

Chapter T

DIESEL PARTICULATE MATTER SAMPLING

I. Diesel Particulate Matter (DPM) Sampling Equipment

- A. **DPM Cassette** - Diesel particulate samples must be collected with the diesel particulate sampler manufactured by SKC, Inc. This sampler uses a submicron impactor which has a cut point of 0.9 micrometer when the flow rate is 1.7 Lpm. Particles greater than 0.9 micrometer are impacted and removed from the sample. The filter is then analyzed for total carbon (elemental and organic) using the NIOSH Analytical Method 5040. Figure 1 shows the DPM cassette, cyclone, and holder assembly.



Figure 1. DPM Cassette, Cyclone and Holder Assembly.

- B. Sampling Pump** - Flow for the sampling assembly can be induced by any of the pumps commonly used for respirable or total dust sampling. Pumps should be calibrated at 1.7 Lpm in accordance with the standard pump calibration procedures.
- C. DPM Sampling Train** - The DPM sampling train consists of the standard 10-mm Dorr Oliver cyclone and SKC DPM cassette, mounted in the MSA holder assembly, and a sampling pump. The only difference from the set-up for respirable dust sampling is that the vortex finder is inserted directly into the SKC sampler instead of being connected to the cassette with the plastic barrel connector. Figure 2 shows the DPM sampling train.

II. Diesel Particulate Matter Sampling Procedures

- A. Personal Samples**
Personal samples should be collected to determine an individual's exposure to diesel particulate matter. For this type of sampling, the holder assembly (with DPM cassette and cyclone) is attached to the worker's lapel.



Figure 2. DPM Sampling Train

- B. Sampling Time** - The standard requires that diesel particulate matter concentrations be expressed as average eight-hour full-shift equivalent concentrations (shift-weighted average). As a result, samples should be collected for the full shift. As with other particulate samples, a 480-minute time will then be used to calculate the concentration of diesel particulate matter.
- C. Pre-survey Calibration of Sampling Pump** - Prepare and calibrate the sampling pump using the procedures in Chapter C, Sampling Pumps, of the Metal and Nonmetal Health Inspection Procedures Handbook.
- D. Control Filter**- The DPM filter cassette contains a control filter, therefore a separate control filter should not be prepared.

NOTE: Record all information on the DPM Field Notes Form. It is not necessary to fill out the Health Field Notes Form as the same information as well as information specific to diesel particulate matter exposures will be recorded on the DPM Field Notes Form.

E. Assemble the Sampling Train

1. Remove the cassette from the plastic storage bag. If the cassette is damaged, do not use it.
2. Remove the plugs from the cassette and place them in a clean, convenient location.
3. Attach the cassette to the cyclone. Refer to Figures 1 and 2. When properly assembled, the cyclone will lock into the steel holder and the cyclone inlet will face forward.
4. Tighten the set screw on the lapel holder so that all fittings are tight and the cassette is secured.
5. There are some checks to be made upon assembly and disassembly of the DPM cassette into the MSA breastplate.
 - C There should be some resistance felt between the cyclone and the cassette and some resistance detected at the cassette connection to the steel hose connector of the holder assembly.
 - C Rotate the cassette and see that the steel outlet hose connection rotates with the cassette.

Both of these tests indicate that the O-rings are in place and providing a leak-tight seal. This is especially important in the holder assembly since it is reused many times. The O-ring in the lower part of the cassette is part

of the cassette.

6. Connect the tubing to the tubing connector on the holder and attach the other end of the tubing to the sampling pump inlet. See Figure 2.

F. Instructions to the Miner

1. Explain to the miner what you are doing, what the sampling device does, and the reason for the sampling (i.e., the hazard).
2. Instruct the miner not to remove the sampling pump or sampling train at any time or cover the sampler or cyclone inlet with a coat or anything else. If the miner does not spend the full shift in the work area, note the time spent elsewhere in the DPM Field Notes.
3. Instruct the miner not to bump, drop, abuse, or tamper with the sampling pump or sampling train.
4. Emphasize the need for the miner to continue to work in a routine manner and report to you any unusual occurrences or problems encountered during the sampling period.
5. Inform the miner when and where the sampler will be removed and that you will be checking the equipment throughout the shift.
6. When conducting diesel particulate matter sampling, instruct the miner not to invert the cyclone holder. If this occurs, it should be reported immediately to the compliance specialist and recorded in the DPM Field Notes.

G. Attach the Sampling Train to the Miner

1. Attach the sampling pump and sampling train to the miner in such a manner that it will not create a safety hazard to the miner or anyone else performing normal activities. Clip, pin, or tape the tubing to the clothing in such a manner that it does not interfere with the miner's job performance and does not present a safety hazard (such as, tubing catching on moving machine parts or railings). If the miner is not wearing a shirt or belt, the compliance specialist should provide a belt or vest to facilitate sampling. These are available in various sizes from the Metal and Nonmetal Warehouse.
2. Attach the sampler to the miner's clothing within the breathing zone. For diesel particulate sampling, attach the sampling train so that the cyclone's

grit pot is on the bottom of the assembly. Be certain that the cyclone inlet is facing away from the body of the miner.

