3

Operating Permit Case Studies

PM10 Emissions from Hot Mix Asphalt Plants

2.0 SOURCES OF EMISSIONS[1,2]

Hot mix asphalt is a mixture of well graded, high quality aggregate and liquid asphaltic cement heated and mixed in measured quantities to produce bituminous pavement material. Aggregate constitutes over 92 percent of the total mixture weight and the relative amounts and types used determine the asphalt mix characteristics. Hot mix asphalt paving can be manufactured by batch mix, continuous mix or drum mix processes, in fixed or portable installations. Of these processes, batch mix plants currently predominate. However, most new installations or replacements to existing equipment are of the drum mix type.

Figures 2-1 and 2-2 illustrate conventional plants, which include batch and continuous processes. Raw aggregate is stockpiled at a location where the bulk moisture content stabilizes to between three and five percent by weight. As processing begins, the aggregate is hauled and placed in the appropriate hoppers of the cold feed unit. The aggregate is metered from the hoppers onto a conveyor belt and transported into a rotary dryer. The hot aggregate leaves the dryer, drops into a bucket elevator, and is transferred to a set of vibrating screens where it is classified into as many as four different grades. In a batch plant, the classified aggregate drops into four large bins according to size. The aggregate is dropped into a pug mill (mixer) and mixed dry for about 15 seconds. The asphalt is pumped from a heated storage tank, weighed and injected into the mixer. The hot mix is dropped into a truck and hauled to the job site. In a continuous plant, the dried and classified aggregate drops into a set of small bins that collects and meters the aggregate through a set of feeder conveyors to another bucket elevator and into the mixer. The hot mix flows out of the mixer into a surge hopper, from which trucks are loaded.

Figure 2-3 illustrates the drum mix process. This process simplifies the conventional process by using proportioning feed controls. Aggregate is introduced near the burner end of the revolving drum mixer and the asphalt is injected midway along the drum. An asphalt pump is linked electronically to the aggregate belt scales to control mix specifications. The hot mix is discharged from the revolving drum mixer into surge bins or storage silos.

In recent years, the asphaltic concrete industry has begun recycling old asphalt paving. The various recycling techniques include both cold and hot methods, with the hot processing conducted at a central plant. In recycling, old asphalt pavement is transported to the plant, crushed and screened to the

