Arch Coal’s Emissions Based Maintenance Program

By Steve “Skinner” Forbush
What are Diesel Emissions?

1. Gaseous
   A. Carbon Monoxide “CO” 50ppm TLV
   B. Nitric Oxide “NO” 25ppm TLV
   C. Nitrogen Dioxide “NO₂” 5ppm TLV

2. Particulate Matter “DPM”
   A. Elemental Carbon “EC”
   B. Organic Carbon “OC”
   C. Total Carbon “EC + OC = TC”
   D. Whole Diesel Particulate Matter

3. A “tip”, CO will usually track with DPM.
What is Maintenance?

Any ideas?
According to Mr. Webster.

Maintenance is:
1. To keep in an exiting state.
2. To preserve from failure or decline.
3. To continue or preserve; keep up.
4. To support or provide for.

Synonyms: preservation, up keep, repairs, and continuance.
A change of paradigm.

- Insanity is: performing the same procedures, expecting different results.

“Albert Einstein “
Maintenance+ or “Emissions Based Maintenance Program”.

1. Wherever you are at now is a good starting point. Continue current PM program.
2. Establish a baseline for emissions.
3. Find out where you should be.
4. Get there.
5. Improve.
Baseline for emissions.

1. Analyzer (Enerac, Testo or Ecom).
2. Trained emissions technicians. As small a group as possible.
3. Repeatability on all tests. RPM’s, engine temperature, good air, etc.
4. Storage and interpretation of data.
5. Passing on the information.
“Doing an emissions test”.

1. Make sure you are in proper ventilation.
2. Warm up the engine to at least 180°F.
3. Make sure everyone is in a safe place.
4. Put the transmission into high gear with the brakes set.
5. Put the engine to full power.
6. After a few seconds insert the analyzer probe.
7. When the CO stabilizes, record the information.
“Doing an emissions test”.

Getting ready!

1. Safety First!!!
   a. Proper Ventilation.
   b. Keep everyone in a safe area.
2. Warm Up the engine and Transmission. The same temperature every time.
3. Keep in mind this test is to determine engine emissions. Not to see if the air filters are plugged, or if there are unexpected parasitic loads on the engine.
4. Repeatability is the Key!!!
“Doing an emissions test”.
Now the Test.

1. It’s better to have one person in the cab and one person using the analyzer.
2. The guy in the cab releases the park brakes and hold down on the service brakes and put’s the Transmission into high gear and Forward or Reverse.
3. Put the engine into full power.
4. After a few seconds put the analyzer into the exhaust flow.
5. The CO will increase to a point where it will stabilizes. Moving 2-3 points at a time.
6. Verify the $O_2$ or $CO_2$ are correct.
7. Record the data.
“Doing an emissions test”. Now what?

1. Check the data on this test with the Baseline.
2. If the results are in line with the baseline go to the next one. If not refer to bullet 3 on “Getting Ready”.
3. In most cases an increase from the baseline can be repaired on the spot in minimal time. Sometimes it will need to be sent to the shop.
Interpretation of the data.

1. $O_2$ and $CO_2$ are designators for engine load and always run inverse.
   *Example:* High $O_2$ (18%) and low $CO_2$ (4%) show the engine is at low load.

2. High CO shows too much fuel for the available combustion air.

3. High NO$_X$ usually shows high combustion chamber temperature.
Baseline.

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<tr>
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So what is High CO??

### TORQUE CURVE TEST
ALL TESTS AT FULL THROTTLE

<table>
<thead>
<tr>
<th>Engine Speed, RPM</th>
<th>CO, ppm</th>
<th>CO2, %</th>
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<td>392</td>
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<td>2100</td>
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<td>1800</td>
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<td>1700</td>
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Baseline

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Passing on the information.

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<tr>
<th>DATA</th>
<th>UNIT</th>
<th>DATE</th>
<th>HR'S</th>
<th>O2</th>
<th>CO</th>
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<th>NOX</th>
<th>NO2</th>
<th>NO</th>
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Our next steps at AWBG.

1. In 1997 when AWBG started the EBMP our numbers weren’t very good.
2. 1597ppm for CO and 997ppm for NO$_X$. This was with all equipment set to OEM specs.
3. Last week our results for the same fleet were 162ppm for CO and 493ppm for NO$_X$. This was after some changes from OEM specs.
4. How did we get there?
Steps to improvement.

1. Full support from Mine Management. This is critical for success.
2. Full support from the Operations side.
3. Maintenance group support.
4. Understanding the Nuts and Bolts of emissions reduction.
5. Training.
Nuts and Bolts.

1. The effects of elevation. All of our mines are at higher elevation (6,500’-9,000’).
2. Most OEM’s did not understand the elevation problem at that time.
3. Emissions contour maps.
4. Torque absorption charts.
How do we get there?
Emissions Contour Maps!!
How do we get there?
Emissions Contour Maps!!
How do we get there?
Emissions Contour Maps!!
Torque Absorption Chart.
Improvement!
Additional uses. Fuel Consumption.
Questions?