, and if you have any questions, please call me anytime.

Best regards,

E. Schmader

Eli Schmader
Engineer

BROOKVILLE EQUIPMENT CORP.
MODEL 20T240D
20-Ton Diesel Locomotive

General Specifications of the Diesel-Powered Equipment Package

Engine Manufacturer			CUMMINS	
Engine Model			QSB-C240 5.9	
Horsepower			240 HP de-rated 190 HP	
Rated Speed			2500 RPM de-rated to 2200 rpm	
Cummins hp limiter – Engine Control Module			190 hp (*NOTE 1)	
Torque Converter			Clark / Hurth	
Converter Model Number			C270	
Part Number			15-20500	
Manufacturer's Maximum Recommended Exhaust Back-pressure (Inwg)			40.7886 Inches Water Gauge	
Maximum Exhaust Out Temperature			285 deg F	
MSHA Engine Approval			**MSHA Part 7**	
MSHA Certification No.			7E-B099-0 (Part 7)	
Rated Speed			2500 RPM	
Rated Horsepower			240 HP	
Exhaust GAS Flow (SCFM)			1337 CFM @ 500 deg C	
ISO 8178-1 Average DPM (gr/hr)			9.1 gr/hr	
Average Ambient DPM Level (mg/m3)			0.012 mg/m3	
MSHA Ventilation Rate (CFM)			13500 CFM (Part 7)	CFM (Part 32)
Pa. State Ventilation Rate (CFM)			13350 CFM	
Emissions Control System			**DST Management System**	
Fuel Injection Pump	Make	Bosch		
	P/N	VP44		
Engine Control Module (ECM)	Make	Cummins		
	P/N	3990517 (New) 3990517RX (Reconditioned)		
ECM software	Make	Cummins (Password Protected)		
	P/N	XJ91413.99		
Joystick	Make	Brookville Equipment		

	P/N	12-1011		
Oxidation Catalyst	Make	Syncat Corp.		
	P/N	M30-221-02		
Heat Exchanger	Make	Paas Tech.		
	P/N	M90-301-01		
DPM Filter	Make	Fleet Guard	Model	M 30
	P/N	M 30	Filter Size	16 x 12 in Outer
	Air Rating (CFM)	2100 CFM	Filter Length	20 in
	Surface Area (in3)	42,231 in3		
	Efficiency			96.9%
	Recommended Exhaust Back-Pressure			> 40 Inches Water Gauge
Note 1	The QSB-C240 5.9 comes with a computer control system that limits the output horsepower. The HP setting is programmed by Cummins.			190 hp

CALCULATION: AMBIENT DPM EMISSION LEVEL FOR CUMMINS QSB5.9 ENGINE

BASED ON SOUTHWEST RESEARCH INSTITUTE TEST DATA

RE: To meet the requirements of the Pennsylvania ACT 182 Diesel Powered Equipment Law, Section 203 -A, a) 1), entitled Exhaust Emission Contro l

To comply with section 203 -A-a-1, the tailpipe emissions for the equipment cannot exceed 0.12mg/m^3, when diluted by 100% of the MSHA approval plate ventilation rate for that diesel engine.

For Brookville Mining Equipment Corporation's request for BOT E approval for our Model 20T240D locomotive, the Cummins Diesel Engine will be used at 190 hp @ 2200 rpm.

MSHA specifications for the Cummins QSB -C240 5.9:
Approval No: 7E -B099-0
Ventilation Req't: 13,500 cfm

The MSHA approved ventilation rate for the C ummins B5.9 is as follows:

Ventilation Rate: 13,500 cfm under MSHA approval 7E -B099-0

Using the equation:

$$\text{Ambient DPM Level} = DPM_{AVG} = PT/V_{vent}$$

Where:

V_{VENT} = Quantity of ventilation air req'd per Cummins emission certification document FR91103, Project No. 601413. (MSHA approval number pending as of 10/7/03)

$$= \frac{13{,}500\ ft^3}{min} \times \frac{1m^3}{35.31\ ft^3}$$

$$= 382\ m^3/min$$

DPM volume extracted from Cummins /MSHA Research Test Data:

Mode Number	DPM Corrected (g/hr)	Weighting Factor	DPM X Weighting Factor
1	15.3	.15	2.3
2	8.9	.15	1.3
3	9.3	.15	1.4
4	5.7	.10	0.6
5	20.0	.10	2.0
6	8.2	.10	0.8
7	6.4	.10	0.6
8	0.6	.15	0.1

Average DPM level over 8178 -1 8 mode Test = 9.1 g/hr

Based on Southwest Research Institute testing filter efficiency was found to be 96.9%. Therefore the DPM would be 9.1 x .031 = .28 g/hr

PT = Average DPM level

$$= \frac{.28gr}{1hour} \times \frac{1000mg}{1gr} \times \frac{1hour}{60min}$$

= 4.667 mg/min

SOLVE FOR AMBIENT DPM LEVEL:

$$DPM_{AMB} = \frac{(4.667\ mg/min)}{382\ m^3/min}$$

$$= 0.012\ mg.m^3$$

CONCLUSION: To comply with section 203 -A-a-1, the tailpipe emissions for the equipment cannot exceed 0 .12mg/m^3, when diluted by 100% of the MSHA approval plate ventilation rate for that diesel engine. 0.012 mg/m^3 < 0.12 mg/m^3, therefore, this engine package meets the requirement.

