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Pennsylvania Technical Advisory Committee
On Diesel Powered Equipment

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RECEIVED
JUN 05 2007
BUREAU OF MINE SAFETY

Joseph Sbaffoni, Director
Bureau of Deep Mine Safety
Fayette County Health Center
100 New Salem Road, Room 167
Uniontown, Pa. 15401

RE: Sandvik Mining and Construction Canada Inc. request for approval of an EJC-935 Non-Permissible Scoop with a Deutz BF4M 1013 FC engine with a DCL International Inc DPM filter and diesel oxidation catalyst.

Dear Mr. Sbaffoni:

Article II-A of the Pennsylvania Bituminous Coal Mine Act (the act) provides for the use of diesel-powered equipment in underground bituminous coal mines. Section 224-A of the act created a Technical Advisory Committee ("TAC") for the purpose of advising the Department regarding implementation of Article II-A.

Background

On February 28, 2007, Sandvik Mining and Construction Canada Inc. submitted a request to the Bureau of Deep Mine Safety (BDMS") for evaluation and approval pursuant to Article II-A of the act of a Deutz BF4M1013 FC 157HP engine (MSHA Approval No. 07-ENA040007) with a DCL International Inc DPM filter and diesel oxidation catalyst system in a EJC-935 Non-Permissible Scoop. Additionally, Sandvik requested an alternative test procedure for the five minute carbon monoxide (CO) tests required under Sections 217-A and 218-A of the act. On March 9, 2007, the Director of BDMS requested the TAC to evaluate the diesel power package and to advise the Department regarding the TAC's recommendation as to whether the diesel power package meets the requirements of the act and for the TAC's recommendation on Sandvik's request for an alternate test procedure for CO testing. The TAC began its investigation on March 22, 2007 when the equipment became available for testing.

The diesel power package now includes the following items:

- Deutz BF4M 1013 FC 157HP@2200 rpm turbo charged diesel engine (MSHA Certification No. 07-ENA040007

JAS
WBB
ALM
SFG
THC File
MMC

- Emissions Control System – DCL International Inc DPM Filter
  - Cordierite Substrate (85% efficiency) W/ Basemetal Washcoat
- DCL International Inc Diesel Oxidation Catalyst
- NETT Technologies, Inc Model OF-10034-MN-00000-00000 flame arrestors

More detailed information on the specifications of the diesel power package is included on the General Specification Sheet which is attached as Attachment 1-1 through 1-3.

Investigation

On March 22, 2007, the TAC and DEP representatives traveled to the Sandvik facilities to inspect the rubber tired tractor. The inspection on March 22, 2007 of the scoop resulted in several concerns from both the TAC and DEP which needed to be addressed.

1. The filter was not 95% efficient
2. There was no spark arrestor provided on the exhaust system. The cordierite filter would serve to provide that protection.
3. There were 2 blankets on the exhaust system which may possibly absorb oil.
4. The surface temperature as measured with a heat gun on several pieces of metal at the end of the exhaust exceeded 302 degrees F.
5. The exhaust gas temperature exceeded 302 degrees F. The diluter system installed at the end of the exhaust system was not performing properly. The placement of the exhaust gas temperature sensors was too far from the exhaust to properly detect the high exhaust gas temperature.

A meeting was held with Sandvik after the inspection and a new date to inspect the scoop would be set after Sandvik addressed these issues.

The TAC and DEP traveled to the Sandvik facilities on April 2, 2007 to conduct the emissions testing and review the changes made by Sandvik addressing the previous concerns.

1. The 2 blankets on the exhaust system were changed to Fire Wrap Blankets which would not absorb oil.
2. The diluter system was removed at the end of the exhaust system and replaced with an enclosure to reduce the surface temperature of the exhaust pipe to below 302 degrees F.

The inspection of the scoop showed that the exhaust gas temperature was still above 302 degrees F as well as the surface temperature of the metal grating at the end of the exhaust. The surface temperature on the new enclosure was measured with a heat gun at 180 degrees F which corrected the problem in that particular area. The position of the exhaust gas sensors was still such that it did not detect the high exhaust gas temperature.

No further tests were conducted and after a meeting with Sandvik another date was set for inspection after Sandvik addressed these issues.