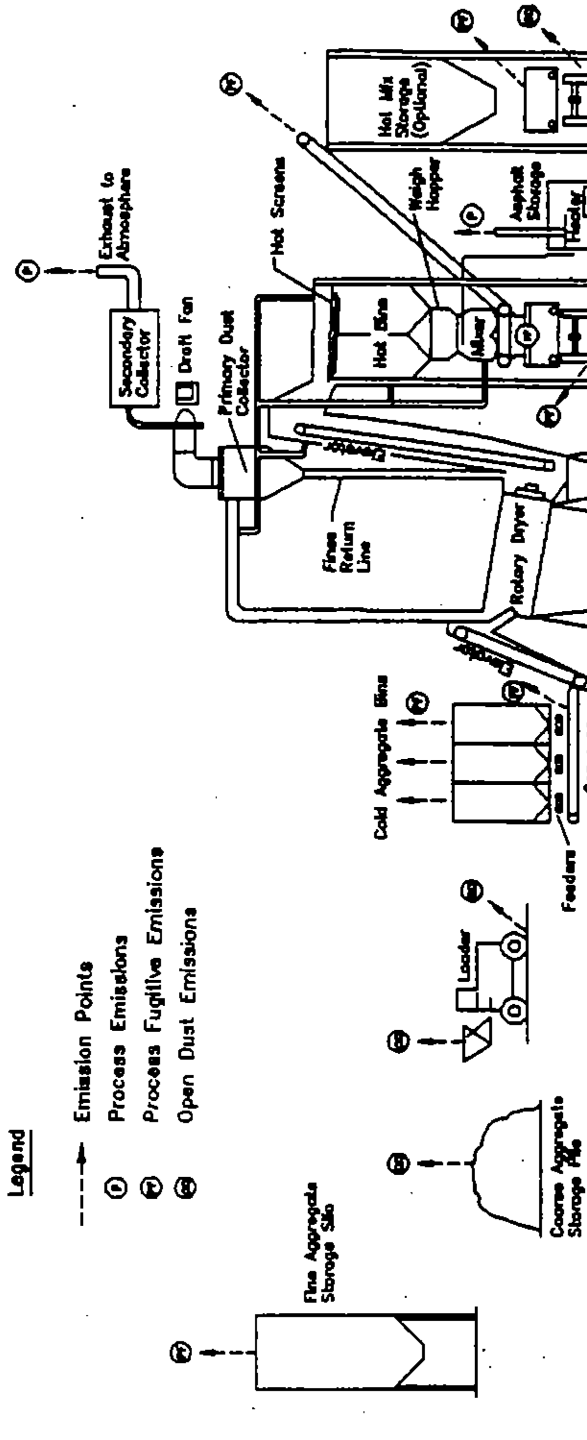


Figure 2-1. General process flow diagram for a batch mix asphalt paving plant.

Figure 2-1.