Cummins Bridgeway

11/2103

To Brookville Equipment

Attention: Larry Conrad

Subject: Cummins Power Match Calibration

Larry,

On Wednesday 11/19/03 Steve Creech and I successfully performed a Cummins Power Match calibration (software calibration#XJ 91413.99) to Engine Serial Number 46331180 at your facility. In effect we have created a lower torque curve rating with in the M.H.S.A. approved Cummins 240 horsepower calibration. The ECM calibration will have to follow the Cummins Product Change Request process for audits and then will be released as a permanent calibration to be used for future new engine orders. At this time a new ECM data tag will need to be installed.

In the event a total ECM failure should occur the proper repair for this application would be for a Cummins certified technician to replace the ECM with a new ECM module and then up load this calibration (software calibration XJ 91413.99) into the ECM. This code will then work as we demonstrated at your facility.

New ECM P/N 3990517
Cummins Recon ECM P/N 3990517

Respectfully Submitted,

Ron Heitman

Application Engineer

Corporate Office 21810 Clessie Court, New Hudson, Michigan 48165 Phone (248) 573-1600 Fax (248) 573-4015
Columbus 4000 Layman Drive, Hilliard, Ohio 43026 Phone (614) 771-1000 Fax (614) 771-0716

www.cumminsbridgeway.com

Engine Performance Data

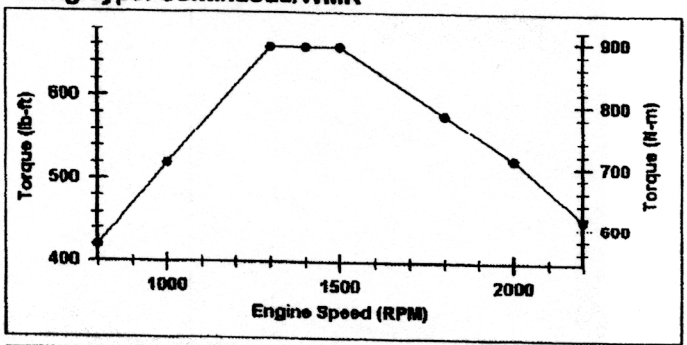
Cummins Inc
Columbus, Indiana 47202-3005
http://www.cummins.com

Industrial	190 BHP (142 kW) @ 2200 RPM 671 lb-ft (910 N-m) @ 1500 RPM		
QSB	Configuration	CPL Code	Revision
FR90857	D403046CX03	8169	23-Jun-2003

Compression Ratio: **16.3:1**
Fuel System: **Bosch Electronic**
Emission Certification: **U.S. EPA Tier 2, CARB Tier 2, JMLIT Step 2, NRMM (Europe) Stage II**
Displacement: **360 in3 (5.9 L)**
Aspiration: **Turbocharged and Charge Air Cooled**

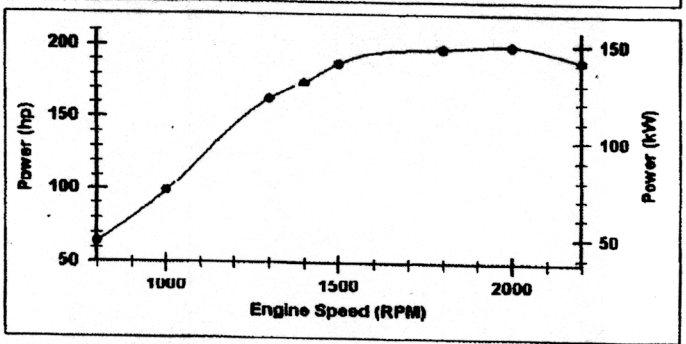
All data is based on the engine operating with fuel system, water pump, and 9.84 in H2O (250 mm H2O) inlet air restriction with 3.94 in (100 mm) inner diameter, and with 1.97 in Hg (50 mm Hg) exhaust restriction with 2.95 in (75 mm) inner diameter; not included are alternator, fan, optional equipment and driven components. Coolant flows and heat rejection data based on coolants as 50% ethylene glycol/50% water. All data is subject to change without notice.

Rating Type: Continuous/WMR



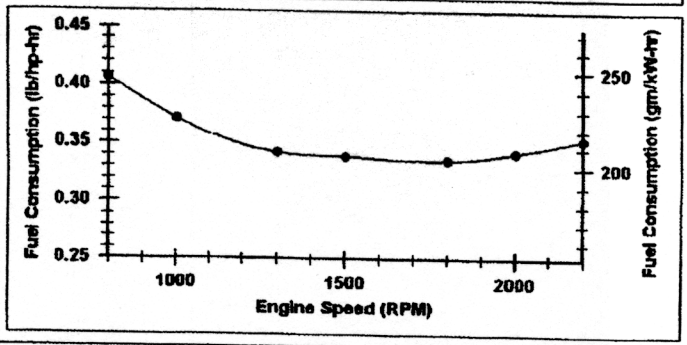
Torque Output

RPM	lb-ft	N-m
800	420	569
1,000	520	705
1,300	658	892
1,400	658	892
1,500	658	892
1,800	578	784
2,000	525	712
2,200	454	616