The TAC and DEP returned to Sandvik on April 9, 2007 to conduct the emissions testing and inspection of the EJC-935 Scoop and review the changes made by Sandvik to the exhaust system addressing the previous concerns. The changes made by Sandvik to the configuration of the exhaust system to address the concerns of the high exhaust gas and surface temperatures

were evaluated. Although the temperatures were now within the acceptable limits, the configuration of the exhaust system presented additional concerns. Since the Cordierite filter was also going to act as the flame arrestor, it needed to comply with all requirements of a flame arrestor as well as the filter. The length of the exhaust system and the number of bends in it beyond the filter/flame arrestor did not comply with a BMS Directive on Diesel Powered Equipment Flame Arrestors dated August 17, 2004 addressing the length of the exhaust pipes and number of bends beyond the flame arrestor and requiring all future approved systems to meet the requirements as stated in the directive. The requirements were discussed with Sandvik and they agreed to make changes to the exhaust system once again to comply with this BMS requirement. Another inspection date would be scheduled after the changes were made.

The TAC and DEP traveled to Sandvik on May 21, 2007 after changes were made to the exhaust system to conduct emissions tests and inspection and evaluate the need for the 90 second stall test.

Previous TAC and DEP concerns were addressed.

1. Sandvik had decided to install NETT Technologies, Inc. Model OF-10034-MN-00000-00000 Flame Arrestors on all branches of the exhaust system, thus eliminating the need to use the Cordierite filter to also act as the flame arrestor. The location of these flame arrestors met the requirements of the BMS directive dated August 17, 2004 for installation of flame arrestors.
2. The location of the exhaust gas temperature sensor was changed to effectively measure the exhaust gas temperature as it entered the environment.
3. Also surface and exhaust gas temperature readings were observed with the highest surface temperatures noted at 265 degrees F and exhaust gas temperature at 250 degrees F, both below the 302 degrees F requirement of Section 203-A (b)(4) of Article II-A
4. The MINE-X Catalyzed Sootfilter Cordierite filter with basemetal catalyst is rated at 85% efficient. Although this does not meet the requirement of 95% efficient, the increased MSHA faceplate ventilation rate of 6,500 CFM as shown in the calculations in Attachment 1 must be complied with at all times so that NO2 compliance is maintained.

The engine and filter extrapolations (Attachment 1-4 through 1-12) show that the diesel power package will result in an average ambient concentration of .066 mg/m^3 of diesel particulate matter when diluted by 100% of the MSHA approval plate ventilation rate for this engine, which is well below the .12 mg/m^3 requirement of Section 203-A (a) (1) Article II-A.

Emission testing was conducted on the tractor and the results are shown in Attachment 2-1 through 2-3. The results of the emission tests showed the engine was performing within MSHA's approval specifications. Both the 5 minute test required under Sections 217-A and 218-A and the alternate 90 second emission test were conducted. Test results of both the 5 minute test and the 90 second alternate test confirm comparable results.

During the 5 minute CO test, water was used to cool the transmission during testing to eliminate overheating and avoid damage to the transmission. Although the diesel powered package can withstand the 5 minute emissions tests as described in Sections 217-A and 218-A of Article II-A, we recommend approval of the attached Alternative Stall Test Procedure (Attachment 3).

In addition to the testing that was conducted, our investigation and our observations confirmed that the diesel power package is capable of meeting all the requirements of Section 203-A of Article II-A of the act without reducing or compromising the level of health or safety afforded by the act .

Dana Mining Co. has requested approval of this piece of equipment prior to the next regular scheduled TAC meeting on July 11, 2007. The need for this approval should be evaluated by the Bureau of Mine Safety. The extended period of time required to make the necessary changes to the scoop for the TAC and DEP evaluation should be considered. Although the TAC's official recommendation for approval must occur at the regular TAC meeting, the TAC will recommend preliminary approval of this Sandvik EJC-935 scoop to the Director based upon his decision of need and upon the condition that all stipulations in this recommendation are complied with.

Recommendation

Our recommendation is based upon the data supplied by Sandvik, the results of the tests conducted on May 21, 2007, as well as the data acquired and observations made during our investigation. The TAC has determined that the Deutz BF4M 1013 FC 157HP engine (MSHA Approval No. 07-ENA040007) with a DCL International Inc. DPM Filter and Oxidation Catalyst System with NETT Technologies Model OF-10034-MN-00000-00000 flame arrestors for use in a Sandvik EJC-935 scoop satisfies the requirements of Section 203-A of Article II-A of the Pennsylvania Bituminous Coal Mine Act. As such, we are recommending approval of the above described diesel power package with the following stipulations:

- This recommendation is provided with the understanding that the General Specification Sheet (Attachment 1) be strictly adhered to.
- A smoke dot test will be preformed during each 100 hr. maintenance interval and the results recorded in the 100 hour records. If at any time the result of the smoke dot test is greater than 3, the DEP and TAC must be notified prior to placing the piece of equipment back in service.

