MNM DPF Selection Guide Actions

Actions or Tasks Addressing Implementation Management

"Mention of any company name or product does not constitute endorsement MSHA."

I do not know whether there is a site champion for DPF selection, installation and maintenance at this mine or in my company.
The Compliance Assistant suggests that you ask your supervisor or other management personnel if there is a person who has been designated to coordinate the implementation of DPFs at your mine. If no one has been selected, then check here for an explanation why it is a good practice to have a site champion.
[CLOSE]

You have indicated that there is no designated site champion for DPFs at your mine.
Read the reason it is important to have a site champion for implementation of diesel particulate filter technology. Then discuss with your management the need for them to consider selecting a person to oversee and coordinate the selection and installation of DPFs at the mine by assembling a team with key personnel from ventilation, industrial hygiene, engine maintenance, vehicle maintenance, production, and operators.

[CLOSE]

Actions or Tasks on the Engine

I do not know whether the engine is a 2- or 4-stroke engine.
Try the following to determine the stroke of the engine:

- Ask the maintenance department or mechanic,
  or
- Get the engine make and model and call
  - MSHA
  - Engine manufacturer, supplier, or rebuild shop

[CLOSE]

Yes, the engine is a 2-stroke engine.
The exhaust from 2-stroke engines contains lubrication (crankcase) oil and generally emits PM at high rates compared to modern 4-stroke engines. Both of these characteristics adversely affect the selection and operating characteristics of a DPF. For active regenerating DPF systems, the size/capacity of the DPF will be larger than a DPF for an equivalent 4-stroke engine. Additionally, the lubrication oil contains metals which is the dominant source of ash that accumulates in the DPF. Because the ash cannot be burned off by simple thermal regeneration and because of the large oil component in the exhaust of a 2-stroke engine, the ash builds up more quickly than with 4-stroke engines. A DPF on a 2-stroke will require more frequent cleaning to remove the ash than if it were on a 4-stroke engine.
Because of these effects on the DPF, and because the 2-stroke engine is an older technology, the Compliance Assistant urges you to consider replacing the 2-stroke engine with a modern (electronically controlled) 4-stroke engine of equivalent power, or retire the vehicle from service.

[CLOSE]

Yes, the engine is burning oil.
When the target engine burns oil, you need to correct this problem.

- Make repairs to the engine (e.g., replace the rings, rebuild the engine) and confirm that the engine no longer consumes oil;
  or

- Replace the engine with a rebuilt engine and confirm that this engine does not consume oil; or
- Replace the engine with a new engine, preferably a newer technology engine that has lower PM emissions. The MSHA M/NM rule has specific requirements on introducing engines to your underground mine, §57.5067. Contact your equipment manufacturer for a list of MSHA or EPA certified engines that will fit your equipment.

DO NOT INSTALL DPF's ON ENGINES THAT BURN OIL, ARE OVERFUELED, OR ARE IN GENERALLY POOR CONDITION.

[CLOSE]

I don't know whether target engine burns oil.

Records of the crankcase oil consumption of this target engine should have been kept. Check with the maintenance person responsible. If there are no records, instruct maintenance to start keeping records because you need to know this information and it is important.

[CLOSE]

I don't know what the exhaust CO concentration of my target engine is.

You need to know the engine CO emissions of this engine.

- Check the maintenance records. If CO records are maintained, the data should be there.
- If there is no CO emission record for the target engine, then you should take steps to obtain exhaust CO concentrations. Since this is so important, you should invest in an exhaust measurement instrument or combustion analyzer. The better instruments measure Oxygen (and compute the Carbon Dioxide concentration), Carbon Monoxide, Nitric Oxide (NO), and Nitrogen Dioxide (NO_2). Some provide software that makes measurement and recording of data easy. Some instruments can obtain the Bacharach smoke number which can be used for assessing the filtration quality of the DPF on an ongoing basis after installation. A partial list of combustion analyzers is presented below.