Power Output

RPM	hp	kW
800	64	48
1,000	99	74
1,300	163	122
1,400	175	130
1,500	188	140
1,800	198	148
2,000	200	149
2,200	190	142



Fuel Consumption

RPM	lb/hp-hr	gm/kW-hr
800	0.406	247
1,000	0.372	226
1,300	0.342	208
1,500	0.339	206
1,800	0.335	204
2,000	0.342	208
2,200	0.353	215

Curves shown above represent gross engine performance capabilities obtained and corrected in accordance with SAE J1995 conditions of 29.61 in Hg (100 kPa) barometric pressure [300ft (91m) altitude] 77 deg F (25 deg C) inlet air temperature, and 0.30 in Hg (1kPa) water vapor pressure with No. 2 diesel fuel. The engine may be operated up to 13,000 ft (3,962 m) maximum altitude. Consult Cummins customer engineering for operation above this altitude.

STATUS FOR CURVES AND DATA: Final
TOLERANCE: Within +/- 5 %

CHIEF ENGINEER:
Lisa A Prentiss

Bold entries revised after 1-Jun-2003

Engine Performance Data

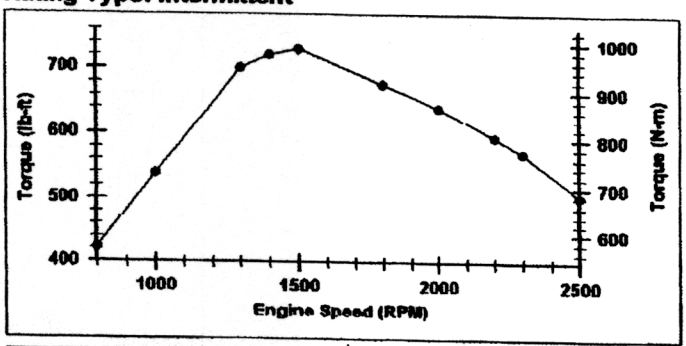
Cummins Inc
Columbus, Indiana 47202-3005
http://www.cummins.com

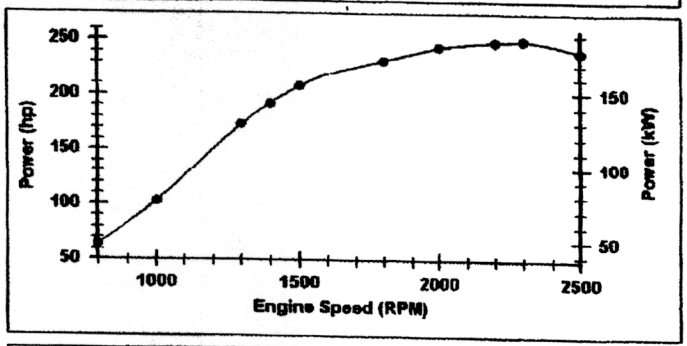
Industrial	240 BHP (179 kW) @ 2500 RPM 730 lb-ft (990 N-m) @ 1500 RPM		
QSB	Configuration D403046CX03	CPL Code 8110	Revision 23-Jun-2003
FR91103			

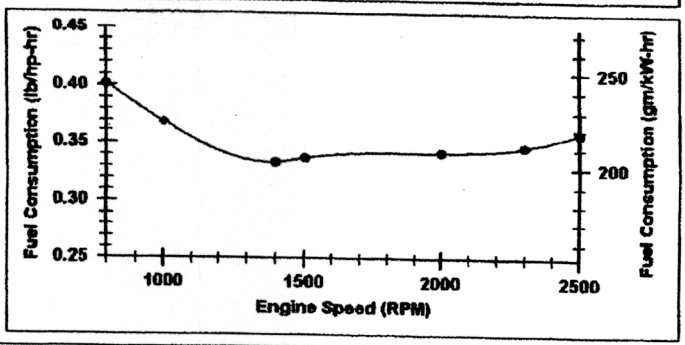
Compression Ratio: 16.3:1
Fuel System: Bosch Electronic
Emission Certification: U.S. EPA Tier 2, CARB Tier 2, JMLIT Step 2, NRMM (Europe) Stage II
Displacement: 360 in3 (5.9 L)
Aspiration: Turbocharged and Charge Air Cooled

All data is based on the engine operating with fuel system, water pump, and 9.84 in H2O (250 mm H2O) inlet air restriction with 3.94 in (100 mm) inner diameter, and with 1.97 in Hg (50 mm Hg) exhaust restriction with 2.95 in (75 mm) inner diameter; not included are alternator, fan, optional equipment and driven components. Coolant flows and heat rejection data based on coolants as 50% ethylene glycol/50% water. All data is subject to change without notice.

Rating Type: Intermittent







Torque Output

RPM	lb-ft	N-m
800	422	572
1,000	539	731
1,300	700	949
1,400	720	976
1,500	730	990
1,800	676	917
2,000	640	868
2,200	595	807
2,300	571	774
2,500	505	685

Power Output

RPM	hp	kW
800	64	48
1,000	103	77
1,300	173	129
1,400	192	143
1,500	208	155
1,800	232	173
2,000	244	182
2,200	249	186
2,300	250	186
2,500	240	179

Fuel Consumption

RPM	lb/hp-hr	gm/kW-hr
800	0.401	244
1,000	0.368	224
1,400	0.334	203
1,500	0.337	205
2,000	0.342	208
2,300	0.347	211
2,500	0.358	218

Curves shown above represent gross engine performance capabilities obtained and corrected in accordance with SAE J1995 conditions of 29.61 in Hg (100 kPa) barometric pressure [300ft (91m) altitude] 77 deg F (25 deg C) inlet air temperature, and 0.30 in Hg (1kPa) water vapor pressure with No. 2 diesel fuel. The engine may be operated up to 10,000 ft (3,048 m) maximum altitude. Consult Cummins customer engineering for operation above this altitude.