H. Collect the Sample

1. Start the sampling pump.
2. Record the following information in the DPM Field Notes:
 - C time the sampling pump was started;
 - C pump and dpm cassette identification numbers;
 - C miner's name, job title, and work location(s);
 - C shift hours per day and days per week worked;
 - C any respirator worn or expected to be worn (brand, model, type of filters); and
 - C whether an acceptable respiratory protection program exists.
3. Check the sampling pump and sampling train as frequently as practical, that is, once an hour if possible, to make sure that the sampling pump is operating properly, and to make sure the tubing and connections are not leaking. Do not adjust the flow rate at any time during sampling. Record what tasks the miner has performed in the time between subsequent checks so that the completed DPM Field Notes will describe the miner's full work shift.
4. Throughout the shift, record other pertinent information:
 - C the quantity and velocity of ventilating air at the location where samples are collected;
 - C condition of ventilation control structures (stoppings, doors, brattices, etc.);
 - C the type of DPM control devices being used and their condition;
 - C type of fuel, such as diesel or biodiesel, in use at the mine;
 - C fuel sulfur content;

- C type of fuel additives used at the mine;
 - C information on the diesel equipment used at the workplace sampled, including:
 - the company equipment number or serial number;
 - the condition of the equipment;
 - whether there is a planned maintenance program in place;
 - whether the engine emits black smoke during acceleration; and
 - whether there is a person authorized to maintain diesel equipment; and
 - C list other equipment that may contribute to the miner's DPM exposure.
5. Collect the sampling train from the miner.
- a. Turn off the sampling pump before removing the sampling train or pump.
 - b. Record the time that the pump was turned off.
 - c. Carefully remove the sampling train:
 - C Keep the cyclone upright to prevent the non-respirable dust in the grit pot from falling back through the cyclone onto the filter.
 - C Remove the filter cassette from the lapel holder and replace the cassette plugs. Place a sample seal on the filter cassette.
 - C Record the sample number on the sample seal. Date and sign the sample seal.

III. Post Inspection Procedures

- A. **Review the DPM Field Notes** - Check that all the necessary information is included in the DPM Field Notes.
- B. **Post-survey Calibration of Sampling Pump** - Check the sampling pump calibration using the procedures in Chapter C of the Metal and Nonmetal Health Inspection Procedures Handbook.
- C. **Cyclone Cleaning and Assembly**
 - 1. Unscrew the grit pot from the cyclone. Empty the grit pot by turning it upside down and tapping it gently on a solid surface.

2. Gently wash cyclone, grit pot, and the vortex finder (cyclone cap) by agitating in warm soapy water or, preferably, wash in an ultrasonic bath. Do not insert anything which can score or scratch the inner lining walls of the cyclone (such as a pipe cleaner).
3. Rinse thoroughly in clean water, shake off excess water, and set aside to dry before reassembly.
4. Inspect the cyclone and filter holder parts for damage or excessive wear, for a loose coupler or vortex finder, and for scoring or rifling (which can trap respirable particles, preventing them from reaching the filter). Pay special attention to the top internal circumference of the cyclone when inspecting for scoring and rifling. Replace defective parts.
5. Reassemble the cyclone, vortex finder (cyclone cap), and grit pot.

D. Transport the Samples for Analysis

1. Complete the Request for Laboratory Analysis (MSHA Form 4000-29) for the samples taken. In Item No. 15 on the form, designate "R" for respirable samples. In Item No. 16, fill in the analysis desired, diesel (carbon). Samples from different lots, used on the same day, should be listed on separate Request for Laboratory Analysis (RLA) forms. Be sure to provide all the information the laboratory will need to fill out the Personal Exposure Data Summary (PEDS).
2. Ship the Request for Laboratory Analysis form(s) with the samples to the MSHA Laboratory.

IV. Exposure Determination

The laboratory will complete the analysis and return an Analytical Report that will include the concentration, concentration limit, error factor, and calculated enforcement concentration limit (concentration limit times error factor). A PEDS will also be generated as appropriate. For each sample, the corrected organic carbon, elemental carbon and total carbon concentration will be reported. The formula the Laboratory uses for calculating diesel particulate concentration is:

$$\text{Carbon Concentration (F g/m}^3\text{)} = \frac{\text{C(F g/cm}^2\text{)} * \text{A(cm}^2\text{)} * 1,000 \text{ L/m}^3}{1.7 \text{ Lpm} * 480 \text{ min}}$$

$$\text{Total Carbon} = \text{Organic Carbon} + \text{Elemental Carbon}$$

Where:

- C = The corrected Organic Carbon (OC) or Elemental Carbon (EC) concentration measured in the thermal/optical carbon analyzer.
- A = The deposit area of the filter media used in the DPM cassette.

If the total carbon concentration exceeds 400 Fg/m^3 , the use of elemental carbon (EC) as an analyte ensures that a citation based on the 400 micrograms of TC per cubic meter of air limit is valid and not the result of interferences such as tobacco smoke, oil mist, and mineral dusts. Total carbon will be estimated using a two-step process to produce an estimate of TC without interferences.

In the first step where total carbon (TC) concentration is determined by adding together the elemental carbon (EC) and organic carbon (OC) results, the error factor is based on both EC and OC sampling and analysis. In the second step where the TC concentration is determined by multiplying the EC result by 1.3, the error factor is based on EC sampling and analysis only. A citation for overexposure to the DPM interim limit will be issued only when both the TC shift weighted average concentration determined by adding EC and OC exceeds $400_{\text{TC}} \text{ Fg/m}^3 \times$ its respective error factor, **and** the TC shift weighted average concentration determined by multiplying EC by 1.3 exceeds $400_{\text{TC}} \text{ Fg/m}^3 \times$ its respective error factor.