You should also investigate instituting an emissions based maintenance program.

[CLOSE]

Combustion Analyzers for Measurement of Diesel Tailpipe Emissions

Manufacturer	Model	Measures
ECOM USA	UGAS, ECOM-AC	O_2, (CO_2), CO, NO, NO_2, smoke number
ENERAC	Model 400	O_2, (CO_2), CO, NO, NO_2
Bacharach	True Spot	Smoke number only

[Go Back *(within this window)*]

Actions for high CO emissions

ngine exhaust CO concentration is, but I don't know whether the level is

CO for this specific engine has been kept, then the exhaust CO is acceptable if it is within the historical variations of the CO for that specific engine.

- If you have no CO baseline or CO records for this specific engine,
  - contact MSHA A&CC angel-james@msha.gov at 304-547-2064 or the engine manufacture to obtain the CO levels that are acceptable for your engine. MSHA may have a list of these on its web site,
    and
  - Institute an emissions based maintenance program for this engine and purchase appropriate exhaust measurement instrumentation as described here.
  - [
  - CLOSE]

- **Yes, the target engine has high CO exhaust concentrations; I need to reduce them.**
- The causes for elevated CO emissions can be the following:
- Air intake restrictions such as a clogged air intake filter; check or replace it with a clean filter.
- Overfueling of the engine, that is, the fuel rack is set too high for the altitude of operation. Have an engine mechanic qualified on the target engine check fuel rack setting and adjust if necessary for altitude according to the engine manufacturer's guidelines. Take this opportunity to reduce the fuel setting to reduce engine horsepower and significantly reduce DPM emissions if the target equipment does not need or use the full horsepower of the engine. You can save fuel, reduce tire wear (tire slippage), and reduce DPM and CO emissions by reducing the fueling rate (derating) the engine.
- Low compression or worn engine. Have the engine serviced and rebuilt if necessary.
- Improperly set timing. Have the engine serviced.
- Establish and emissions based maintenance program.

- [CLOSE]

• MNM DPF Selection Actions or Tasks

- The following section presents the tasks which must be accomplished to ensure proper selection of a Diesel Particulate Filter which best suits the target equipment and its operational situation.
  Acquire Exhaust Temperature Traces

- **I have decided that I may want to get temperature traces for the target vehicle myself.**
  Below are the steps for getting exhaust temperature traces. Also, MSHA or NIOSH can assist you in equipment selection and its use.

1. Obtain the necessary temperature logging equipment (example). The items include the following:
   Self-contained battery-powered temperature logger for Type K thermocouple. The logger should be able to log a temperature every 15 to 30 seconds for a full shift (about 3000 data points for a 12-hr shift logging every 15 seconds). A cigarette pack sized logger is available that can log over 8000 points for a little over $200 and includes software.
   Stainless steel thermocouple type K temperature probe, 1/8 inch or larger diameter and of length long enough to reach to the center of the exhaust pipe from an female NPT port in wall of the exhaust pipe. These cost about $30.
   NPT to compression fitting adapter to hold thermocouple;
   Type K thermocouple wire, type K connectors male and female to make an extension of the thermocouple leads, or purchase (about $15) a fabricated extension, tie wraps, etc.
   Laptop or desktop PC with software for downloading data from logger.
2. Locate a spot for the temperature probe on the existing exhaust pipe at the point where the DPF would probably be attached. Contact MSHA, angel-james@msha.gov or 304-547-2064 before installing a probe on a part 36 permissible machine.
3. Make a 1/2" diameter hole in the wall of the exhaust pipe and weld a 1/2" NPT coupling to accept the 1/2" male adapter for the temperature probe;
4. Insert thermocouple probe so that the tip of the probe is at the center of the pipe. Snug fittings;

