

**DIVISION OF AIR QUALITY
TOXICS PROTECTION BRANCH
AIR TOXICS SUPPORT TEAM
INVESTIGATION OF ASPHALT TERMINAL MODELING SCENARIOS**

Investigation # 03008

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An ambient air monitoring study along with emission tests were conducted in 2001 to estimate concentrations of several toxic pollutants in a residential suburban area adjacent to a liquid asphalt distribution terminal (Associated Asphalt, Inc.) and a hot mix asphalt plant (APAC-CAROLINA, Inc.). This study was conducted in response to air quality issues arising from odor complaints and potential health concerns from residents of the Milford Hills area in Salisbury, NC. To address these concerns, the NC Division of Air Quality (DAQ) performed ambient air monitoring and dispersion modeling of the relevant air pollutants of interest, including hydrogen sulfide (H₂S). The federal Agency for Toxic Substances and Disease Registry (ATSDR) provided H₂S monitors and technical assistance to support the quality control of the data produced by the monitors.

Asphalt terminal operations in terms of emission control practices have evolved before and after the study over the recent 5-year period. As a result, concerned citizens and ATSDR were interested in the corresponding exposures from the different practices (referred to as “operating scenarios”) of the community to ambient H₂S concentrations. In response to citizen’s and ATSDR request, DAQ performed dispersion modeling of emissions from different asphalt terminal operating scenarios. The assumptions, procedures, and results of the modeling are discussed in the remainder of the memorandum, which consists of the following sections:

1. Background on Asphalt Facilities Emission Control Practices in Salisbury.
2. Dispersion Modeling
3. Regulatory Implication
4. Conclusions
5. References

Background on Asphalt Facilities Emission Control Practices in Salisbury

Nuisance odors are commonly linked with asphalt operations. That connection is an oversimplification of a four-step asphalt supply chain from manufacture to end-use. Before asphalt becomes a roadway it is: 1) Refined at a petroleum plant, 2) Transported via rail or barge to, and stored at, a terminal, 3) Transported via tanker-truck to a hot-mix plant, where it is mixed with aggregate, and 4) Transported via truck and applied to become a roadway. Each process step has a unique odor magnitude and emission profile.

In Salisbury a hot-mix plant and a terminal share a property line. Concerned about odor and potential health problems, residents of the Milford Hills area registered over four hundred complaints with DAQ and the City of Salisbury. An investigation was conducted by DAQ in 2001. That investigation found that H₂S emissions from the asphalt terminal were the primary cause of these odors, and that based on modeling relative to the current AAL, each facility met the current AAL.¹ Table 1 presents the annual H₂S emissions for the two asphalt facilities involved.

The Associated Terminal emissions measurements were collected under normal operations using EPA Method 15 for H₂S. NC DAQ requested the testing, approved the test plan, audited the on-site measurements and process conditions during testing, and approved the test report.² Testing occurred in September of 2001 and the final report was received by DAQ in November 2001. Given that high H₂S emission concentrations were measured at the asphalt terminal and levels above the odor threshold were detected in the neighborhood, a question remained as to what were the H₂S emissions from the hot mix asphalt facility. DAQ staff surveyed operations and emissions at the hot-mix terminal. The purpose of the emission survey was to assess whether there were detectable levels of H₂S emissions from the APAC facility. Given this objective to assess (and not formally determine) H₂S emission concentrations, it was decided to use DAQ survey instruments. DAQ ambient air monitors are capable of producing only estimates of the actual emission levels of the pollutants in question. Drager tubes and a multi-gas electrochemical monitor manufactured by RAE Systems were used. Their accuracy and precision in this application is considered to be limited to one significant figure. The temperature and moisture of the dryer-mixer vent gas stream were at the edge of the acceptable instrument range established by the manufacturer.

Table 1. Salisbury Emissions Observed During the DAQ/ATSDR Study.