STATUS FOR CURVES AND DATA: Final
TOLERANCE: Within +/- 5 %

CHIEF ENGINEER:
Lisa A Prentiss

Bold entries revised after 1-Jun-2003

Intake Air System

Maximum allowable air temperature rise over ambient at Intake Manifold (Naturally Aspirated Engines) or Turbo Compressor inlet (Turbo-charged Engines): (This parameter impacts LAT and altitude capability)	30.6 delta deg F	17 delta deg C

Charge Air Cooling System

Maximum intake manifold temperature at 25 deg C (77 F) ambient	140 deg F	60 deg C
Maximum allowable pressure drop across charge air cooler and OEM CAC piping (IMPD):	4 in-Hg	102 mm Hg
Maximum Intake Manifold Temperature Differential (Ambient to IMT) (IMTD):	63 delta deg F	35 delta deg C
Intake manifold temperature for Fan-ON	140 deg F	60 deg C

Exhaust System

Maximum exhaust back pressure:	3 in-Hg	76 mm Hg
Recommended exhaust piping size (inner diameter):	2.95 in	75 mm

Lubrication System

Nominal operating oil pressure		
@ minimum low idle	10 psi	69 kPa
@ maximum rated speed	65 psi	448 kPa
Minimum engine oil pressure for engine protection devices		
@ minimum low idle	10 psi	69 kPa

Fuel System

Fuel cooling requirements (with diesel fuel)		
Maximum heat rejection to return fuel at max. coolant and inlet fuel temperature:	51 BTU/min	0.9 kW
@ fuel return flow rate of:	220 lb/hr	100 kg/hr
@ fuel return temperature prior to cooler:	133 deg F	56 deg C
Maximum supply fuel flow:	306 lb/hr	139 kg/hr
Maximum return fuel flow:	289 lb/hr	131 kg/hr
Engine fuel compatibility (consult Service Bulletin #3379001 for appropriate use of other fuels)	DF2	
Maximum fuel inlet pressure:	12 psi	80 kPa

Performance Data

Maximum low idle speed:	1,200 RPM
Minimum low idle speed:	700 RPM
Minimum combined converter and hydraulic stall speed:	

	Rated Power		Maximum Power		Torque Peak	
Engine Speed	2,500 RPM		2,300 RPM		1,500 RPM	
Output Power	240 hp	179 kW	250 hp	186 kW	208 hp	155 kW
Torque	504 lb-ft	683 N-m	571 lb-ft	774 N-m	730 lb-ft	990 N-m
Friction Horsepower	43 hp	32 kW	36 hp	27 kW	17 hp	13 kW
Intake Manifold Pressure	48 in-Hg	1,208 mm Hg	49 in-Hg	1,230 mm Hg	49 in-Hg	1,251 mm Hg
Turbo Comp. Outlet Pressure	51 in-Hg	1,301 mm Hg	52 in-Hg	1,313 mm Hg	51 in-Hg	1,294 mm Hg
Turbo Comp. Outlet Temperature	327 deg F	164 deg C	327 deg F	164 deg C	327 deg F	164 deg C
Inlet Air Flow	557 ft3/min	263 L/s	530 ft3/min	250 L/s	369 ft3/min	174 L/s
Charge Air Flow	39 lb/min	18 kg/min	38 lb/min	17 kg/min	27 lb/min	12 kg/min
Exhaust Gas Flow	1,337 ft3/min	631 L/s	1,303 ft3/min	615 L/s	1,002 ft3/min	473 L/s
Exhaust Gas Temperature	930 deg F	499 deg C	952 deg F	511 deg C	1,002 deg F	539 deg C
Maximum Fuel Flow to Pump	304 lb/hr	138 kg/hr	298 lb/hr	135 kg/hr	225 lb/hr	102 kg/hr
Heat Rejection to Coolant	4,800 BTU/min	84.4 kW	4,601 BTU/min	80.9 kW	3,696 BTU/min	65 kW
Heat Rejection to Fuel	51 BTU/min	0.9 kW	45 BTU/min	0.8 kW	23 BTU/min	0.4 kW
Heat Rejection to Ambient	984 BTU/min	17.3 kW	1,200 BTU/min	21.1 kW	1,211 BTU/min	21.3 kW
**Steady State Smoke	0.6 Bosch		0.6 Bosch		1 Bosch	

**When operating Naturally Aspirated engines above SAE J1995 conditions, it should be noted that smoke levels will increase due to combustion inefficiencies associated with a reduction in the air to fuel mixture.