As discussed above, we are also recommending approval of an alternate test procedure for Sections 217-A and 218-A of the Act.

These official recommendations to the director will be included in the agenda for the next TAC Meeting on July 11, 2007. Although the TAC's official recommendation for approval must occur at the regular TAC meeting, the TAC will recommend preliminary approval of this Sandvik EJC-935 scoop to the Director based upon his decision of need and upon the condition that all stipulations in this recommendation are complied with.

Paul Borchick

Ron Bowersox

Diesel Engine and System Information:

This section contains the following information:

- General Specification Sheet
- MSHA Approval Test Results (ISO 8178-1)
- OEM Spec Sheet
- MSHA Lug Curve
- DPM Extrapolation of emission control system
- Filter efficiency verification from MSHA
- Alternate Stall Test

General Specification Sheet

I. Engine

Manufacturer	**Deutz**	**High Idle (RPM)**	**2500**
Manufacturer Address	**3883 Steve Reynolds Blvd. Norcross, Ga. 30093**	**Particulate Index (PI)**	**3000 cfm**
Model Number	**BF 4M 1013 FC**	**Gaseous Ventilation Rate (CFM)**	**6500 cfm**
Serial Number	**TBD**	**Raw DPM (gr/hp)**	**4.88 g/hr**
Horse Power	**157@ 2200 rpm**	**MSHA 7E Approval Number**	**07-ENA0400007**
Clean Intake Air Restriction (H^2O)	**12" wg**	**Type of Aspiration**	**Turbo**
Max. Allowed Backpressure H^2O	**30" wg**	**Fuel Delivery System**	**Mechanical Injection**
Turbocharger Boost Pressure	**21.8 PSI**	**Low Idle (RPM)**	**650**

II. Filter System

Manufacturer	**DCL International Inc**
Manufacturer Address	**P.O Box 90 Concord, Ontario Canada L4K 1B2**
Model Number	**4010-SA-5U55-X1**
System Type	**Non-disposable Ceramic**
System Composition	**cordierite**
Efficiency Rating	**85%**
Type of Regeneration	**Base Metal washcoat**

III. Catalyst

Manufacturer	**DCL International Inc**
Manufacturer Address	**P.O Box 90 Concord, Ontario Canada L4K 1B2**
System Name	**MINE-X® Custom Add-On Size 10 Catalytic Purifier**
Model Number	**4009-ID-1R10-21**

C1- Test

Motorhersteller:	Deutz AG	Datum:	29.07.2004
Motortyp:	BF 4M 1013 FC	Ort:	Köln - Porz
Ausführung:	Code CE117		
Motorprüfstand:	D11		
Ingenieur:	Horstmann		
Prüfstandsfahrer:	Kossmann		
Test-Nr.:	1_0218		

Certification for MSHA, calculation of ventilation rates

Gross power

Engine type:	BF 4M 1013 FC	117,00 kW at	2200 1/min	Eng.No: 981 360	Date: 29.07.2004
Engine Code:	Code CE117				

Fuel Data:	m.% C: 86,200	m.% H: 13,300	m.% S: 0,150	m% O: 0,000
Stoich Air Demand, kg/kg fuel:	14,4862		Densitiy, kg/dm^3 at 15 °C:	0,8428