Terminal (Associated)	Annual Throughput	EF (a) (lb/hr)	EF (a) (lb/ton)	Actual (b) (lb/yr)	Potential (c) (lb/yr)	Equipment in operation (%)
Tank Filling	120,000 tons	0.3000	0.004900	588	2,628	22 %
Tank Heating	4 tanks, 24hr/day	8.1E-6	#N/A	0.3	0.3	100 %
Truck Loadout	120,000 tons	0.0008	0.000017	2	7	31 %
Railcar Heating (d)	1,330 cars	0.0061	#N/A	128	53	240 % (e)
Total				718	2,688	

Hot-Mix Plant (APAC)	Annual Throughput	EF (lb/hr)	EF (lb/ton)	Actual (lb/yr)	Potential (lb/yr)	Equipment in operation (%)
Tank Filling	4,340 tons	0.01	0.0002	1	88	1 %
Dryer-Mixer	101,000 tons	0.7	0.0050	505	6,132	8 %
Total				506	6,220	

FOOTNOTES

- (a) = Emission factor
- (b) = Actual emissions calculated by multiplying lb/ton EF by annual throughput.
- (c) = Potential emissions calculated by multiplying lb/hr EF by 8,760 hr/yr.
- (d) = During DAQ study railcars heated on average 15.8 hours.
- (e) = Potential assumes one railcar is heating continuously. Typical shipment is ten cars; approximately three heat at a time.

Both facilities had approximately the same total actual annual emissions (terminal 718 vs. hot-mix 506 lb/yr). Table 1 shows that terminal tank filling and the hot-mix dryer-mixer are responsible for the majority of plant emissions. Not shown in Table 1 are the individual source exit gas characteristics (see Table 13 in Reference 1 for exit gas characteristics). Off site odor and dispersion are greatly dependant on exit gas characteristics. The flowrate (cubic feet per minute) at those sources are very different. The dryer-mixer flowrate is 1,000 fold greater than terminal tank fillings. This results in more favorable dispersion of the hot-mix plants H₂S emissions; off site impacts are very low, even below odor thresholds. APAC is apparently similar

in size and operation to the other 210 plants statewide hot-mix asphalt plants.³ Given this similarity, hot-mix plants are expected to cause minimal public exposure to H₂S and will not be discussed here further.

Although the asphalt terminal emissions were not in violation of any DAQ rules based on the 2001 DAQ study, the NC Division of Public Health, Occupational and Environmental Epidemiology Branch (DPH-OEEB) believes that an increased risk of bronchial constriction for asthmatics and nasal mucosa inflammation resulted from offsite H₂S levels in Salisbury.⁴

At one point in time Associated operated with no air pollution control equipment. DAQ reconstructed four historical operating scenarios, or terminal emission control practices, that occurred over the past 50 years. One of those conditions is considered “typical” and used to represent exposure levels to the other terminals located in the state. Presented below chronologically are the four scenarios depicting different process descriptions:

1. Chevron opened an asphalt terminal at 1825 Jake Alexander Blvd in 1952. In 1996 the terminal changed owners from Chevron to Associated (then called Inman Asphalt). Little is documented about historical process throughput, but a former employee indicated that previous levels were similar to current levels (100,000 – 120,000 ton/year; for the purpose of this modeling effort, we assumed the worst-case throughput of 120,000 ton/yr). Tank storage capacity in 1997 was 630,000 gallons. Figure 1 is an aerial photo of the 1996 facility.
2. Between 1997 and 2001 Associated expanded its processing capacity 6-fold (4,000,000 gallon storage tank capacity) and its boiler capacity 7-fold to heat asphalt in the storage tanks. Figure 2 is an aerial photo of the facility in 2001. During 2000 for less than one-year a 1,000 cubic feet per minute (cfm) rating fan was installed to draw and collect vapors from the storage tanks through a container sprayed with Ecosorb™ solution.⁶ The rationale for this configuration was apparently twofold: experiment with the use of Ecosorb™, and experiment with reducing the buildup of vapors in the tank headspace for safety considerations. For example, another processing / storing asphalt company, Owens Corning, has documented concerns over vapor space explosion hazards from asphalt tanks. Most Owens Corning’s tanks use a fan to vent and control the vapor space composition and prevent explosive conditions. Owens operates an asphalt roofing manufacturing plant and road asphalt paving terminal in Morehead City, NC.⁷
3. In September 2001 extensive source testing was performed. At that time the fans venting the storage tanks had been removed. Two separate strategies were employed for emission reduction. At the truck loadout carbon beds were being used. Although not documented by the source testing, carbon beds have previously demonstrated significant removal efficiencies (greater than 85%) on various applications and for many pollutants. Indications from the emission test is that carbon beds exhibit a 99.9+% collection efficiency for H₂S, assuming the same H₂S concentration between the storage tank and truck loadout vents. Conversely, storage tank emissions were vented into scrubber spraying a dilute solution of plant oils, known as Ecosorb™. At two locations where source strength was expected to be equal testing showed relatively high concentration of 2,370 ppm H₂S exiting the Ecosorb™ scrubber and relatively low levels of 0.2 ppm exiting the carbon bed. Based on these data and statements in product literature emission reduction capabilities are indicated and assumed to be near or at zero.