Cranking System (Cold Starting Capability)

Unaided Cold Start:		
Minimum cranking speed:	150 RPM	
Minimum ambient temperature	10 deg F	-12.2 deg C
Cranking torque at minimum unaided cold start temperature:	302 lb-ft	410 N-m
Aided Cold Start:		
Minimum ambient temperature with Grid Heater only	10 deg F	-12 deg C
Minimum ambient temperature with Ether only:	-20 deg F	-29 deg C
Minimum ambient temperature with coolant and lube heater only:		
Cold starting aids available	Intake Manifold Heater, Block Heater, Oil Pan Heater	

Noise Emissions

Top	95.8 dBa
Right Side	98.5 dBa
Left Side	99.6 dBa
Front	99.3 dBa
Exhaust noise emissions	110.5 dBa

Estimated Free Field Sound Pressure Level at 3.28ft. (1m) and Full-Load Governed Speed
(Excludes Noise from Intake, Exhaust, Cooling System and Driven Components)

End of Report

Project no. 601413

Project name: **Certification - Diesel**

Test Engine: **CUMMINS Model QSB-C240 (FR91103), SN 46079909**

Fuel: **MSHA FUEL, Sulfur= 430 ppm**

Description	Units	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
RPM	rpm	2500	2501	2500	2500	1500	1501	1501	748
Torque	lb.ft	505	378	251	49	703	523	348	1
HORSEPOWER	hp	240	180	120	24	201	149	99	0
Barometric pressure	in.Hg	29.5	29.5	29.5	29.5	29.6	29.5	29.5	29.5
ASTM VM 800, DP	"H2O	0.00	0.00	9.91	0.00	0.00	4.02	0.00	1.22
ASTM V.M 1600, DP	"H2O	0.00	0.00	4.56	5.10	0.00	1.70	3.21	0.00
ASTM VM 5000, DP	"H2O	1.47	1.32	0.00	0.00	0.66	0.00	0.00	0.00
fluid flow uncorrected	lb/hr	2350	2232	2003	1226	1614	1245	973	296
Pbar (atmospheric)	mmHg	749.7	749.7	750.0	750.0	751.3	749.6	749.3	748.9
Temp air inlet (dry bulb)	oF	79	78	79	79	78	81	82	81
PT correction		0.983	0.984	0.983	0.983	0.985	0.981	0.980	0.981
fluid flow corrected	lb/hr	2311	2195	1970	1205	1590	1222	953	291
RH air intake	%	53	60	55	54	55	49	56	52
H2O vapour in dry air	lbH2O/lbda	0.01162	0.01328	0.01202	0.01189	0.01169	0.01129	0.01360	0.01216
H2O correction in fluid	lbH2O/lbfld	0.01149	0.01310	0.01188	0.01175	0.01156	0.01116	0.01342	0.01200
H2O in meter fluid	lb/hr	26.54	28.76	23.40	14.16	18.38	13.64	12.79	3.49
Dry air flow corrected	lb/hr	2284	2166	1947	1191	1572	1208	940	287
MW of dry air	lb/mol	28.85	28.85	28.85	28.85	28.85	28.85	28.85	28.85
Air lbs/hr		2284	2166	1947	1191	1572	1208	940	287
Fuel Temperature	oF	81	82	83	83	82	84	84	85
Fuel lbs/hr	lb/hr	88.1	69.9	49.8	17.2	68.8	51.7	35.2	2.0
GRN WAT (grains H20/lb dry air)	grH20/Lbda	81.33	92.94	84.16	83.21	81.83	79.01	95.20	85.05
Oil temperature	oF	224	219	213	209	215	210	204	184
Exhaust Temperature	oF	849	743	634	413	1001	931	832	257
Air Inlet restriction	"H2O	14.7	13.6	10.9	6.4	6.1	4.2	3.9	0.4
Exhaust back pressure	"H2O	39.6	30.8	23.0	6.2	19.3	10.5	5.6	0.6
Exhaust flow (wet)	lb/hr	2399	2265	2020	1222	1659	1273	988	293
Fuel /Air Ratio		0.03814	0.03182	0.02525	0.01429	0.04327	0.04231	0.03695	0.00691
J conversion		0.91078	0.92005	0.93426	0.95496	0.90108	0.9035	0.90995	0.96837
Gas Analysis									
O2 (DRY)	%	9.52	11.33	13.03	16.23	6.66	8.02	9.63	18.28
CO2 (DRY)	%	8.03	6.65	5.37	2.97	10.24	9.16	7.95	1.44
CO (DRY)	ppm	58	51	79	192	410	204	156	120
NOX (DRY)	ppm	707	413	285	204	993	703	689	228
NO (DRY)	ppm	693	383	249	150	990	648	672	189
NO2 (DRY)	ppm	14	30	36	54	3	55	17	39
N2O (DRY)	ppm	1	1	1	1	2	1	1	1
SO2 (DRY)	ppm	18	15	12	6	18	19	16	4
O2 (WET)	%	8.67	10.42	12.18	15.50	6.00	7.25	8.76	17.70
CO2 (WET)	%	7.31	6.12	5.01	2.84	9.22	8.28	7.23	1.40
CO (WET)	%	0.0053	0.0047	0.0074	0.0183	0.0369	0.0184	0.0142	0.0116
NO2 (WET)	ppm	13	28	34	51	3	49	15	38
NO (WET)	ppm	631	352	233	143	892	586	611	183
N2O (WET)	ppm	1	1	1	1	2	1	1	1
SO2 (WET)	ppm	16	14	12	5	16	17	15	4
HC (WET)	ppm	14	30	89	169	10	32	51	195