Mode			1	2	3	4	5	6	7	8
Speed	n	1/min	2200,0	2200,0	2200,0	2200,0	1500,0	1500,0	1500,0	700,0
Torque		%	100,0	75,0	50,0	10,0	100,0	75,0	50,0	0,0
Torque calculated		Nm	507,8	380,9	253,9	50,8	604,0	453,0	302,0	0,0
Torque observed		Nm	517,3	387,5	258,4	48,3	615,4	461,2	307,5	4,9
Fuel mass flow	B	kg/h	26,7904	20,07	13,95	5,13	20,57	15,34	10,45	0,86
Water content of intake air	ha	g/kg	8,44	8,23	8,06	8,02	7,93	8,15	7,97	8,18
Air mass flow, dry	GAIRD	kg/h	692,439	585,364	467,901	319,554	413,036	339,275	276,991	97,204
Air mass flow, wet	GAIRW	kg/h	698,3	590,2	471,7	322,1	416,3	342,0	279,2	98,0
Temp air intake		°C	26,2	26,3	26,2	26,3	26,8	26,9	26,7	27,0
Exhaust mass flow, wet	GEXH	kg/h	725,1	610,3	485,6	327,3	436,9	357,4	289,6	98,9
Fuel to air ratio	f/a	kg/kg	0,03869	0,03429	0,02982	0,01606	0,04980	0,04521	0,03772	0,00884
Dry to wet correction factor	J		0,9147	0,9232	0,9318	0,9576	0,8947	0,9029	0,9172	0,9709
Humidity correction factor NOx	FHUM		0,966	0,959	0,952	0,938	0,971	0,968	0,958	0,929
HC, wet	HC	ppmC1	178,1	185,6	112,8	267,2	49,1	85,4	121,6	181,2
CO, dry	CO	ppm	89,7	69,6	75,9	487,0	136,7	102,3	80,2	89,0
CO2, dry	CO2	%	7,97	7,11	6,14	2,98	10,49	9,47	7,76	1,69
NOx, dry	NOx	ppm	540,5	506,7	448,6	244,4	826,3	812,6	744,3	179,9
NO2, dry	NO2	ppm	15,5	17,7	14,4	8,7	18,5	32,6	32,0	3,6
NO, dry	NO	ppm	525,0	489,0	434,2	235,7	807,8	780,0	712,3	176,3
NO2 corrected	NO2-K	ppm	13,7	15,7	12,8	7,8	16,1	28,5	28,1	3,2
NO, corrected	NO-k	ppm	463,9	432,9	385,3	211,7	701,9	682,1	625,9	159,1
CO, corrected	CO-k	ppm	82,0	64,3	70,7	466,4	122,3	92,4	73,6	86,4
CO2, corrected	CO2-k	Vol-%	7,29	6,56	5,72	2,85	9,38	8,55	7,12	1,64
NO2 emission	mNO2	g/h	15,8	15,2	9,9	4,1	11,1	16,2	12,9	0,5
NO emission	mNO	g/h	348,6	273,7	193,9	71,8	317,7	252,6	187,8	16,3
CO emission	mCO	g/h	57,4	37,9	33,2	147,4	51,6	31,9	20,6	8,2
CO2 emission	mCO2	g/h	80287	60845	42204	14185	62279	46417	31314	2464
Ventilation rate, NO based	cfm NO	cfm	6466	5078	3597	1332	5894	4685	3485	302
Ventilation rate, NO2 based	cfm NO2	cfm	954	918	596	246	674	978	782	31
Ventilation rate, CO based	cfm CO	cfm	571	376	330	1465	513	317	204	82
Ventilation rate, CO2 based	cfm CO2	cfm	5077	3848	2669	897	3939	2935	1980	156

Ventilation rate, maximum	cfm	6466
	cfm, rounded	6500
	cfm/HP	41

CO emission in C1-Test:	0,72 g/kWh		
NOx emission in C1-Test:	5,21 g/kWh		
HC emission in C1-Test:	0,49 g/kWh		
Particulate emission in C1-Test:	0,077 g/kWh		4,876 g/h
Particulate index:	2869 cfm		
Particulate index, rounded:	3000 cfm	19	cfm/HP

BF4M1013FC Specification data Tier II

General

Cylinders	4	
Cyl. arrangement	In line	
Bore	108 mm	4.3 in.
Stroke	130 mm	5.1 in.
Cylinder Displacement	1.19 liter	72.7 in.^{3}
Total displacement	4.76 liter	290.7 in.^{3}
Compression ratio	17.5:1	
Combustion system	Direct injection	
Aspiration	Turbocharged / aftercooled	
	Std. turbo size III	

Fuel system

Lift pump suction head, max	1.5 m	59.1 in.
Lift pump flow @max rpm	600 l/h	2.6 GPM
Max restriction in fuel supply line	200 mbar	80 in. H_2O
Max restriction in fuel return line	500 mbar	200 in. H_2O
Max restriction in fuel pre-filter	200 mbar	80 in. H_2O
Fuel filter type	Replaceable cartridge	
Fuel consumption @ max rating	33.2 l/h	8.8 GPH
Fuel consumption @ peak torque	23.8 l/h	6.3 GPH