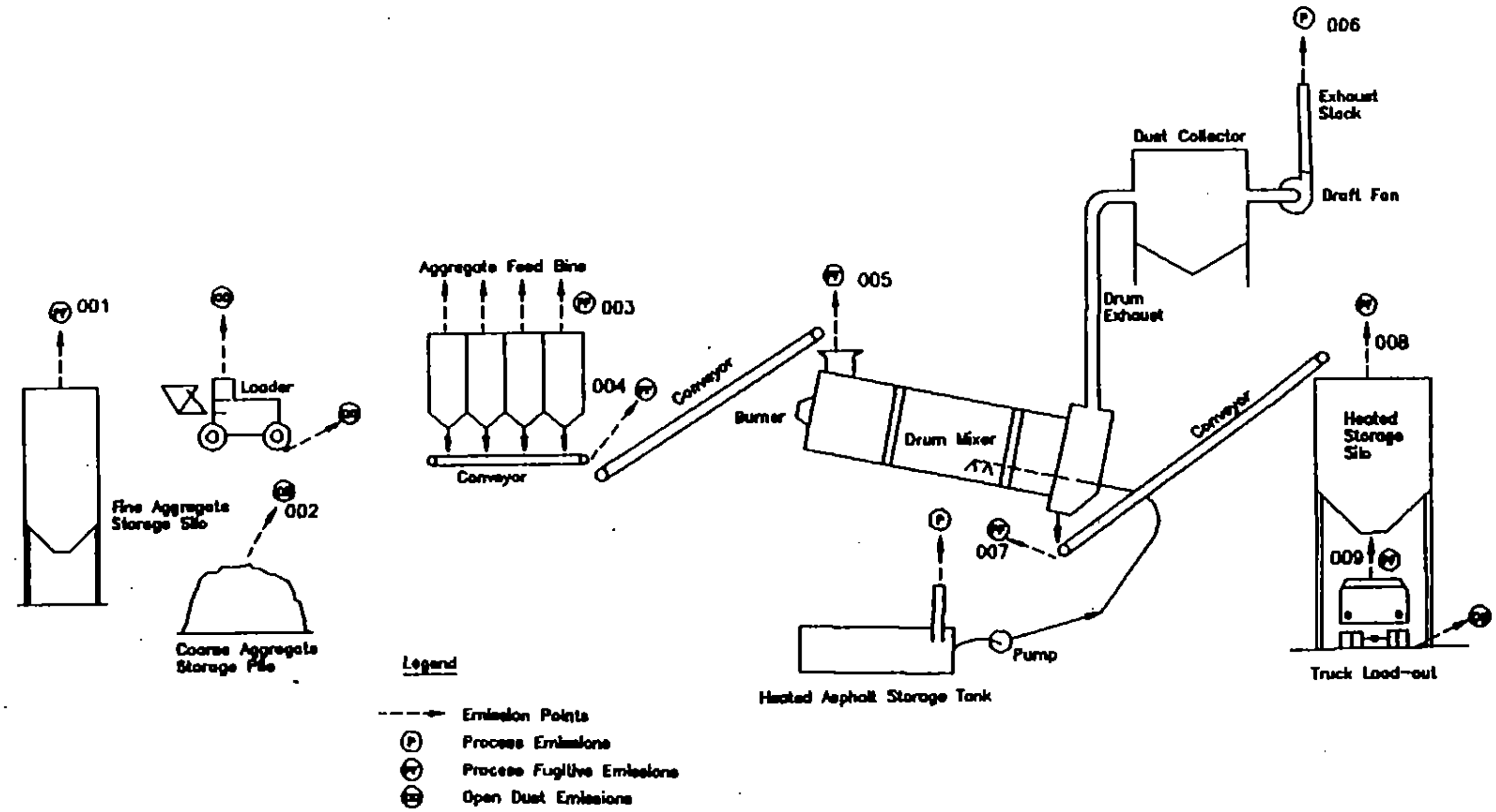


Figure 2-3. General process flow diagram for a drum mix asphalt paving plant.

QUESTION AND ANSWER WORKSHEET

1. What are the minimum components that must be contained in a Part 70 operating permit for this (or any other) source?

2. Identify the emission sources for a drum mix plant.

3. What regulations, standards, etc. would compliance of this type of source be based on?

4. What types of limits and conditions would you specify in the permit for the drum mixer itself?

CASE EXAMPLE ONE
ASPHALT PLANT

INTRODUCTION

A batch asphalt plant is required to obtain a new operating permit as part of the regulatory requirements for operating permits established under Title V of the Clean Air Act Amendments (CAAA) of 1990 and the subsequent promulgation of regulations under 40 CFR 70. The asphalt plant is a batch mix plant rated at 275 tons per hour. Particulate emissions are controlled by use of a fabric filter. The typical operation is five days per week, 10 hours per day. The actual operation is dependent upon the weather conditions and paving contracts that are active at any given time. There are times when the plant operates 24 hours per day providing asphalt for paving conducted during the nighttime hours. The asphalt plant has the capability to burn either natural gas or Number 2 grade oil to dry and heat the aggregate material used for the asphalt paving mixture. In addition, the plant has recycled asphalt paving in the past and plans to continue to do so in the future.

The purpose of this exercise is to review the available information concerning the operation and maintenance history of the plant, determine what parameters, if any, should be monitored, and develop specific permit conditions that address those concerns. You will be asked to address specific questions concerning the plant and its operation as a guide in the evaluation of permit application information.

PROCESS DESCRIPTION

The batch asphalt plant process is a series of five separate processes used in combination to produce an asphalt paving mix. The overall flow diagram for the asphalt plant is shown in Figure 1. The first step is the blending and conveying of aggregate materials that form the basis of the asphalt mix. The aggregate mixture is a blend of crushed stone of various sizes and sand to form the aggregate. Crushed stone and sand are stockpiled at the plant site according to size. Aggregate and sand are brought to individual feed bins from the stockpiles by means of a front end loader. The aggregate and sand are discharged from the feed bins onto a conveyor belt in the approximate weight blend required for the asphalt being produced at the time. "Base" mixes utilize a large proportion of large diameter (3/4 to 1 1/2 inches) crushed stone. "Top" mixes utilize a much higher proportion of sand