4. At the completion of the DAQ study the facility was found in compliance with the NC toxic air pollutant guideline. However, carbon beds were installed on all three storage tank vents in April 2002, and this control configuration has remained since then.

Figure 1. Arial Photograph of the Associated Terminal in 1996.



Figure 2. Arial photo of the Associated Terminal in 2001.



In Table 1 two distinct categories of emissions from tanks are identified: tank filling and tank heating. Tank filling emissions (or working losses) occur when the tank is being filled. Conversely emissions from tank heating (or breathing losses) occur when liquid expands and contracts due to changes in ambient temperature or barometric pressure. Stored asphalt is maintained at approximately 300°F, a pumpable temperature.

Recall the scenarios discussed above, specifically scenario two. Between 1997 and 2001 Associated installed several hundred feet of ducting and four 1,000cfm fans to draw and collect storage tanks vapors. As part of a good-faith effort to control emissions three different control devices were evaluated at the exit of the system: a series of activated granular carbon canisters, a fiber glass pre-filter in front of the carbon canisters, and Ecosorb™ scrubber.

On or about August 2000 Associated had the Ecosorb™ scrubber installed. As discussed above Ecosorb™ emission reduction capabilities are assumed to be near or at zero. H₂S concentrations were observed during tank filling using two different sampling methods. Using a semi-quantitative Drager tubes DAQ staff showed concentrations of 400 ppm H₂S, facility staff owned a multi-gas monitor and measured 200ppm, that value was 10 fold higher than the monitors audit gas. As a conservative estimate the lower concentration, 200ppm, is believed to be true. Actual fan pumping rates were measured at 710 cfm.

Owens Corning, another large-scale asphalt processor with operations in Morehead City, is fundamentally different than Associated. The terminal sells both roofing tar and paving asphalt. Owens Corning in conducted similar emissions tests and identified that a lower explosive limit (LEL) monitor could be an effective surrogate for H₂S concentrations.⁸ Owens Corning emission tests cannot be applied to Associated. Roofing tar is chemical and physically a different material. Emission factors observed by Owens cannot be transferred to any historical Associated scenario.

Using Associated source data, ATAST observation data, and vapor space properties assumptions, emission factors were calculated; each is presented below in Table 2. For estimation purposes the following two data sets were used in calculation of the “Tank Filling / uncontrolled (fan)” scenario below: a) the measured concentrations from the ATAST investigation in August 2000, b) the tank filling pump rate and the fan flowrate from the September 2001 source test. The operation of the fan increases the emission factor (lb/ton) from 0.0049 to 0.0120. This data suggests that use of the fan had the undesired consequence of increasing H₂S emissions during tank filling operations. This hypothesis has not been confirmed and could warrant further investigation.