Combustion air system

Combustion air flow @ max rating	720 m^3/h	424 CFM
Max allowable clean restriction	50 mbar	20 in. H_2O
Max allowable dirty restriction	65 mbar	26 in. H_2O
Charge air press. @ max rating	1.5 bar	21.8 psi
Turbo outlet temp. @ max rating	171 °C	339.8 °F
Temp. after charge air cooler	50 °C	122.0 °F
Temp. after charge air cooler - Genset	40 °C	104.0 °F
Delta T Across CAC (Industrial)	100 mbar	40 in. H_2O

Exhaust system

Exhaust gas flow @ max rating	1830 m^3/h	996 CFM
Exhaust temp @ max rating	510 °C	950 °F
Max allowable back pressure	75 mbar	30 in. H_2O

Cooling system

Type	External radiator	
Coolant flow rate @ max rpm	180.0 l/min	47.6 GPM
Coolant heat reject.% of gross power	50.8 %	
Max coolant temp @ engine outlet	110 °C	230 °F
Max coolant operating pressure	1.5 bar	21.8 psi
Coolant volume in engine	7.4 liter	7.8 qt.
Coolant volume, cooler & pipes, min	0.06 l/kW, 0.05 qt/hp	
Expansion tank capacity, min	30% of circ. Coolant volume	

Lubrication system

Lubrication type	Forced feed lubrication	
Oil flow at max rpm	49.7 l/min	13.1 GPM
Oil pump relief valve setting	6 bar	87 psi
Max oil temperature in oil sump	130 °C	266 °F
Filter volume	1.5 liter	1.6 qt.
Oil change interval	500 hours	

Electrical

Starter motor	12V, 3.1kW	24V, 4.8kW
Max battery CCA	1300A	750A
Max. drop, battery (+), max	1.0V	

Physical data

Length	970 mm	38.2 in.
Width	598 mm	23.5 in.
Height	990 mm	39.0 in.
Weight, dry	432 kg	950 lb.
Max bending @ housing:	800 Nm	589.6 lb-ft
Max force @ flywheel:		
Axial:	N	0 lb.
Radial:	6000 N	1351.4 lb.

Performance data

Peak torque	630 Nm	464.3 lb-ft
@ rpm	1500	
low idle speed	650 rpm	

Gross power	**Genset (LTP)**		**Variable speed**			
Engine RPM	**1500**	**1800**	**2000**	**2100**	**2200**	**2300**
kW, intermittent	106.0	122.0	117.0	120.0	123.0	125.0
Hp, intermittent	144.2	165.9	159.1	163.2	167.3	170.0
kW , continuous			101.0	103.0	105.0	106.0
Hp, continuous			137.4	140.1	142.8	144.2

Fuel consumption						
g/kWhr	207.0	210.0	217	215	221	224
lb/hphr	0.339	0.344	0.356	0.353	0.362	0.367

Combustion air						
m^3/h	447	607	640	670	690	720
CFM	263	357	377	394	406	424

Exhaust gas						
m^3/h	1150	1550	1640	1710	1760	1830
CFM	677	912	965	1006	1036	1077

Coolant						
l/min	170	205	157	164	172	180
GPM	44.9	54.2	41.5	43.3	45.4	47.6

Heat rejection to coolant						
kW	50	54.3	57.7	56.4	61.4	63.5
BTU/min	2844	3089	3282	3208	3492	3612

Heat rejection to charge air						
kW	15.5	26.1	22.2	24.9	25.4	27.4
BTU/min	882	1485	1262.7	1416	1445	1559

Noise, dB(A)

Avg. @ 1 meter

Certifications

U. S. EPA Non-road Tier 2
California ARB Non-road
European COM 2

All data refer to standard conditions of 25 C°, 1000 mbar
Data are based on max intermittent output, unless noted

DEUTZ Corporation
3883 Steve Reynolds Blvd
Norcross, GA 30093 USA

Document: BF4M1013FC_EPA2
Revision: 0
Date: 28 Feb., 2003

MSHA

Lug Curve

TORQUE CURVE TEST - ALL TESTS AT FULL THROTTLE		
MSHA # :	07-ENA040007	
Engine:	Deutz BF4M 1013FC	
Engine Rating:	173 HP @ 2300 RPM	
Engine Speed, RPM	CO, ppm	CO2, %
1000	1491	11.7
1200	238	11.26
1400	166	10.41
1600	112	9.48
1800	116	9.17
2000	123	8.88
2100	120	8.57
2300	125	8.57

* Note – The listed engine has been approved by MSHA in two horsepower configurations the above lug curve has been set on the higher horsepower version, however the listed engine will fall within the range of this lug curve.

