Source Category: Asphalt Manufacturing

INTRODUCTION

The purpose of this document is to provide a forum for public review and comment on the evaluation of candidate control measures that may be considered by the States in the Midwest Regional Planning Organization (MRPO) to develop strategies for ozone, PM2.5, and regional haze State Implementation Plans (SIPs). Additional emission reductions beyond those due to mandatory controls required by the Clean Air Act may be necessary to meet SIP requirements and to demonstrate attainment. This document provides background information on the mandatory control programs and on possible additional control measures.

The candidate control measures identified in this document represent an initial set of possible measures. The MRPO States have not yet determined which measures will be necessary to meet the requirements of the Clean Air Act. As such, the inclusion of a particular measure here should not be interpreted as a commitment or decision by any State to adopt that measure. Other measures will be examined in the near future. Subsequent versions of this document will likely be prepared for evaluation of additional potential control measures.

The evaluation of candidate control measures is presented in a series of "Interim White Papers." Each paper includes a title, summary table, description of the source category, brief regulatory history, discussion of candidate control measures, expected emission reductions, cost effectiveness and basis, timing for implementation, rule development issues, other issues, and a list of supporting references. Table 1 summarizes this information for the asphalt manufacturing source category.

SOURCE CATEGORY DESCRIPTION

There are two industries that fall under the category of asphalt manufacture: hot mix asphalt plants and asphalt roofing. Hot mix asphalt plants produce asphalt paving materials, while the asphalt roofing industry manufactures asphalt-saturated felt rolls, fiberglass and organic (felt-base) shingles, and surfaced and smooth roll roofing for use mainly in roof construction.

Hot mix asphalt (HMA) is created by mixing and heating size-graded, high quality aggregate (which can include reclaimed asphalt pavement) with liquid asphalt cement. HMA can be manufactured by batch mix, continuous mix, parallel flow drum mix, or counterflow drum mix plants. In batch mix plants, aggregates are sent to a rotary dryer, where upon exit, the hot aggregate is sorted into size grades and weighed, then dropped into the pug mill (mixer), where it is combined with liquid asphalt. In parallel flow drum mix plants, sized aggregate is introduced to the dryer drum at the burner end. As the drum rotates, the aggregates and combustion products move toward the opposite end of the drum. The liquid asphalt cement is added midway down the drum, therefore facilitating heating and mixing in the same unit. In counterflow drum mix plants, the flow of aggregate is opposite the flow of exhaust gases, and the liquid asphalt cement is added after the burner flame to reduce material contact with the hot exhaust gases. Once mixed, the HMA is conveyed to hot storage silos, or loaded onto trucks to be hauled to the job site. Approximately 85% of all plants use the counterflow drum mix design, while 10% use batch mix, and 5% use parallel flow drum mix. Continuous mix plants are not readily used and make up less than 0.5% of the existing HMA plants.

TABLE 1a – CONTROL MEASURE SUMMARY FOR ASPHALT MANUFACTURING

Control Measure Summary	**NOx Emissions (tons/year) in 5-state MRPO Region**	
2002 Existing measures : State fuel combustion rules	2002 Base:	4,014
2009 On-the-Books measures: None identified	Reduction: 2009 Remaining:	-0 4,014
Candidate measure: Apply Available Combustion Modification Controls to All Asphalt Manufacturing Plants *Emission Reductions:* 25% control from 2002 in MRPO region *Control Cost:* $17,630/ton to $21,084/ton *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 Reduction: 2009 Remaining:	-1,004 3,011

Control Measure Summary	**SO_2 Emissions (tons/year) in 5-state MRPO Region**	
2002 Existing measures : State fuel combustion rules	2002 Base:	3,614
2009 On-the-Books measures: None identified	Reduction: 2009 Remaining:	-0 3,614
Candidate measure: Apply Available Fuel Switching Controls (Natural Gas or Low-Sulfur Fuel Oil) Where Feasible to All Asphalt Manufacturing Plants *Emission Reductions:* cannot be estimated at this time – requires site-by-site analysis of availability of natural gas *Control Cost:* cannot be estimated at this time – requires site-by-site analysis of availability of natural gas *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 Reduction: 2009 Remaining:	Cannot be estimated at this time