Table 2. Asphalt Emission Factors from the Associated terminal

Source Description		Quantity or Rate	Emission Factor	
			(lbs H ₂ S / ton asphalt)	(lbs H ₂ S / hr)
Tank Filling	uncontrolled (no fan)	61 ton/hr (237 gpm)	0.004900 (a)	0.3000 (a)
Tank Filling	uncontrolled (fan)		0.012000 (b)	0.7400 (b)
Tank Filling	controlled		0.000017 (c)	0.0010 (c)
Tank Heating	uncontrolled (no fan)	Approx. 4 mil gal storage	#N/A	8.1E-6 (a)
Truck Loadout	uncontrolled	138 ton/hr (536 gpm)	0.004900 (c)	0.6800 (c)
Truck Loadout	controlled		0.000017 (a)	0.0008 (a)
Railcar Heating	uncontrolled	90 tons in railcar	#N/A	0.0061 (a)

Source footnotes:

- (a) Associated source test in September 2001.
- (b) ATAST observation in August 2000.
- (c) Vapor space properties assumptions.

Dispersion Modeling

Each of the above four scenarios was modeled using the Air Quality Analysis Branch (AQAB) normal compliance determination procedures.⁹ A digital map of the September 2001 facility was created, and receptors (or discrete ground level points) were placed around the terminal property boundaries. The predicted maximum impacts are presented in Table 3. Also presented in the table are approximated impact radii. An impact radius is not a normal AQAB product but one that will estimate the exposed area. Combined with population density a number of persons affected annually can be calculated. Two threshold values (56 ug/m³ and 33 ug/m³) were chosen to define the radius. The two values correspond with Science Advisory Board (SAB) recommended revisions in the H₂S AAL. Each proposed AAL is chosen to protect against 100% of adverse health even in sensitive populations; i.e. based on the epidemiological literature, ambient concentrations below 56 ug/m³ and 33 ug/m³ should prevent all asthma attacks in asthmatics and eye pain respectively. A third threshold value (120 ug/m³ with a 24-hr average period) was also proposed by the SAB to protect against nasal mucosa inflammation.¹⁰ Based on modeling no asphalt terminal are expected to cause a 24-hr average greater than or equal to 120 ug/m³. Nasal inflammation effects are not expected.

For modeling simplicity, the following two assumptions were made:

- 1) The Salisbury Terminal operates 3-separate tank systems. Submitted process records show one system was used the majority of the time. Plant wide throughput was assumed to be though that one system. And
- 2) It has been indicated that terminal throughput over the past decade was comparable to current levels (100,000-120,000 ton/yr). Unfortunately no historical pre-1990 throughput information is available. Both management style and storage capacity can affect throughput, but one cannot be calculated from the other.

Table 3. Terminal control matrix for hydrogen sulfide emissions

	Long-standing (1952-1999)	Aug. 2000	Sept. 2001	April 2002 to present
Tank Filling	Uncontrolled w/o fan	Uncontrolled w/ fan	Uncontrolled w/o fan	Controlled w/o fan
Truck Loadout	Uncontrolled	Uncontrolled	Controlled	Controlled
Railcar Heating	Uncontrolled	Uncontrolled	Uncontrolled	Uncontrolled
Estimated years of operation (years)	~ 45	1	1	1
Actual Annual Emissions (lb/yr)	1,304	2,043	718	132

Relevant Proposed Standards; 56 ug/m3 (human-airway resistance)

1-hour max impacts (ug/m3)	900	1,103	404	9.2
Radius of impact (miles) Concentration greater than 56	0.7	1.2	0.2	0
Area (miles square)	0.4	1.1	0.05	0
Persons exposed (a)	56	168	7	0
Asthmatics exposed (b)	6	17	1	0

Relevant Proposed Standards; 33 ug/m3 (human-eye pain)

24-hour max impacts (ug/m3)	86	114	59	1.3
Radius of impact (miles) Concentration greater than 33	0.12	0.12	0.3	0
Area (miles square)	0.01	0.01	0	0
Persons exposed (a)	2	2	0	0