AN ASPHALT BATCH PLANT

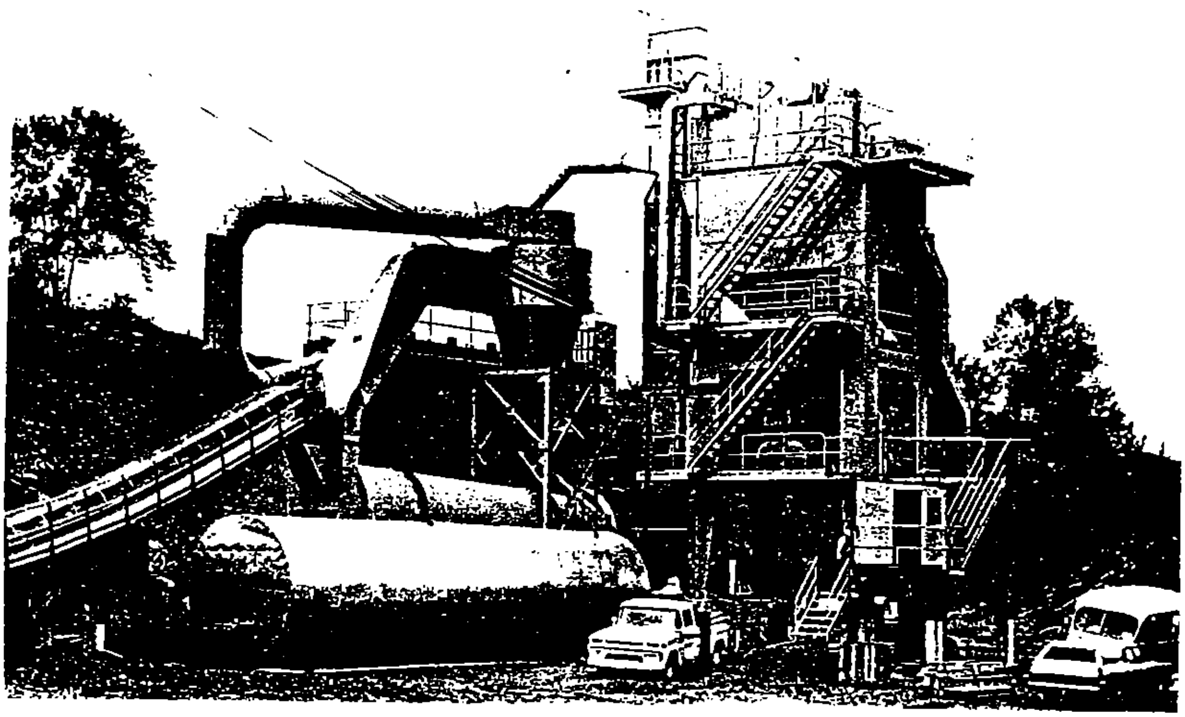
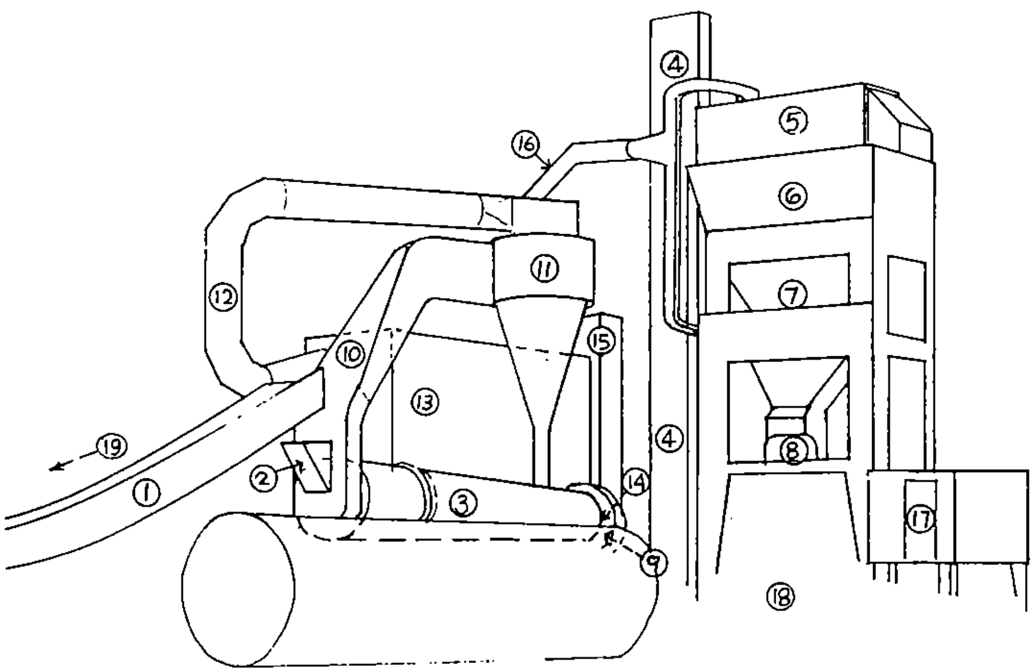


DIAGRAM OF AN ASPHALT BATCH PLANT



LEGEND

(19)	Cold Feed Bins
1	Cold Feed Conveyor
2	Dryer Feed Chute
3	Rotary Dryer
4	Hot Elevator
5	Hot Screens Area
6	Hot Bins Area
7	Weigh Hopper
8	Pugmill
(9)	Burner
10	Exhaust Duct to Primary Collector
11	Primary Collector (Cyclone)
12	Duct: Primary to Secondary Collector
13	Secondary Collector (baghouse)
(14)	Fan
15	Stack
16	Scavenger Ductwork
17	Control Cabin
18	Truck Loading Area

and fine material in the mix. The second step is the belt conveying of the "wet" aggregate blend to a rotary drum dryer. The belt conveyor is covered to reduce the potential for fugitive dust generation.