DPM Calculation Sheet

Engine Model	Deutz BF 4M 1013 FC (157 HP@2200rpm)
MSHA Number	07-ENA0400007
Ventilation Rate	6500 cfm
Filter Type	Cordierite
Filter Efficiency	85%

Convert DPM From (grams/hr) to (mg/min)

(4.88g/hr.) X(1hr./60min)X (1000mg/g)= 81.33mg/min

Convert Ventilation Rate from cfm to m^3/min.

(6500 ft^3/min) X (.028315 m^3/ ft^3) = 184.05 m^3/min.

Divide DPM (mg/min) BY Ventilation Rate (m^3/min.)

(81.33mg/min) -:- (184.05 m^3/min.) = ..442 mg/m^3

Solve for Ambient DPM Level AT 85% Filter Efficiency

.442 m^3/min X (100-85% Filter Efficiency) = **.066 mg/ m^3**

Diesel Particulate Matter (DPM)
Control Technologies

Last updated: 12/07/05

Table I:	Paper/Synthetic Filters
Table II:	Non-Catalyzed Particulate Filters, Base Metal Particulate Filters, Specially Catalyzed Particulate Filters, and High Temperature Disposable Filters
Table III:	Catalyzed (Platinum Based) Diesel Particulate Filters

Note: These tables are not all-inclusive and only contain companies who have contacted MSHA in order to list their control technologies.

Table I: Paper/Synthetic Filters

The filters listed below have been evaluated by MSHA and are deemed to be essentially identical (under section 72.503(c)) to the standard paper filter that was previously tested by an independent laboratory for MSHA. MSHA will accept use of these filters as evidence of compliance with the applicable emission limits in sections 72.500 - *Emission limits for permissible diesel-powered equipment*, 72.501 - *Emission limits for nonpermissible heavy-duty diesel-powered equipment, generators and compressors*, or 72.502 - *Requirements for nonpermissible light-duty diesel-powered equipment other than generators and compressors* when properly installed on diesel-powered equipment.

The control device shall be installed and maintained in accordance with the filter supplier's specifications. This includes use at the supplier's specified exhaust gas temperature limit. The limits specified in this table are either 185°F or 302°F to correspond with the Part 36 temperature limits for machines using either water bath scrubbers or dry heat exchangers, respectively, to cool the exhaust gas. Where the filter supplier has not provided information to MSHA on the exhaust gas temperature limit (either 185°F or 302°F), the purchaser needs to contact the filter supplier for this information.

In choosing filters intended for use on permissible machines, contact the machine manufacturer and the filter supplier to ensure the filter is compatible with the machine and sized properly for the engine exhaust flow, temperature, and desired operating life and that the filter meets any specific MSHA approval requirements for filters used on that machine. The filter must be installed and maintained in accordance with the machine manufacturer's and the filter supplier's specifications.

In choosing filters intended for use on nonpermissible machines, the filters must be used with exhaust gas cooling systems that limit the exhaust gas temperature to either the filter supplier's specified limit or 302°F, which ever is lower. The efficiency of the filters in Table I is not accepted as meeting the emission limits in sections 72.501 or 72.502 at exhaust gas temperatures above 302°F. Refer to Table II for filters that can be used at higher exhaust gas temperatures and their DPM filtration efficiencies.

The filter tests are performed in a consistent manner on as-received filter samples. However, filter surface area/face velocity and filter life (loading time or number of allowable cleanings) are not considered even though they may affect the filter's in-use efficiency and the choice of a filter for a specific application. The filter is evaluated to ensure that there are no obvious leaks or mechanical failures during the test, the exhaust backpressure does not exceed the engine manufacturer's limit during the test, and that no hazardous off-gassing or combustion occurs at the filter's maximum

operating temperature. The test results below are preliminary and MSHA reserves the right to make additions or deletions to this list as new information becomes available.