Asphalt roofing materials are produced through a series of steps, including asphalt preparation, followed by felt saturation, coating, mineral surfacing, cooling and drying, product finishing, and packaging. Preparation of the asphalt is done through a process called blowing, which involves bubbling air through liquid asphalt flux at 500^{o}F for 1 to 10 hours in a unit called a blowing still. The amount of time depends on desired characteristics of the roofing asphalt. Inorganic salts can also be used as catalysts to achieve desired properties and increase the rate of reaction. After asphalt preparation, the various asphalt roofing products can be made through the production steps. Saturated felt is produced by passing organic felt through the spray section of the saturator where asphalt at 205 to 250oC (400 – 480oF) is sprayed on one side of the felt. The saturated felt is then run over a series of rollers in the saturator dip section, where the bottom rollers are submerged in hot asphalt. In the next step, heated drying-in drums and the wet looper proved heat and time, respectively, for the asphalt to penetrate the felt. Lastly, the saturated felt is passed through water-cooled rolls and onto the finish floating looper, rolled, and cut to product size. Production of asphalt roofing shingles, mineral-surfaced rolls, and smooth rolls is similar to the production line of the saturated felt rolls, including saturation, coating, application of a granule and sand or banking surface, pressing, cooling, finishing through floating looper, and finally rolling, processing through a seal-down applicator and shingle cutter for shingles, or processing through a laminating applicator and laminating operation for laminated shingles.

The dryer operation is the main source of pollution at hot mix asphalt manufacturing plants. Dryer burners capacities are usually less than 100 mmBtu/hr, but may be as large as 200 mmBtu/hr. Natural gas is the preferred source of heat used by the industry, although oil, electricity and combinations of fuel and electricity are used. The reaction of nitrogen and oxygen in the dryer creates nitrogen oxide (NOx) emissions in the combustion zone, while sulfur dioxide (SO2) emissions are the product of oxidation of sulfur containing compounds in fuels. Particulate emissions result from the volatilization of materials that later form condensates and from material handling. Volatile organic compound (VOC) emissions are the by-product of incomplete combustion.

As for asphalt roofing manufacturing plants, PM and VOC emissions are largely from asphalt storage tanks, blowing stills, saturators, coater-mixer tanks, and coaters. The PM from these units consists primarily of recondensed asphalt fume, while sealant strip and laminant applicators are sources of small amounts of PM and VOCs. Asphalt heaters are also sources of the combustion products, NOx and SO2, due to combustion of natural gas and/or fuel oils.

Table 2 summarizes the LADCO emission inventory for asphalt manufacturing facilities in the MRPO. In general, emissions from an individual hot mix asphalt plant are relatively low on a regional basis. Most emit less than 50 tons per year of any criteria pollutant. However, there are a large number of plants in each state, and each plant can emit between 20-75 pounds per hour on a short-term basis (typically when production is high during the ozone season). In total across the MRPO region, these plants emit less than 0.1 percent of the total SO2 and NOx emissions from all MRPO sources.

For Ohio, the LADCO inventory listed only one hot mix asphalt plant, presumably because other facilities were too small to be included in the point source inventory. Information provided by Ohio EPA indicates that there are roughly 500 hot mix asphalt plants in Ohio. Since annual emission information for these Ohio facilities was not readily available, we calculated emissions for these 500 facilities assuming that they emitted at the average rate for other plants in the MRPO region. A more detailed inventory for both the Ohio plants and other plants in the MPRO should be developed to support any future regulatory development efforts.

Like hot mix asphalt plants, emissions from an individual asphalt roofing plant are relatively low on a regional basis. There were 13 asphalt roofing manufacturing plants identified in the 2002 LADCO inventory.

TABLE 2 – 2002 EMISSIONS FROM ASPHALT MANUFACTURING FACILITIES

SIC Code: 2951 – Hot Mix Asphalt		**2002 Annual Emissions (tons/year)**			
State	**No. Facilities**	**SO_2**	**NOx**	**VOC**	**PM10**
Illinois	185	415	574	441	308
Indiana	53	330	212	159	349
Michigan	101	394	671	481	457
Ohio	1* 500**	25* 1,789**	27* 2,218**	100* 2,673**	3* 1,643**
Wisconsin	47	221	233	29	155
TOTAL:	**886**	**3,149**	**3,908**	**2,673**	**2,912**
SIC Code: 2952 – Asphalt Roofing					
Illinois	9	241	59	227	100
Indiana	2	0	1	9	2
Michigan	1	33	15	16	8
Ohio	1	191	31	74	147
TOTAL:	**13**	**465**	**106**	**323**	**257**
TOTALS FOR MRPO REGION		**3,614**	**4,014**	**2,996**	**3,169**

* The 2002 LADCO for Ohio listed only one hot mix asphalt plant, presumably because other facilities were too small to be included in the point source inventory.

** The Ohio EPA stack test database indicates that there are approximately 500 hot mix asphalt plants in Ohio. Since annual emission information for these Ohio facilities was not readily available, we calculated emissions for these 500 facilities assuming that they emitted at the average rate for other plants in the MRPO region. A more detailed inventory for the Ohio plants should be developed to support any future regulatory development efforts.

