DOCUMENTING EMISSIONS AND ENERGY REDUCTIONS of WMA AND CONVENTIONAL HMA

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8 Dec 2008
NOTE: due to the re-issuance of the RFP, this Emissions Protocol is in the process of being revised. Specifically, both EPA Method 25A and Method 25Aap will be used to assess VOC stack emissions. Further, specific recommendations for tuning plant burners, prior to emissions testing, will be provided.

A revised protocol will be posted in lieu of this protocol by 18 Dec 2008; and the revised date will be indicated above.
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PLANT AND PAVING OPERATIONS

Plant Emissions Stack Testing and Energy Requirements

Introduction:
Stack testing should include mass emissions rate measurement of NOx, CO2, and VOC to compare stack emissions from WMA technologies and conventional HMA. It is suggested that stack emissions reporting be standardized as lbs per hour (of mix produced) and include a recording and reporting of average production rate in tons HMA or WMA produced per hour, during each test period. Testing should be performed by a certified tester and should include either two (2) or three (3) 60-minute stack sampling runs per technology, if possible. Note: the number of runs may have to be adjusted to the available run time using WMA technology. Production rates should be recorded every 15 minutes during each test run and used to determine average production rate in tons mix produced per hour for each run. The data from all individual test runs during a test period (conventional HMA or WMA) should be averaged to determine the overall results for each technology. Stack gas volumetric flow rates, moisture content, and a variety of other parameters should also be determined for each run, in accordance with U.S. EPA stack testing methodology. In order to assess fossil fuel and energy use reductions, it is suggested that beginning and end fuel usage data be recorded for each test run. This may be accomplished with direct fuel usage meter readout, where available, or by tank gauging as appropriate.

Stack Emissions Testing and Analytical Methods:
Suggested test methods are in accordance with U.S. EPA protocol used historically in the HMA Industry and are as follows:

• Sampling point locations per USEPA Method 1, if ports have not been established during previous stack testing. If ports have been previously established, the test firm may wish to confirm that their location is consistent with that specified by USEPA Method 1. Access platforms and an appropriate power source must also be available during testing.

• Stack Gas Volumetric Flow Rate per USEPA Method 2

• Stack Gas Temperature and Moisture content per USEPA Method 4

• NOx Emissions per USEPA Method 7E

• CO2 Emissions per USEPA Method 3A (continuous method preferred over method 3 Orsat)

• VOC Emissions per USEPA Method 25A (reported as Molecular Weight of Propane)

Energy Requirements and Operational Data:

Attached is an Operational Data Entry sheet for use in identifying WMA technologies and binder characteristics, and for calculating the amount of energy required to produce the mix. As indicated on the Operational Data Entry sheet, recorded information will include:

- WMA technology and Binder characteristics
- RAP usage/rate (if applicable)
- Change in Drag Slat amperage for each technology
- Average Production Rate
- Unit fuel consumed per tons of mix processed

Suggested Reporting Of Stack Emissions and Energy Results:

- Average mix production rate in tons/hour
    - o Conventional Mix Test Period
    - o WMA Test Period
- lbs CO2/hour; lbs NOx/hours; lbs VOC/hour reported as MW of propane
    - o Conventional Test Period (average all runs)
    - o WMA Test Period (average all runs)
    - o percent Reduction
- Fossil Fuel Usage - Gallons or Cubic Feet Gas/Ton mix
    - o Type of Fuel Used i.e., #2 oil, Natural Gas, other
    - o Conventional Test Period (average all runs)
    - o WMA Test Period (average all runs)
    - o percent Reduction
- Include appendix for field test data and calculations summary

Approximate Costs Associated with Stack Emissions Testing:

- Any travel costs, outside locality, are not included.

- Complex reporting of results will incur extra charges; this is not anticipated.
- Costs for developing Test Plans are not included; however, Test Plans are not anticipated to be needed.
- There are minimal differences in costs (+/- $300) associated with conducting either two or three stack tests.
- Baseline costs are anticipated to be approximately $3,000 - $5,000
  - Per Technology (comparison with conventional HMA is an additional technology – i.e., a complete round of testing would be needed).
  - Includes three stack tests
  - Includes simple reporting of results
  - Costs are for a local company to conduct the emissions testing -- travel costs would be incurred for non-local companies.

Emissions Surrounding Laydown Operations

Introduction:

Ideally, placement of each mix, conventional and WMA, would use the same paving equipment; material placed one day apart, approximately during the same time-frame. To minimize variability, it is also recommended that the paving machines utilized are equipped with properly functioning engineering controls. The recommended test period, for field emissions, is between 3 and 4 hours; more detail follows.