The third step in the batch process is the drying and heating of the aggregate material in the rotary drum dryer. The dryer drum is inclined slightly and material is fed into the elevated portion of the drum. As the drum rotates, the material gradually moves to the lower end of the drum. The drum is equipped with "flights" or partitions inside the drum to prevent the aggregate from merely sliding up the walls of the drum. These flights force material to fall through the center of the drums diameter where it can have more intimate contact with the hot gas stream.

Heat is provided by a burner located at the lower end of the drum. The fuel used to produce the heat is either natural gas or No. 2 fuel oil. The combustion gas is used as the source of heat to dry and heat the aggregate to its proper temperature of 425-450 °F at the aggregate discharge end of the rotary dryer. The combustion gases lose heat as they contact the aggregate and are collected by ductwork at the upper end of the drum and vented to a fabric filter. Fine materials that are suspended in the gas stream and separated by the fabric filter before discharge to the atmosphere. The dust collected by the fabric filter are conveyed to a "fines" bin for use in the final asphalt paving mixture.

The fourth step in the process is the conveying and screening of the heated aggregate. The aggregate is conveyed by a bucket elevator to a series of vibrating screens to classify the aggregate according to size. The screens provide three separate size ranges of aggregate to storage bins. Oversized material is rejected and discharged to a waste pile. This classification process allows precise control over the asphalt paving mixture characteristics to meet Department of Transportation (DOT) requirements for asphalt specifications.

The fifth and final step is the measurement, by weight, of the proportions of large and small aggregate, sand, and asphalt into the pugmill. The pugmill is a rotary screw mixer that blends the aggregate with the asphalt to produce the asphalt paving cement. After blending in the pugmill, the mixture is discharged into the bed of a dump truck. Several blending and dumping cycles are needed to fill a truck bed depending upon the size of the truck.

The largest source of process emissions is the aggregate dryer. Fine material is suspended in the exhaust gas stream and is carried out of the dryer drum. The particulate is separated from the combustion gas stream by the fabric filter. Other sources in the plant include the bucket elevator used to transport the hot, dried aggregate up to the screens and the screens themselves. These areas are kept under negative pressure by keeping the units tightly sealed and venting them to the main exhaust system and the fabric filter. This design minimizes the generation of fugitive dust emissions from the dried aggregate.

The largest potential sources of fugitive emissions during normal operations include the aggregate storage piles, vehicle traffic in the storage yard area, conveying of material from the feed bins to the dryer, and dumping of the asphalt paving material into the trucks. Fugitive dust emissions are minimized in the conveying and transfer of material by the inherent moisture of the material. Fugitive emissions from the vehicular traffic areas is controlled through the use of watering (sprinkler system) to maintain wet roadways. the fugitive emissions from the pugmill discharge in to the trucks is not controlled. The asphalt blending generally reduces the potential for fugitive dust emission. However, some small quantity of condensible organic materials are noticeable by from short-term visible opacity with a characteristic "blue haze".

Another overlooked source of fugitive emissions is the emptying of the dry material weigh bins at the end of daily operations. This dried material cannot be stored overnight and must be emptied from the system. This is accomplished by the dumping of dried aggregate into a dump truck without the application of asphalt to the aggregate. Water sprays are positioned to wet the material as it enters the truck to reduce the emission potential. This material is placed on a waste material storage pile for recycling back into the process.

The asphalt plant also periodically includes recycled asphalt paving material in the virgin feed material. The use of recycled asphalt reduces the energy required to dry an heat the material in addition to reducing the costs associated with virgin aggregate. No modification to the feed system or the dryer drum have been incorporated to handle the recycled asphalt. Through experimentation it has been determined that the maximum optimum percentage of recycled asphalt is limited to between 20 and 25 percent of the feed material for this plant. Attempts at higher percentages has generally shown the presence of a high opacity detached plume at the stack exit. This is believed to be caused by the heating of the recycled asphalt material and the volatilization of organic compounds that recondense upon cooling in the atmosphere.