- Temperature Logging Items from OMEGA Engineering

Part Number	Description	Cost
OM-SL-L620	Self-contained data logger for Type K thermocouple (See note below)	$207
KQ1N-14G-12	Type K Thermocouple, 12" long, 1/4" diameter, standard plug connector	$27
GECK10-4	10-ft extension, Standard Jack, Miniature plug, Type K	$15
Hardware item	1/2" NPT male to 1/4" compression fitting adapter	?
	Alternative, smaller thermocouples and extension	
KMQSS-125G-6	Type K Thermocouple, 6" long, 1/8" diameter, miniature plug connector	$24
GECK10-4	10-ft extension, Miniature connectors, Type K	$15

- Note: Make sure the software included with the logger is version 6. Version 5 will not run on Windows 2000 or NT. Version 5 runs on Windows 98.

- [CLOSE]

- **You have decided to contact a DPF supplier or consultant to obtain exhaust temperatures. Here are some things to consider.**

1. Be aware that not all DPF suppliers or manufacturers offer both active and passive DPFs. There may be consequences if the temperature profiles do not result in a recommendation of a product offered by the DPF supplier or manufacturer.
2. Make certain (negotiate an agreement) that you own the temperature data that is obtained by the DPF supplier or contractor providing the exhaust temperature logging service. If there is a fee, ask whether the fee includes an analysis of the temperature profile and what that analysis provides (it should provide the critical information on exhaust temperatures and duty cycles that allow selection of the proper DPF.
3. Make certain that temperature traces are obtained for *all* full-shift scenarios that the equipment experiences. Temperature trace data should be obtained for each of these possible scenarios several times.
4. For every shift for which temperature traces are obtained, describe the activities of the equipment in general terms for your records and to provide to the supplier along with the logged data.
5. If the DPF supplier cannot come to your mine to set up the temperature profiling instrumentation, he may offer to lend you or sell you the equipment for you to install to acquire the temperature yourself. If this is the case, you might want to consider buying the parts recommended in "I want to take the temperatures myself" response to the question.

- [CLOSE]

- **Exhaust Temperature Trace Analysis Procedure**
- Note that many DPF suppliers will want your raw exhaust temperature data for their own analysis, so you are not required to do this analysis. However, when you are faced with reassigning the equipment to a different type of work, and it is using a passive DPF, you will have to reassess the exhaust temperatures. You can use your analysis of the present data as a baseline for comparing the effects on exhaust temperature from the equipment reassignment.
- You have decided to analyze the exhaust temperature traces yourself. Below is an outline of one way to obtain an estimate of the critical temperature governing the possibility of using a passive regenerating DPF on the target equipment. The method below was designed to operate on data produced by the data logger mentioned in the equipment kit.
- **Download the data**

1. If you remove the data logger from the equipment, stop the data logger prior to disconnecting the thermocouple. If the logger remains on the equipment, stop it from logging, but do not shut it off.
2. Start the software, remove the protective cap over the data jack, and then connect the cable from the PC to logger.
3. Assuming that you have tested all of this and everything is set correctly, select "Download." You will have an opportunity to set the current time to the correct local time. This is important as all the data on the logger is referenced to this time setting.
4. Downloading the data starts when time is set.
5. Optionally select, "Function" and set to "Deg C."
6. Save the data as a *.txt file using something to identify the equipment and date in the name.
7. Shut off the data logger to clear memory and restart if appropriate.

- **Importing data into a spreadsheet**

1. Import or otherwise put the logged data for one shift into spreadsheet software, for example, Microsoft Excel®. The logger used as an example, saves the data as *.txt file. Using the File | Open in Excel, navigate to the folder containing the temperature *.txt data file; change the Files of Type: to "Text Files" so the data file becomes visible. Highlight the data file, and accept all the defaults by clicking on "Next" several times and then "Finish" as explained in the directions in the logger software manual.
2. Save the file as an *.xls file.

- **Clean up the data**
- Below is only one way to use Excel to analyze the data to arrive at the critical temperature and depends on having data analysis add-in available. If you need assistance, contact NIOSH or MSHA-A&CC, or check here to download a spreadsheet that performs the temperature analysis from time and temperature data copied into the proper columns.