Placement of Monitors

During the placement of each technology, conventional HMA and WMA, the paver hopper, screed, and paver operator areas and, if appropriate, paving crew member(s), will be monitored for asphalt fume emissions. The purpose of this testing is to document, with some statistical power, the reduction in field application emissions using WMA as compared with using conventional HMA. A certified industrial hygienist (“CIH”) should be employed to oversee and/or conduct the exposure sampling; one or two assistants for the CIH may also be used to conduct field work. Stationary monitors will be placed on the paving machine to simulate worst case emissions potential and to document emissions reductions. This will assist in statistically validating changes in emissions due to mix technologies and temperature of application. Due to differences in paving machine configurations, six (6) location-specific stationary monitors (and up to 2 background monitors, if necessary) will be placed, as consistently as possible, with the criteria below. Placement of these monitors should be conducted with close cooperation between the industrial hygienist and the paving crew or the crew's machine shop as some of the sampler locations may need to be slightly fabricated with brackets or braces.

Monitoring cartridges should be placed as follows:

➢ (1) Hanging off the back inside wall of the hopper, centrally located approximately 6 – 12 inches below the top of the hopper.

➢ (1) Hanging in front of an Operator Panel, as central as possible on machine (ensure clearance of 6 inches from panel box); e.g., if there are two operator seats/panels, hang monitor on the front of one of them (preferably the one not being used) as close to the central portion of the paving machine as possible.

➢ (1) Attached to the highest point of one side of the central step railing (document height off ground)

➢ (2) Each one hanging above each side of the screed/auger discharge area end box (typically located near guide bars or control box); ensure clearance of approx 6 inches from sides of paver and 4 feet above pavement mat (this may require field fabricating a mounting bracket). Note the length of screed extension as compared with placement of the monitor.

➢ (1) Extending off the central rear portion of screed walkway, 5 feet above pavement mat (this will require field fabricating a mounting bracket, tripod, or other apparatus or obtaining a pre-fabricated apparatus (with mounting bracket) from NCAT. This ensures consistent location placement (see diagram below). Please contact Brian Prowell at NCAT.

Note that typical paving equipment and the paving application process should be considered as a harsh environment for IH sampling equipment. It is recommended that each pump is enclosed in sturdy zip-loc type bags and secured to appropriate paving apparatus using duct-tape, fabricated brackets, and/or bungee cords. Because of the number of monitoring devices proposed, and the unusual work environment, it is recommended that either one highly experienced field hygienist is used for field monitoring, or two less-experienced field hygienists are utilized.

Sampling and Analytical Method

Traditional gravimetric procedures will be used to quantify asphalt fume emissions. NIOSH Method 5042 is to be used to measure asphalt fume emissions, as both Total Particulate Matter (TPM) and Benzene Soluble Matter (BSM). Stationary (and personal) sampling pumps (capable of 1 to 4 liters/minute) should be connected to a pre-weighed 2.0-micron PTFE membrane filter (SKC Cat. No. 225-17-07 or equivalent) with a cellulose support pad in a 37-mm cassette filter holder. Flow calibration will be performed pre- and post-sampling. Calibrate pumps for approximately 2 to 3 liters per minute. The goal is to collect a large enough sample to increase analytical sensitivity without overloading the sampling media. Keep completed samples cold by placing them in a cooler with ice packs and protect them from light by wrapping them with foil. This allows further chemical-specific analysis if warranted. Minimum field sampling collection times should be between 3 and 4 hours; two such sampling events are ideal, and 6 hours would be the maximum recommended sampling time using one single media cartridge. Based upon one full day of paving, at the speed of approximately 200 tons mix/hour with a 2”-3” lift, paving time would be approximately 6 and 8 hours, including an allowance for down time and other work-related stoppages / activities. If it is anticipated that the paving machine will not operate for a period longer than 30 minutes, the sampling pumps should be shut off. A concurrent log of work stoppages longer than 15 minutes should be documented and should be factored into the final 8 hour time-weighted average fume emissions reporting.

If there is availability of pumps, one or two background samples could be taken and positioned upwind of the paving operation; descriptive data should be collected on potential confounders from the site, e.g., construction dust and any other background interferences. The background samples are only needed if there is potential for confounding; the CIH should review specific circumstances. Depending on the proximity of the paver's diesel exhaust stack to the sampling locations, the CIH may need to obtain an additional sample to minimize the impact of diesel exhaust on asphalt fume measurements.