FOOTNOTES

(a) = NC pop density is 153 per square mile; US 2000 census

(b) = 10% Asthma incidence; DPH-OEEB

Table 3 presents the actual annual emissions and the offsite impacts for each of the four historical scenarios of the Associated terminal. Annual emissions were calculated using this emission factors presented above in Table 2. The most significant observation is that over time the actual annual emission (lb/yr) has decreased, with the exception of August 2000. The trend interruption confirms the undesired increase in storage tank emissions resulting from active ventilation with a fan as compared to passive ventilation without a fan. The modeling predictions (1-hr max and 24-hr max) follow a similar pattern. The shaded gray cells represent an exceedance of the proposed AAL guidelines. Only the Associated current facility scenario would comply with all the proposed AAL guidelines.

The radius of impact has no direct regulatory relevance and is presented only to estimate community exposure; i.e. a person living 0.69 of a mile of Associated (slightly inside the impact radius) in 1990 would have been exposed, at least once, to a concentration greater than 56ug/m3 for one hour, that same persons would have not exposure a 24-hr average of 33ug/m3. Assumptions about population density and asthma incidence were made.

Regulatory Implication

The implications statewide are complicated to predict. Each facility has unique control devices, property boundaries, and stack gas characteristics. Compliance is determined on a facility-by-facility basis. In collaboration with the NC Department of Transportation (DOT), the states largest purchaser of asphalt, 14 terminals were identified.⁵ DOT and DAQ databases were merged below in Table 4a and 4b.

Six terminals were investigated by DAQ Central Office staff as part on an informal survey: Four terminals in Wilmington were visited in cooperation with DOT staff on a routine visit; Transflo terminal was visited because of its close proximity to the DAQ headquarters; and Owens Corning was investigated, but not visited.

The main survey conclusion was that these terminals have different process characteristics and different emission control practices. Four of the 14 terminals sell only emulsified asphalt. Emulsified asphalt is the combination of three basic ingredients: asphalt, water, and an emulsifying agent. Liquid at ambient temperatures, this mixture is typically used for paving tertiary roads and for dust suppression, erosion control, or road repair. The Central Oil terminal had the smallest throughput and onsite storage of all facilities visited. Emissions of H₂S are present but at lower concentrations; roughly 40% less than standard asphalt.¹¹ Each other Emulsion terminal was contacted and questioned about their throughput. Based on smaller throughput and less emissions, emulsified terminals will likely not be affected by an H₂S AAL revision as much as paving asphalt terminals.

Table 4a. Department of Transportation Supply Terminals (Binder Asphalt)

Company Name	Address	City / Phone	Facility ID / Class	Air Pollution Control Device
Transflo Terminal Services, Inc. (Coastal Fuels)	604 N. Salem St.	Apex, (919) 362-8675	9200505 Small	Railcar Heating + Truck Loadout
Coastal Fuels	601 N. Hoskins Rd.	Charlotte,	No	Unknown
Citgo Asphalt Charlotte Terminal	1801 Westinghouse Blvd.	Charlotte, (704) 588-5290	No	Unknown
APAC	1124 S Holden Rd	Greensboro, (336) 292-6875	No	Unknown
Owens Corning Trumbull Division	107 Arendell St.	Morehead City, (252) 726-4101	1600074 Title V	Tank Filling, Truck Loadout, + Product Mixing
Associated Asphalt	1825 Jake Alexander Blvd	Salisbury, (704) 636-0781	8000148 Small	Tank Filling, Railcar Heating, +Truck Loadout
Chemserve Terminal Inc	2005 N 6th St	Wilmington, (910) 762-8588	6500240 Title V	None
Citgo Asphalt Refining Company	3345 River Rd.	Wilmington, (910) 799-0483	6500013 Title V	None
Apex Oil Co.	3314 River Rd	Wilmington, (910) 799-0030	6500147 Small	None
Coastal Fuels	5025 Overdale Rd	Winston-Salem	No	Unknown

Table 4b. Department of Transportation Supply Terminals (Emulsified Asphalt)