PROCESS SPECIFICATIONS

As mentioned previously, the asphalt plant is rated at a nominal 275 tons per hour production rate. This rate varies according to the moisture content of the feed material and drops substantially when the aggregate material is very wet, particularly after heavy rainfall. The burner for the dryer is nominally rated at 100 x 10^6 Btu/h using either natural gas or No. 2 oil. Natural gas is the preferred fuel. However, during periods of wet weather when the aggregate is at a higher than normal moisture content, the firing of No. 2 oil is preferred because it produces more useable heat and less moisture from the combustion of the fuel. Fuel flow to the burner is not monitored or measured. The operator maintains control of the plant by monitoring the demand for aggregate and the temperature of the dried aggregate leaving the dryer.

The system fan is rated at 50,000 actual cubic feet per minute (ACFM) to draw the dryer exhaust and other gas streams through the fabric filter. The fabric filter contains 360 felted Nomex™ (Nomex is a registered trademark of E.I. DuPont de Nemours, Inc.) bags. Each bag is 8 inches in diameter and 12 feet long. A pulse-jet cleaning system is used to continuously clean the bags during operation. The cleaning system is subdivided into three compressed air headers. Each header supplies compressed air for cleaning of 12 rows of bags. Each row contains 10 bags. The overall configuration of the system is a 36 x 10 bag configuration. Access to the bags for replacement is provided by doors located on the top of the fabric filter.

The normal operating temperature of the fabric filter is between 350 and 375 °F. Temperatures vary depending upon the ambient temperature, moisture content of the aggregate feed, and the percentage of recycled asphalt added to the dryer. A temperature indicator (thermocouple) is located at the fabric filter inlet to provide the operator with an indication of the fabric filter operating temperature. The temperature of the aggregate as it is discharged from the dryer in to the bucket elevator to the screens is also monitored. The fabric filter pressure drop is also measured by a differential pressure gauge. The typical pressure drop ranges between 3.5 an 6.0 inches of water across the fabric filter. The nominal compressed air pressure for the cleaning system is 100 pounds per square inch, gauge (psig).

The production rate for the asphalt plant is not instantaneously or continuously monitored. Each batch of asphalt is formulated according to a DOT formula depending upon the application of the asphalt paving material. The weigh scales below the storage bins are used to approximate the quantity of large and small aggregate as well as the quantity of asphalt blended with the aggregate prior to mixing in the pugmill and dropping into a truck. The approximate hourly production may be estimated by calculating the net weight increase of the trucks as they enter and leave the plant. This information is recorded by the plant for billing purposes.

OPERATING HISTORY

The asphalt plant has been in operation at the same location since 1972 adjacent to a quarrying operation. The components have been gradually replaced or repaired over the plants operating history as a result of normal wear and tear. Initially the asphalt plant operated with a low energy wet scrubber to control particulate emissions. However, problems with water quality and discharge permits provided the incentive to remove the scrubber and replace it with the fabric filter. The fabric filter was installed in 1977.

Early experiences with the operation of the fabric filter were not good. Three complete change-outs of the bags were required in the first three years of operation. Problems included excessively high temperatures that led to premature failure of the bags, and high pressure drop across the fabric filter due to the presence of moisture blinding the bags. Pressure drops in excess of 10 inches were encountered and when this occurred, excessive fugitive emissions were generated at the dryer, bucket elevator and screens. The Agency cited the asphalt plant operators several times for violation of opacity regulations and failure to provide adequate controls for fugitive emissions. Corrective actions included placing a temperature measurement device in the gas stream prior to the fabric filter to monitor inlet gas temperature, the installation of improved compressed air dryer/separators to remove water and oil that may be entrained in the compressed air, routine preventive maintenance of the compressor, and changes in operations during routine daily start up and shut down of the plant. The fourth set of bags installed lasted approximately two years before excessive leakage and high pressure drop forced the replacement of the bags. Since 1982, the fabric filter has had an average bag life of four years.