Filter Supplier	Filter Manufacturer	Filter Model	Exhaust Temperature Limitation, °F
Atlas Copco Wagner 303-217-2823	Atlas Copco Wagner	5540051000, 5540248100, 5575074800	Contact Filter Supplier
Baron Filtration Co. 1-800-760-3105	Baron Filtration Co.	Media Spunbond	185
Champion 501-525-6867	Luber-Finer	LAF3931, LAF3931 with fire retardant	Contact Filter Supplier
DBT America, Inc 614-337-7600	DBT	516372, 518404	Contact Filter Supplier
Donaldson Corporation 1-800-374-1374	Donaldson Company, Inc.	P530866, P539366, P549541	Contact Filter Supplier
Donaldson Corporation 1-800-374-1374	Donaldson Company, Inc.	P604516, P607123, P607124	302 See Flyer
Dry Systems Technologies® (Formerly Paas Technologies) 630-427-2051	Dry Systems Technologies®	M30-090-0, M30-115-PA, M30-168-0, M30-201-CA, M30-241-PA, M30-245-PA, M30-250-0, M30-250-PA, M30-251-PA, M30-152-0, M30-265-0, M30-271-0, M30-277-0, M30-292-0, M30-411-0, M40-038-0, M40-050-0, M40-141-PA, M40-150-0, M40-272-0, M40-416-0, M50-244-0, M70-276-PA, M70-417-0	302
ENK Industrial Ed Molish 205-786-4566	ECO Environmental	ENK13-19280, ENK19-19205, ENK19-29160, ENK20-29270, ENK24-29200, ENK25-19175, ENK26-19175, ENK26-29150, ENK28-19107, ENK28-19145, ENK28-19175	302 See Flyer
Endustra Filter Manufacturers 800-521-1008	Endustra	R020001	185
Endustra Filter Manufacturers 800-521-1008	Endustra	R030042, R030072, R030137, R040957	302
Filter Service & Testing Corp. (Bunderson) 435-637-3567	Filter Service & Testing Corp. (Bunderson)	FST-115-26, FST-110-28, FST-125-26C, FST-110-22C, FST-100-20, FST-90-16	302 See Flyer
Fleetguard Attn: Brad Long (931) 372-9708	Fleetguard	AF25900	185

Filter Supplier	Filter Manufacturer	Filter Model	Exhaust Temperature Limitation, °F
Getman Corporation 269-427-5611	Getman	605803, 605803 with 605807 pre-filter, 605810, 605811	Contact Filter Supplier
Industrial Environmental Health Consultant, LTD 304-598-3465	Microfresh	DA101	Contact Filter Supplier

Table II: Non-Catalyzed Particulate Filters, Base Metal Particulate Filters, Specially Catalyzed Particulate Filters, and High Temperature Disposable Filters

Contact the filter supplier to ensure the filter is compatible with the machine and sized properly for the engine exhaust flow, temperature, and desired operating life. The filter must be installed and maintained in accordance with the filter supplier's specifications. The test results below are preliminary and MSHA reserves the right to make additions or deletions to this list as new information becomes available.

Non-Catalyzed Particulate Filters, Base Metal Particulate Filters, Specially Catalyzed Particulate Filters, and High Temperature Disposable Filters	Manufacturer	DPM Filtration Efficiency*
Non-Catalyzed Diesel Particulate Filters, Cordierite, Series FN	CleanAir Systems, Santa Fe, New Mexico 800-355-5513	85 %
Non-Catalyzed Diesel Particulate Filter, Cordierite, Part Nos. 2000EC, 1800EC, 1500EC, 1100EC, 1050EC, 1000EC, 900EC, 700EC, 500EC	Nett Technologies Toronto, Canada 800-361-6388	85%
Non-Catalyzed Diesel Particulate Filter, Silicon Carbide, Series 3000ES, 2500ES, 2000ES, 1500ES	Nett Technologies Toronto, Canada 800-361-6388	87%
Titan™ and Blue Sky™ (non-catalyzed) Sootfilter System, Silicon Carbide	DCL International Inc. Concord, Canada 800-872-1968	87%
Cattrap™ Diesel Particulate Filter (passively regenerated, base metal catalyst) Cordierite	Engine Control Systems Newmarket, Canada 800-661-9963	85%
Unikat Combifilter™ (actively regenerated), on board regeneration, Cordierite	Engine Control Systems Newmarket, Canada 800-661-9963	85%
Unikat Combifilter™ (actively regenerated), on board regeneration, Silicon Carbide	Engine Control Systems Newmarket, Canada 800-661-9963	87%
Unikat Combifilter™ (actively regenerated), off board regeneration, Cordierite	Engine Control Systems Newmarket, Canada 800-661-9963	85%
Diesel Particulate Filter (noncatalyzed with fuel additive), Cordierite, Model Numbers. SXS-B, SXS-B/F A, and SXS-E	Catalytic Exhaust Products, LTD 800-551-5525	85%