G		0.00088	0.00161	0.00237	0.00364	0.00028	0.00039	0.00101	0.0045
R		-0.00212	-0.0024	-0.0027	-0.0032	-0.0019	-0.00194	-0.0022	-0.0035
HUM&TEM CORR FACTOR		0.98795	0.95926	0.97942	0.98105	0.98722	0.99376	0.9615	0.98211
NO CORR	ppm	638	367	237	146	904	589	636	186
NO2 CORR	ppm	13	29	35	52	3	50	16	38
N2O CORR	ppm	1	1	1	1	2	1	1	1
Emission Rate									
CO2	gr/hr	120851.1	95479.9	69773.7	23912.2	105429.6	72618.4	49233.1	2819.7
CO	gr/hr	55.7	46.4	65.2	97.9	268.2	102.8	61.3	14.9
NO2	gr/hr	22.5	47.6	50.3	46.1	3.7	45.5	11.2	8.1
NO	gr/hr	719.8	391.0	225.4	83.8	704.6	352.7	295.3	25.6
N2O	gr/hr	1.8	1.7	1.7	1.1	1.7	1.0	0.9	0.2
SO2	gr/hr	39.1	32.0	23.3	6.6	26.3	22.1	14.7	1.2
HC	gr/hr	7.4	14.9	38.9	45.0	3.5	8.9	11.0	12.4
PART 7, SUBPART E CATEGORY B									
NO CFM	25 ppm	13353	7254	4181	1555	13071	6542	5478	475
NO2 CFM	5 ppm	1359	2878	3045	2789	221	2752	680	488
CO2 CFM	5000 ppm	7614	6015	4396	1506	6642	4575	3102	178
CO CFM	50 ppm	553	461	648	973	2666	1021	609	148
NOX ppm - wet EURO, EPA, ISO		644	380	266	195	895	635	627	220
NOX ppm(corr) EURO,EPA,ISO		651	397	272	198	907	639	652	224
NOX GR/HR EURO, EPA, ISO		1125	647	396	175	1083	586	464	47
NOX cfm EURO, EPA, ISO		13613	7823	4786	2112	13104	7086	5609	572
PF (sample mass)		0.00171	0.00106	0.00122	0.00126	0.00323	0.00172	0.00179	0.00115
Pfcorr (correction factor)		0.988	0.967	0.983	0.985	0.987	0.992	0.963	0.981
Pfcorr	gr	0.00169	0.00103	0.00120	0.00124	0.00319	0.00171	0.00172	0.00113
M sample	kg	0.11981	0.11825	0.11814	0.11979	0.11982	0.11979	0.11982	0.23955
PT (DPM)	gr/hr	15.3	8.9	9.3	5.7	20.0	8.2	6.4	0.6
PT weighted	gr/hri	2.3	1.3	1.4	0.6	2.0	0.8	0.6	0.1
PARTICULATE INDEX (weighted	CFM	1355	786	821	338	1179	484	379	55
PARTICULATE INDEX	CFM	5397							

Southwest Research Institute
MWM-Deutz 916-6 8-Mode Test Results

Mode No.	% speed	% torque	Speed rpm	Torque ft-lb	Power hp	Weighting Factor
1	rated	100	2300	206	90	15 %
2	rated	75	2300	155	68	15 %
3	rated	50	2300	103	45	15 %
4	rated	10	2300	21	9	10 %
5	int.	100	1500	232	66	10 %
6	int.	75	1500	174	50	10 %
7	int.	50	1500	116	33	10 %
8	idle	0	650	0	0	15 %

ISO 8178 Mode No.	Engine Out HC g/hp-hr	DST Out HC g/hp-hr	HC % Red	Engine Out CO g/hp-hr	DST Out CO g/hp-hr	CO % Red	Engine Out NOx g/hp-hr	DST Out NOx g/hp-hr	NOx % Red	Engine Out PM g/hp-hr	DST Out PM g/hp-hr	PM % Red
1	0.062	0.013	79%	0.836	0.075	91%	2.90	2.93	-1%	0.528	0.021	96.0%
2	0.121	0.023	81%	0.724	0.081	89%	4.42	4.20	5%	0.387	0.018	95.4%
3	0.338	0.082	76%	1.253	0.153	88%	6.04	5.73	5%	0.677	0.018	97.3%
4	0.637	0.444	30%	3.622	3.761	-4%	13.66	13.93	-2%	2.123	0.019	99.1%
5	0.080	0.011	86%	1.074	0.096	91%	2.39	2.37	1%	0.974	0.008	99.2%
6	0.106	0.005	96%	0.590	0.106	82%	3.86	3.66	5%	0.438	0.024	94.4%
7	0.168	0.030	82%	0.800	0.171	79%	5.57	5.09	9%	0.614	0.024	96.1%
8 (g/hr)	0.750	0.080	89%	8.900	8.500	4%.	20.10	20.20	-0%	4.956	0.504	89.8%
8-mode	0.14	0.030	79%	0.96	0.200	79%	4.19	4.050	3%	0.635	0.020	96.9%

DRY SYSTEMS TECHNOLOGIES, GP
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15 July 1999

Pennsylvania DEP Bureau of Deep Mine Safety
Gene Davis, Member of the TAC Committee
Bob DuBreque, Member of the TAC Committee

Subject: RESEARCH REPORT

Attached is a report that details the results from an emission test series conducted at the Emissions laboratory of Southwest Research Institute in San Antonio. The purpose of this test series was to determine the filtration efficiency of a Model M38 DST Management System attached to a MWM D916-6 Diesel Engine. Specifically, these tests were conducted to demonstrate that the DST Management System meets all parts of the Pennsylvania Part II-A Diesel Regulations.