The Agency required annual stack testing to determine compliance with emission limitations early in the plant's operating history. These tests, coupled with routine inspections constituted the Agency's compliance policy during the early years. However, the lessening of operation and maintenance problems (as evidenced by increased bag life and fewer problems with fugitive emissions) have allowed a change in compliance determination procedures. The plant has requested a waiver of annual stack test requirements in favor of routine testing using a fluorescent dye and visual screening with an ultraviolet (black) light to determine the presence of bag leaks or seal leaks between the bags and the tubesheet connections. The procedure requires the addition of the dye to the gas stream at the end of the production day. The access doors on the top of the fabric filter are opened and when it has become adequately dark after sunset, visual scanning for the presence of the fluorescent dye on the tubesheet or in the bags is conducted. The plant usually performs these visual inspections on a monthly basis. The Agency has required testing after the routine installation of a complete set of bags but has accepted the use of the visual blacklight test as an acceptable indicator of the fabric filter performance in achieving compliance with the emission limits.

Beginning in 1984, the asphalt plant was granted permission to add recycled asphalt to the aggregate feed. Initial experimentation with the feed percentage indicated that although the plant could successfully achieve addition of between 40 and 45 percent recycled asphalt by weight, it was not possible to achieve the regulatory limit for opacity (20 percent using Reference Method 9). A "condensing" plume or haze was formed beyond the stack exit and the temperature of the gas stream entering the fabric filter was higher than normal (400-425 °F). The plant conducted several tests at differing feed percentages to determine the affect on the measured particulate emission rate. The results of the stack tests determined that the plant could comply with the particulate emission limitation (57.7 lb/h) at all nominal feed percentages up to 45 percent. The opacity observations, however, would exceed the regulatory limit when the feed percentage approached 35 percent of the mixture entering the dryer. It was believed that this increase in opacity was due to the combined effects of increased temperature through the fabric filter and the volatilization of some of the organic constituents of the asphalt upon reheating in the drum. These constituents would then condense after passing through the fabric filter. Based on these results, the plant decided that it would limit the feed percentage of recycled asphalt to less than 30 percent rather than petition for a variance from the opacity limitation. The use of recycled asphalt as part of the mixture is not a continuous operation. Approximately forty percent of all asphalt paving sales, however, use recycled asphalt, however.

QUESTIONS

With the information provided in this example, answer the questions below. The case examples and the problem solving session are group activities. Develop a consensus opinion where more than one answer appears appropriate. If you substantially disagree with the opinions of the group you should note this and raise your issues during the discussion period.

1. As a permit engineer you will often be required to verify assumptions and calculations to determine if they are consistent with regulatory requirements or typical operating parameters. For example, you may be required to review control equipment parameters to determine if they are consistent with the process and whether the values fit typical norms. Please calculate the following values:

   Estimated total cloth area: ______________________________
   ____
   ____

   Estimated air-to-cloth ratio: ______________________________

   Is the value for the air-to-cloth ratio within the normal range expected for fabric filters using pulse-jet cleaning systems: ______________________

2. Since this an existing system with an operating history, you have information that supports the conclusion that the ventilation system is adequately sized to handle the gas volume produced from the operations. With the heat input of the burner provided to you, illustrate how you would estimate the gas volume produced by the combustion of either oil or natural gas. For the purposes of this estimation you may assume an excess air level of 40 percent: ____________________
   ____
   ____
   ____
   ____
   ____

3. The estimated combustion gas volume is substantially lower than the rated gas volume handling capacity of the fan and the fabric filter. However, the gas flow measurements obtained during stack testing have consistently shown gas volumes to be in the range of 48,000 to 50,000 ACFM. How would you explain this apparent discrepancy? ____

4. List the major elements that you would include in the permit such as stack testing requirements, or reporting requirements. This list should include major topic areas for the permit as well as site-specific issues such as use of recycled asphalt.

5. The asphalt plant has installed a thermocouple at the fabric filter inlet with a display output in the control room for the operator. In addition, a differential pressure gauge is also installed but its readout is not available to the operator in the control room. Based on the information provided would you require the installation of continuous recording devices for temperature and pressure drop at the fabric filter and why? If

this plant was a new source just being constructed, would you have answered differently? ____________________

6. Develop specific permit conditions to establish production limitations, emission limits, and emission testing methodology.

Production limitations: ____________________

Emission limitations: ____________________

Emission testing requirements: ____________________

7. Develop any "special" permit conditions that you believe would help maintain continuous compliance and assist in long-term operation and maintenance of this plant and its control equipment: ______________________________