1. Insert a new worksheet by right clicking on the sheet's tab, and selecting "Insert." Highlight and copy the time and data column by highlighting the two cells of numeric data appearing in column

- **Specific installation considerations for DPFs using fuel borne catalysts**
- The installation of the DPF itself is straightforward and should follow the general installation considerations (above) for passive DPFs. However the requirement for a fuel borne catalyst (FBC) introduces added considerations:

1. Upon a new "green" installation, the DPF (and engine) must be first run with a heavy dose of FBC to coat all the engine and exhaust components with the catalyst. The DPF supplier's instructions should be followed rigorously.
2. The FBC must be in the fuel in adequate concentrations *at all times*. Moderate overdosing is not a problem but is wasteful. A system must be established that ensures the presence of the FBC in the fuel. Some of the options are the following:
   On-board auto dosing system which senses the fuel added during fueling and meters in the proper amount of FBC
   Separate fueling storage and distribution system for the equipment requiring a FBC. A mechanism must be established that prevents fueling any equipment with the improper fuel, e.g., special nozzles that mate with the fuel tank.
   Manual dosing by noting the fuel taken on during refueling and filling a vessel to the appropriate mark with the FBC and adding it to the tank
3. Because of the use of the FBC and the desirability of not releasing it into the workplace, it is important to monitor the filtration status of the DPF on a regular basis. The use of the smoke number is highly recommended at regularly scheduled maintenance. The purchase of a combustion smoke tester or combustion analyzer with built in smoke number testing provisions is recommended. A partial list was presented above.

- [CLOSE]

- **Specific considerations for installation of a passive, heavily catalyzed DPF.**

1. Heavily catalyzed DPFs have been found to convert significant portions of engine-out NO (compliance level of 25 ppm) to NO_2 (compliance level of 5 ppm). Not only is the compliance level of NO_2 5 times lower than that of NO, the health effects of NO_2 are more serious. As a result, it is necessary to monitor the workplace continually for NO_2 preferably using a direct-reading hand held instrument.
2. Should the NO_2 levels be unacceptable, then ventilation must be increased. Should that not be possible or fail to reduce the NO_2 concentrations to acceptable levels, the catalyzed DPF system must be abandoned in favor of an active DPF system.
3. Refer to MSHA PIB P02-04 regarding issues with NO_2 emissions with heavily Pt-catalyzed DPFs.

- [CLOSE]

-

Installation and Operation Considerations for Active DPFs

- **General considerations for installation and operation of an active DPF.**

1. Unless the exhaust temperature is borderline for the DPF (for example, the DPF is a base-metal catalyzed system that just does not quite passively regenerate), the active DPF can be mounted anywhere that is convenient. The exhaust pipe between the engine and the DPF does not need to be insulated. There may be a preferred mounting orientation to the DPF that must be considered.
2. The DPFs are sized to store soot for the full shift or operational period between regenerations. As a result, they are larger than the comparable passive DPFs for the same engine.

3. All DPF system installations require an exhaust back pressure monitor and alarm with multiple indicator lights representing good, marginal, and unsafe exhaust back pressure levels. Back pressure monitoring is needed because as the ash builds up during use, a regenerated DPF will start the shift at progressively higher exhaust back pressure leaving less capacity for soot loading. At some point, the back pressure alarm will start coming on near the end of the shift because of this lack of capacity for soot. The DPF will have to be cleaned of the ash, unless the regeneration station does this as part of the regeneration process. The point here is that a full shift of operation is to be expected before the "red" back pressure light comes on; this is the design criteria used by the DPF manufacturers. The other point is that the system is probably sized with an over capacity to account for a reasonable amount of ash buildup; however, the capacity of the DPF may not be suitable to collect soot for two full shifts. The function of the alarm light is to prevent engine and DPF damage from extending the operation beyond the capacity of the DPF and the acceptable engine back pressure. [Go Back *(within this window)*]