Non-Catalyzed Particulate Filters, Base Metal Particulate Filters, Specially Catalyzed Particulate Filters, and High Temperature Disposable Filters	Manufacturer	DPM Filtration Efficiency*
PERMIT™ FBC Filter System (specially catalyzed with fuel borne catalyst), Cordierite	CleanAir Systems, Santa Fe, New Mexico 800-355-5513	85%
High Temperature Disposable Exhaust Filter Part Number P604516	Donaldson Company, Inc. 1-800-374-1374	83% max. temp. 650°F See Flyer
Filter Service & Testing Corp. (Bunderson) 435-637-3567 FST-115-26, FST-110-28, FST-125-26C, FST-110-22C, FST-100-20, FST-90-16	Filter Service & Testing Corp. (Bunderson)	80%, max. temp. 650°F See Flyer
PERMIT™ FBC Filter System (specially catalyzed with fuel borne catalyst), Cordierite Installed on a Deutz-MWM Model 916 Diesel Engine	CleanAir Systems, Santa Fe, New Mexico 800-355-5513	87%

*Manufacturer's laboratory based efficiency (Not determined under in-mine test)

Table III: Catalyzed (Platinum Based) Diesel Particulate Filters

Caution: MSHA has identified the platinum based catalyzed particulate filters in listed in Table III as a source for generation of increased concentrations of Nitrogen Dioxide (NO_2) in the mine atmosphere. Actual in-mine NO_2 concentrations will be dependent on the mine's ventilation system. Refer to MSHA's Program Information Bulletin No. P02-4 (http://www.msha.gov/regs/complian/PIB/2002/pib02-04.htm) for additional information.

For coal mine operators, MSHA's Program Information Bulletin No. P02- 7 (http://www.msha.gov/regs/complian/PIB/2002/pib02-07.htm) details the steps that must be taken to ensure that platinum based catalyzed filters installed prior to July 16, 2002 do not increase in-mine NO_2 concentrations. After July 16, 2002, coal mine operators should not install filters listed in Table III.

Contact the filter supplier to ensure the filter is compatible with the machine and sized properly for the engine exhaust flow, temperature, and desired operating life. The filter must be installed and maintained in accordance with the filter supplier's specifications. The test results below are preliminary and MSHA reserves the right to make additions or deletions to this list as new information becomes available.

Catalyzed (Platinum Based) Diesel Particulate Filters	Manufacturer	DPM Filtration Efficiency*
Catalyzed Diesel Particulate Filters, Cordierite, FC, FD	CleanAir Systems, Santa Fe, New Mexico 800-355-5513	85 %
DPX™ and DPX II™ Catalyzed Soot Filter System, Cordierite	Engelhard, Iselin, New Jersey 800-523-3599	85 %
Catalyzed Diesel Particulate Filter, Cordierite, Part Nos. 2000SF/SE, 1800SF/SE, 1500SF/SE, 1100SF/SE, 1050SF/SE, 1000SF/SE/, 900SF/SE, 700SF/SE, 500SF/SE	Nett Technologies Toronto, Canada 800-361-6388	85%
Catalyzed Diesel Particulate Filter, Silicon Carbide, Series 3000SC/SS, 2500SC/SS, 2000SC/SS, 1500SC/SS	Nett Technologies Toronto, Canada 800-361-6388	87%
Titan™ and BlueSky™ Sootfilter System, Silicon Carbide	DCL International Inc. Concord, Canada 800-872-1968	87%
MINE-X® Catalyzed Sootfilter, Cordierite WITH BASE METAL CATALYST	DCL International Inc. Concord, Canada 800-872-1968	85%
Purifilter™ (passively regenerated), Silicon Carbide	Engine Control Systems Newmarket, Canada 800-661-9963	87%
Catalyzed Diesel Particulate Filter, Cordierite, Model Numbers. SXS-CX and SXS-C	Catalytic Exhaust Products, LTD 800-551-5525	85%

*Manufacturer's laboratory based efficiency (Not determined under in-mine test)