REGULATORY HISTORY

Emission control regulations for asphalt manufacturing historically focused on particulate emissions. However, emission controls for SO2, NOx, and VOCs are available from both hot mix asphalt plants and asphalt roofing processes.

Under Title I of the Clean Air Act, EPA has developed New Source Performance Standards (NSPS) for certain specified categories of new and modified large stationary sources. There are two NSPS regulations for Asphalt Manufacturing Plants contained in 40 CFR Part 60 under Subpart I and Subpart UU. Subpart I applies to any hot mix asphalt plants constructed or modified after June 11, 1973, while Subpart UU applies to asphalt roofing facilities constructed or modified after November 18, 1980 for saturator or mineral handling and storage, asphalt storage tanks, and blowing stills that process and/or store asphalt used for roofing purposes, and after May 26, 1981 for asphalt storage tanks or blowing stills that process and/or store only non-roofing asphalts. Both of these regulations specify emission standards for particulate matter only.

Title I also subjects new and modified large stationary sources that increase their emissions to permitting requirements that impose control technologies of varying levels of stringency (known as New Source Review, or NSR). NSR prescribes control technologies for new plants and for plant modifications that result in a significant increase in emissions, subjecting them to Best Available Control Technology (BACT) in attainment areas and to the Lowest Achievable Emission Rate (LAER) in nonattainment areas. The control strategies that constitute BACT and LAER evolve over time and are reviewed on a case-by-case basis in state permitting proceedings. Recent BACT/LAER determinations have included controls such as low-NOx or ultra-low-NOx burners, restricting fuels to natural gas or low sulfur diesel, and afterburners for VOC control.

Under Title III of the CAA, EPA develops National Emissions Standard for Hazardous Air Pollutants (NESHAPs). On February 12, 2002, the EPA deleted the asphalt concrete manufacturing source category from the NESHAP source category list because available data indicated that there were no major sources of HAP emissions. On May 7, 2003, EPA published this NESHAP with Maximum Achievable Control Technology (MACT) requirements that apply to the manufacture of asphalt roofing materials. This MACT standard includes limits requiring control of both particulate and total hydrocarbon emissions, including the use of combustion devices, if necessary, to achieve reductions of hydrocarbon emissions.

In the Midwest RPO States, asphalt manufacturing plant emissions are subject mainly to PM limits, although they may also be subject to SO2 or NOx fuel combustion requirements depending on the size and age of the facility. PM requirements vary by state, but most asphalt plants already have some form of PM emission control (cyclone, scrubber, or baghouse). Facilities may have to meet state-specific SO2 requirements for fuel-burning equipment when burning fuel oil.

Wisconsin's regulations limit NOx emissions from new asphalt manufacturing plants with 50 MMBtu/hour or greater heat input to 0.15 lb/MMBtu firing gaseous fuel, 0.20 lb/MMBtu firing distillate fuel oil, and 0.27 lb/MMBtu firing residual fuel oil or waste oil. No other MRPO States have NOx limiting regulations that apply to asphalt plants. Existing plants with a maximum design heat input of 75 mmBtu/hour were required to complete a combustion optimization study to minimize NOx by December 31, 2002.

CANDIDATE CONTROL MEASURES

Emissions from asphalt roofing plants consist mainly of PM and VOC emissions from storage tanks, blowing stills, saturators, coater-mixer tanks, and coaters. Most asphalt roofing plants utilize control systems to meet PM and VOC limits, and, where applicable, the NESHAP and NSPS requirements. Control systems for emissions vented from saturators and coaters include low-voltage electrostatic precipitators (ESP), high-energy air filters (HEAF), coalescing filters (mist eliminators), afterburners, fabric filters, and wet scrubbers.

The major emission source from hot mix asphalt plants is the drum dryer, which emit PM, NOx, SO_2, CO, and VOC. Emissions of NOx and SO2 are the result of natural gas and fuel oil combustion, while CO and VOC are emitted as a result of incomplete combustion of that fuel. Almost all hot mix asphalt plants use both primary and secondary PM control devices on the rotary dryers. Primary control devices include large diameter cyclones, skimmers, and settling chambers, which are followed by secondary control devices such as fabric filters or venturi scrubbers.