Two series of ISO 8178-1 eight mode emissions tests were conducted:

- Diesel Engine untreated emissions at the outlet of the exhaust manifold
- DST system aftertreated emissions at the outlet of the filter housing

The MWM Diesel engine was calibrated to the MSHA published fuel injection rate of 40 lbs/hr ±1.2 lbs/hr and the rated engine speed of 2300 rpm. The engine was fitted with a Model M38 MSHA approved DST Management System aftertreatment device that consists of a water-cooled catalyst, water-cooled bellows, a tube-and-shell heat exchanger, a flame arrestor, a Type M30 PAAS DPM paper filter and two water-cooled elbows. The coolant flow through the two water-cooled elbows and the water-cooled catalyst was blocked to simulate the operating conditions of the Outby DST Systems used in Pennsylvania, where these components not water-cooled. The inlet temperature into the heat exchanger changed from 680 to 711 when the water flow is blocked. All individual tests were conducted under strict control of all test protocols according to the requirements of EPA 40 CFR, Part 89.

THE OVERALL (ISO 8178-1 COMPOSITE) DPM REDUCTION BY ACHIEVED BY THE DST MANAGEMENT SYSTEM WAS MEASURED AT 96.9%. This DPM reduction meets and exceeds the requirements of Article II-A in the Pennsylvania Diesel Regulations for 95% or greater DPM reduction by aftertreatment.

The MSHA approved MWM D916-6 diesel engine has a published Part 32 ventilation rate of 8,100 cfm (229.4 m3/min). The Part 7 particulate index (1 mg/m3) is 11,500 cfm (325.6 m3/min) The DPM production (eight-mode composite) based on MSHA published data is 0.3256 gr/min.

AT MEASURED AFTERTREATMENT EFFICIENCY OF 96.9%, THE CALCULATED AMBIENT DPM IS 0.088 MG/M3 WITH 50% OF PART 32 VENTILATION. This meets and exceeds the requirement of Article II-A in the Pennsylvania Diesel Regulations for a calculated ambient exposure of 0,12 mg/m3 or less.

Please contact Norbert Paas, Managing Partner of Dry Systems Technologies at above numbers, if there are further questions about the attached SwRI report.

Sincerely

Norbert Paas
Managing Partner
Dry Systems Technologies
W98/DST/M99/SWRI TESTING/TAC REPORT

SOUTHWEST RESEARCH INSTITUTE

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July 15, 1999

TO: Paas Technologies, Inc.
1843 Choke Cherry Drive
Louisville, CO 80027-2443

ATTN: Mr. Norbert Paas

SUBJECT: DST Model M38 Diesel Power Package PM Efficiency Results

This letter summarizes the results of exhaust emission tests performed by SwRI for Paas Technologies under SwRI Project 08-2646. The objective of the project was to determine the exhaust PM filter efficiency of a DST Model M38 Diesel Power Package.

A 94 hp MWM D916-6 test engine equipped with a DST Model "M38 Diesel Power Package" was supplied by Paas Technologies, Inc. EPA nonroad diesel engine test procedures, identified in Title 40, Part 89 of the U.S. Code of Federal Regulations were used to quantify particulate emissions. This procedure is commonly referred to as an "8-mode test," and also meets the requirements of ISO 8178-1. For all tests, the engine was operated on emissions certification grade ASTM No. 2-D diesel fuel meeting EPA specifications, which are identical to those required by MSHA. SwRI followed calibration protocols required by EPA in Part 89. PM emissions were determined for each mode of operation using full-flow dilution sampling techniques meeting the requirements of EPA.

Based on the particulate measurements, the DST system demonstrated a 96.9 percent reduction in composite 8-mode PM emissions.

If you have questions, feel free to contact Steven G. Fritz at 210-522-3645. Our fax is 210-522-3950.

Prepared by:

Steven G. Fritz

Steven G. Fritz, P.E.
Senior Research Engineer
Department of Emissions Research

Submitted by:

Terry Ullman for

Charles T. Hare
Director
Department of Emissions Research
Automotive Products and
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Technology for a safer and cleaner mining environment

TESTS TO ESTABLISH AMBIENT DPM EXPOSURE LEVELS

30 January 2001

COMMONWEALTH OF PENNSYLVANIA
BUREAU OF DEEP MINE SAFETY
100 New Salem Road
Room 167
UNIONTOWN, PA 15401

>>>DRAFT<<<

Phone: 724-439-7469

Gentlemen

Dry Systems Technologies® had performed a series of test to establish the ambient exposure levels for DPM from the DST Management System™ Diesel Power Packages used in Pennsylvania. To date, the following systems are in use, or are ready to be placed into service:

- Model M85 — Attached to a 150 HP Caterpillar 3306 diesel engine (96.0% reduction needed)*
- Model M105 — Attached to a 94 HP MWM D-916-6 diesel engine
- Model M115 — Attached to a 100 HP Caterpillar 3304 diesel engine (96.0% reduction needed)*
- Model M141 — Attached to a 57 HP Isuzu C240 diesel engine (94.4% reduction needed)*
- Model M150 — Attached to a 110 HP Isuzu 6BG1 diesel engine (95.6% reduction needed)*

* Not in service

We performed a number of efficiency tests in two laboratories and on two engine models as follows:

Laboratory	Engine Make and Model	Engine-Out DPM	DST-Out DPM	% Reduction	Test Method
WVU Morgantown	88 Hp MWM D916-6			98.39%	ISO 8187
WVU Morgantown	88 Hp MWM D916-6			98.90%	BoM Transient "Mining Cycle"
SwRI San Antonio	94 Hp MWM D916-6	0.635	0.020	96.86%	ISO 8187
SwRI San Antonio	94 Hp MWM D916-6	0.855	0.014	98.36%	Transient "Mining Cycle
SwRI San Antonio	94 Hp MWM D916-6	0.877	0.015	98.29%	Transient "EPA Off-Highway Cycle
SwRI *** San Antonio	110 Hp Isuzu 6BG1	18.91 g/hr	1.24 g/hr	93.44%	ISO 8187
SwRI San Antonio	110 Hp Isuzu 6BG1			>99%	Particle Mass & Sizing Method
Average of the 3 ISO Tests				96.28%	
Average of transient tests				98.52%	
Average of all tests				97.71%	

*** This test had tunnel problems and resulted in the measurement of added ambient DPM. The test will be re-run next week and is expected to be in the 97% range.

The average reduction from three tests (including the test at SwRI we will re-run) is 96.23%, which is more than the minimum needed to meet the 0.12 mg/m3 ambient exposure limit with MSHA gaseous ventilation air.

PAAS TECHNOLOGIES, INC

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Technology for a safer and cleaner mining environment

Technical Advisory Committee
COMMONWEALTH OF PENNSYLVANIA
BUREAU OF DEEP MINE SAFETY
100 New Salem Road
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UNIONTOWN, PA 15401

Phone: 724-439-7469

Gentlemen

Dry Systems Technologies® has performed a series of test to establish the ambient exposure levels for DPM from the DST Management System™ Diesel Power Packages used in Pennsylvania at two different laboratories using two different engine models. In addition, we applied transient test cycles and also highly sophisticated DPM sizing technology to supplement the ISO test results. These test resulted in the following average DPM reductions by the DST Management System:

Laboratory	Engine Make and Model	Engine-Out DPM	DST-Out DPM	% Reduction	Test Method
WVU Morgantown	**88 Hp MWM D916-6**			**98.39%**	**ISO 8187**
WVU Morgantown	88 Hp MWM D916-6			98.90%	BoM Transient "Mining Cycle"
SwRI San Antonio	**94 Hp MWM D916-6**	**0.635**	**0.020**	**96.86%**	**ISO 8187**
SwRI San Antonio	94 Hp MWM D916-6	0.855	0.014	98.36%	Transient "Mining Cycle
SwRI San Antonio	94 Hp MWM D916-6	0.877	0.015	98.29%	Transient "EPA Off-Highway Cycle
SwRI San Antonio	**110 Hp Isuzu 6BG1**	**18.91 g/hr**	**1.24 g/hr**	**93.44%**	**ISO 8187**
SwRI San Antonio	110 Hp Isuzu 6BG1			>99%	Particle Mass & Sizing Method
Average of the 3 ISO Tests				96.23	
Average of transient tests				98.52	
Average of all tests				97.71	

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Technology for a safer and cleaner mining environment

29 January 2001

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Phone: 724-439-7469

Gentlemen

Dry Systems Technologies® had performed a series of test to establish the ambient exposure levels for DPM from the DST Management System™ Diesel Power Packages used in Pennsylvania at two different laboratories using two different engine models. The purpose of these tests was to demonstrate that a 0.12 mg/m3 ambient exposure level, or less can be achieved with the DST Management System™.

The engine, a MSHA Part 7E-A (Outby Approval 7E-B 059-0) approved 129 Hp Isuzu 6BG1 diesel engine has the following MSHA published emissions criteria:

Laboratory	Engine Make and Model	Engine-Out DPM	Particulate Index	Gaseous Ventilation	Test Method
MSHA approval test data	**129 Hp Isuzu 6BG1-MA**	**27.2 g/hr**	**16,000 cfm**	**6,000 cfm**	**ISO 8187**

The same engine model was derated from 129 Hp to 110 Hp as a first step to lower the engine-out DPM concentrations to achieve lower ambient exposure as follows:

Laboratory	Engine Make and Model	Engine-Out DPM	Particulate Index	% Reduction	Test Method
SwRI San Antonio	**110 Hp Isuzu 6BG1-MA**	**18.9 g/hr**	**11,500 cfm**	**30.5%**	**ISO 8187**

The same engine was fitted with a DST Management System as a second step to lower the ambient DPM exposure as follows:

Laboratory	Engine Make and Model	DST-Out DPM	Particulate Index	% Reduction	Calculated ambient exposure	Test Method
SwRI San Antonio	**110 Hp Isuzu 6BG1-MA**	**1.2 g/hr**	**727 cfm**	**95.6%**	**0.12 mg/m3**	**ISO 8187**