Three blank samples should be taken to the job site; the caps for the cassettes are removed and immediately replaced at the job site with no air being drawn through them. Both background and blank samples should be extracted and analyzed following the same testing and analytical protocol as the samples taken from around the paver.

While sampling in the field, mix temperatures (both in the hopper and on the mat as it exits the screed strike area) should be monitored and recorded every 30 minutes, during the test period, with an infrared thermometer gun.

It is essential that weather-related information be collected and documented at least four times during the sampling period. Information would include, at minimum: wind speed and direction, air temperature, humidity, and other weather related comments.

For any personal sampling, names of all workers will be recorded along with observations during sampling including smoking habits. Workers must be asked not to smoke, or if they must, pumps must be turned off while smoking. During any personal sampling, attempt to restrict job rotations, if possible, in order to provide a valid exposure evaluation of the position. Document pertinent information regarding work positions and activities.

Photographs, illustrating field application of these technologies, will be taken throughout the sampling event. Diagrams noting the area sample locations and locations of workers are also helpful. Noting the direction of the paving application is important, especially in relation to wind direction.

<u>Suggested Reporting Of Results:</u>

- Anomalies in sampling and results
- Visual observations of emissions
    - Conventional Test Period
    - WMA Test Period
- Mix temperature (hopper and mat)
    - Conventional Test Period
    - WMA Test Period
    - Percent reduction

- Weather data including ambient temperature and humidity
- Worker activities
- Diagrams and/or photographs documenting activities and sampling locations.
- Notation whether paver is equipped with functioning engineering (emission reduction) controls.
- Background-corrected asphalt fume emissions (TPM and BSM) reported in mg/m3
    - Conventional Test Period (average all runs)
    - WMA Test Period (average all runs)
    - percent Reduction

<u>Approximate Costs Associated with Industrial Hygiene Field Emissions Testing:</u>

- Any travel costs, outside locality, are not included.
- Analytical costs are approximately $100 per sample (11 samples per 3 – 4 hour event) x 2 events per day
- Labor at approximately $110 per hour (10 hours) x 2 people
- Report writing and miscellaneous at approximately $600
- Baseline costs are anticipated to be approximately $5,000 - $6,000
    - Per Technology (comparison with conventional HMA is an additional technology – i.e., a complete round of testing would be needed).
    - Costs are for local hygienists to conduct the field monitoring -- travel costs would be incurred for non-local hygienists.
    - Monitoring equipment (pumps) may or may not be included in the labor rates, but should not substantially affect the estimated baseline costs.

Facility Operational Data Needs and Energy Usage

3 Pages to be filled out during each Production run for each WMA technology and corresponding HMA control run:

Mix / Fuel Information

TRIAL DATE: ________________________

TYPE of MIX: HMA or Warm Mix Asphalt: _________________________

Asphalt Binder type/specification/PG-grade: ______________________________

Polymer type or tradename (if known, e.g., SBR, SBS,) __________________________

Average RAP usage/rate (if applicable): ___________________________

FUEL TYPE: _________________________

Production Data

Initial FUEL LEVEL (with units) @ **Beginning** of Run: __________________________

START TIME of Production Run: __________________________

Drag Slat AMPERAGE (typical)
(avoid recording during transitions): ________________________

RECORD Mix Production Rate approximately every 15 minutes

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

RECORD Production Rate approximately every 15 minutes (continued)

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

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Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

DOWN TIME: note any periods of down time

Start Time: ______________ End Time: ______________

Start Time: ______________ End Time: ______________

Start Time: ______________ End Time: ______________

RECORD Production Rate approximately every 15 minutes (continued)

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

Time: ____________ Rate Mix Processed (tons/hour): ____________________

DOWN TIME: note any additional periods of down time

Start Time: ______________ End Time: ______________

Start Time: ______________ End Time: ______________

AVERAGE Hourly Production Rate (tons/hour) (from above): ____________________

END TIME of Production Run: ___________________________

Ending FUEL LEVEL (with units) @ **End** of Run: ________________________

TOTAL RUN TIME (hours): ________________________

Total Amount of Mix Processed (tons): _________________________

Total Amount Fuel used (with units): ___________________________

CALCULATED Hourly Production Rate (tons/hour)
(from fuel usage and amount processed): _________________________

CALCULATED Total Fuel Usage Rate
(units of fuel type) per ton Total Mix Processed: ____________________