SO2 emissions can be reduced by changes in fuels consumed, use of alkaline aggregate to absorb sulfur compounds from exhaust gas, or by add-on control systems. Currently, natural gas is the fuel of choice by most asphalt manufacturers, minimizing the SO2 emissions from fuel combustion. Low-sulfur fuel oil is an option for reducing SO2 emissions. Alkaline aggregate (i.e., limestone) may adsorb as much as 50percent of the sulfur compounds from the exhaust gas. The add-on control systems include both wet scrubbers and dry scrubbers. Scrubber systems remove both SO2 and PM. Particulate and SO2 removal efficiencies will vary significantly with scrubber design and site-specific factors.

The strategies for controlling NOx emissions can be divided into three broad categories: (1) stoichiometry-based combustion modification systems, (2) dilution-based combustions modifications, and (3) post-combustion flue gas clean-up. Combustion modification technologies for the dryers, such as low-excess air or low-NOx burners, are considered to be technically feasible as a retrofit technology and have been required in recent BACT/LAER determinations. According to a recent analysis by the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), dilution-based combustion control strategies such as flue gas recirculation is generally not considered a retrofit technology for most devices due to size or layout constraints. Also, SJVUAPCD indicates that the use of post-combustion emission controls such as selective non-catalytic reduction (SNCR) or selective catalytic reduction (SCR) would be debatable since the affected units generally have unit exhaust temperatures below those needed for SNCR or SCR to perform well.

A single candidate control measure for NOx and SO2 is discussed below. It is based on available controls that have been identified in other state regulations or recent BACT/LAER determinations.

Measure ASPH1 – Apply Available Controls to All Facilities in the Region. Under this approach, all hot mix asphalt plants and asphalt roofing processes in the MRPO region would be required to apply available controls for NOx and SO2. For NOx, we are assuming that sources could achieve a 25 percent reduction from uncontrolled levels through combustion modifications such as low-NOx burners, similar to that required in SJVUAPCD proposed new rule 4309. Sources could reduce SO2 emissions by switching to natural gas or low-sulfur fuel oil; however, we cannot determine an SO2 percent reduction at this time because we cannot determine whether natural gas or low-sulfur fuel is available for these plants.

EMISSION REDUCTIONS

We estimated the emission reductions expected from adoption of the control measure limit emissions from asphalt plants in the following manner:

1. Obtained 2002 actual emissions from the MRPO's 2002 inventory (or assumed rates for plants in Ohio as noted in Table 2).
2. For the control measure, we assumed the adoption of NOx limits would achieve on average across the MRPO region a *25 percent reduction* in NOx emissions. We do not have plant specific data to determine how many plants could feasibly switch to natural gas or low-sulfur fuel oil, so no estimates of SO2 reductions have been made.

Table 3 summarizes the actual annual NOx emissions for 2002; the projected emissions in 2009 are based applying achieving a 25% reduction in 2009 emissions by applying available controls to all facilities in the region.

TABLE 3
COMPARISON OF ACTUALEMISSIONS AND CANDIDATE CONTROL MEASURES

NOx Emissions (tons per year)					
		On-the-Books (none determined)		Available NOx Controls for All Asphalt Plant Fuel Combustion	
State	2002 Actual	Reduction from 2002	2009 Remaining	Reduction from 2002	2009 Remaining
IL	633	0	633	158	475
IN	213	0	213	53	160
MI	686	0	686	172	515
OH	2,249	0	2,249	562	1,687
WI	233	0	233	58	175
MRPO	**4,014**	**0**	**4,014**	**1,004**	**3,011**

COST EFECTIVENESS AND BASIS

The SJVUAPCD recently analyzed the cost-effectiveness of NOx emission reductions for asphalt plants resulting from proposed new Rule 4309. The calculations were based on the assumption that operators would replace burners with low-NOx burners to meet the proposed emission limits. The requirements of SJVUAPCD Rule 4309 are similar to the Control Measure *ASPH1* identified in this White Paper, and the adoption of Control Measure *ASPH1* would likely have a cost-effectiveness similar to the SJVUAPCD proposed rule. The SJVUAPCD determined that the cost-effectiveness for the proposed NOx controls would range from $17,630 to $21,084 per ton reduced.

TIMING OF IMPLEMENTATION

Generally, sources are given a 2-4 year phase-in period to comply with new rules. Under Phase II of the NOx SIP Call, EPA provided a 2-year period after the SIP submittal date for compliance. States generally provided a 2-year period for compliance with RACT rules. For the purposes of this White Paper, we have assumed that SIP rules would be adopted in early 2007 and that a 2-year period after SIP submittal is adequate for the installation of controls. Thus, emission reductions available from the control of asphalt manufacturing plants would occur in 2009.

It should be noted that the SJVUAPCD proposed a 4-year period to bring units into full compliance with the rule requirements. This consideration is proposed because the socioeconomic impact analysis for this proposed rule identified potential impacts to this group. To mitigate these potential impacts, the compliance schedule was restructured to provide the asphalt/concrete sources extra time to comply with the proposed limits.

GEOGRAPHIC APPLICABILITY

The suggested control measures would apply to all asphalt manufacturing plants throughout the MRPO region, not just in nonattainment areas.

SEASONAL APPLICABILITY

In addition to emission reductions during the ozone season to attain the ozone NAAQS, reductions are needed throughout the year to address the PM2.5 NAAQS and regional haze. Thus, the candidate control measures are intended to be applied on an annual basis. An alternative scenario could be developed to create separate ozone season and non-ozone season emission control requirements if more stringent control is needed during the ozone season.

AFFECTED SCCs

The primary SCCs affected by this candidate control measure are:

3-05-001-01	Asphalt Roofing, Asphalt Blowing: Saturant Asphalt (with and without afterburner)
3-05-001-02	Asphalt Roofing, Asphalt Blowing: Coating Asphalt (with and without afterburner)
3-05-001-10	Asphalt Roofing, Asphalt Blowing (with and without afterburner)
3-05-001-16	Asphalt Roofing, Shingle Saturation: Dip Saturator, Drying-in Drum Section, Wet Looper, and Coater with ESP
3-05-001-17	Asphalt Roofing, Shingle Saturation: Dip Saturator, Drying-in Drum Section, and Coater
3-05-001-18	Asphalt Roofing, Shingle Saturation: Dip Saturator, Drying-in Drum Section, and Wet Looper with HEAF

3-05-001-19	Asphalt Roofing, Shingle Saturation: Spray/Dip Saturator, Drying-in Drum Section, Wet Looper, Coater, and Storage Tanks
3-05-002-01	Hot Asphalt Plants, Rotary Dryer: Conventional Plant
3-05-002-02	Hot Asphalt Plants, Hot Elevators, Screens, Bins, and Mixer
3-05-002-05	Hot Asphalt Plants, Drum Dryer
3-05-002-06	Hot Asphalt Plants, Asphalt Heater: Natural Gas (3-05-050-20 for MACT)
3-05-002-07	Hot Asphalt Plants, Asphalt Heater: Residual Oil (3-05-050-21 for MACT)
3-05-002-08	Hot Asphalt Plants, Asphalt Heater: Distillate Oil (3-05-050-22 for MACT)
3-05-002-09	Hot Asphalt Plants, Asphalt Heater: LPG (3-05-050-23 for MACT)
3-05-002-10	Hot Asphalt Plants, Asphalt Heater: Waste Oil
3-05-002-11	Hot Asphalt Plants, Rotary Dryer Convention Plant with Cyclone
3-05-002-40	Hot Asphalt Plants, Mixers: Batch Process
3-05-002-41	Hot Asphalt Plants, Mixers: Continuous Process
3-05-002-42	Hot Asphalt Plants, Mixers: Drum Mix Process
3-05-002-50	Hot Asphalt Plants, Conventional Continuous Mix Plant: Rotary Dryer
3-05-002-51	Hot Asphalt Plants, Conventional Batch Mix Plant: Rotary Dryer, Natural Gas - Fired
3-05-002-52	Hot Asphalt Plants, Conventional Batch Mix Plant: Rotary Dryer, Oil – Fired
3-05-002-55	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Natural Gas - Fired
3-05-002-56	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Natural Gas, Parallel Flow
3-05-002-57	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Natural Gas, Counterflow
3-05-002-58	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Oil - Fired
3-05-002-59	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Oil, Parallel Flow
3-05-002-60	Hot Asphalt Plants, Drum Mix Plant: Rotary Drum Dryer/Mixer, Oil, Counterflow

REFERENCES

1. National Pollutant Inventory. *Emission Estimation Technique Manual for Hot Mix Asphalt Manufacturing.* June 1999.
2. U.S. EPA. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: Section 11.1 Hot Mix Asphalt Plants, Section 11.2 Asphalt Roofing Plants.* April 2004.
3. Eastern Research Group. *Emission Inventory Improvement Program, Hot-Mix Asphalt Plants, Volume II, Chapter 3*. July 1996.
4. San Joaquin Valley Unified Air Pollution Control District. *Final Draft Staff Report: Proposed New Rule 4309 (Dryers, Dehydrators, and Ovens)*. November 17, 2005.
5. Bay Area Air Quality Management District. *Best Available Control Technology Guideline: Hot Mix Asphalt, Batch Mix Facilities*. June 28, 2000.
6. New jersey Department of Environmental Protection. *State of the Art (SOTA) Manual for Asphalt Plants*. July 1997.