Central	PO Box 33	Black Mt, 28711	No	Unknown
Asphalt Emulsion, Inc	151 Emmett Road	Dunn, (910) 230-3640	No	Unknown
APAC-Tapco	PO Box 21088	Greensboro, (336) 292-6875	No	Unknown
Central Oil Asphalt Corp	3345 River Rd	Wilmington, (910) 799-2905	No	None

Owens Corning is another operation fundamentally different than the normal paving asphalt terminal. Owens Corning in Morehead City sells both roofing and paving asphalt. This dual-purpose operation requires onsite blending of different asphalt grades (paving grade, roofer’s flux, and “zero pin”) to meet customer demands typically specified by physical properties (i.e. Performance Grade). Asphalt is oxidized in a high temperature blower and the resulting emissions are incinerated.

The Owens Corning calculates emissions based on proprietary corporate emission factors. Table 5 below presents itemized emissions as reported in their 2000 inventory, significant portions of which are from tank filling. Owens Corning has a total of 16 storage tanks; emissions from seven tanks are controlled with fiber bed filters. While these filters are effective in collection of entrained aerosols and reducing opacity, they are not effective for H₂S removal.

DAQ has not modeled the Owens Corning facility emissions. Initial observations from the emissions inventory are that the actual H₂S emissions are three-fold greater than any of the four Associated scenarios. The facility may have problems complying with the current or a revised H₂S AAL because of the storage tank emissions.

Table 5. Itemized Owens Corning Emissions.

Source	Emissions (lbs/yr)	Percent of total
Boiler, Preheater, Tank Burner	0	0
Asphalt Tanks (16 total; 7 controlled)	6,384	88%
Remelt Process Tanks (no controls)	0	0
Converters	755	10%
Truck Loading Racks	107	1%
Total	7,246	

The Transflo terminal in Apex is yet another unique terminal. It maintains no on site storage tanks. Liquid asphalt is only pumped once from a heated rail car to an individual customers tanker truck, thereby reducing working emissions by a factor of two. This is possible through a close relationship with a refinery. Transflo customers contact the refinery directly to make a purchase; it is the responsibility of the refinery to guarantee an appropriate supply. Conversely, Associated has no single, standing refinery relationship and buys asphalt on the open market. Consequently, significant onsite storage is required. Figure 3 shows the single loadout rack and the row of asphalt storage at the CSX facility.

In addition to the zero storage tanks, Transflo maintains two carbon bed control devices to control railcar emissions and truck loadout. Typically asphalt arrive onsite as a solid. Before asphalt is unloaded it must be heated to pumpable temperatures at/above 290°F. Associated testing showed a small amount of airflow out of the railcar was measured during heating. However, qualitative flow measurements during railcar unloading showed that the direction of airflow was negative – meaning that air was being induced into, and not out of, the railcar. Although expected affect of emissions is expected to be minimal, Transflo places a cap unit over each railcar hatch during heating. Each cap is approximately 2-feet in diameter and filled with activated carbon, as well as a modified truck air filter that prevents the carbon from seeping into the railcar. Each dome filter uses about one pound of activated carbon. The carbon is changed whenever the air filter turns black. The second Transflo control device is similar to the Associated terminal truck loadout system; during loadout displaced air is drawn through an activated carbon canister. The Transflo is most similar to the “April 2002 to present” Associated condition, and is expected to comply with any of the three H₂S AAL proposals.

Figure 3. Transflo Asphalt terminal, Apex NC.



Properly maintained carbon devices can be very effective for pollution control, provided good operation and maintenance practices. For example, the Associated permit requires frequent testing for breakthrough with a handheld monitor. When breakthrough is indicated, the old carbon bed is removed and a new one is installed.

Chemserve, Citgo, and Apex are the remaining facilities involved in the informal survey. These three Wilmington terminals receive asphalt by barge and operate no air pollution control devices. Only Chemserve had on site storage of additional chemicals (e.g. sodium dichromate and sulfuric acid). All three facilities are similar to the “longstanding” operations at Associated. Compliance is determined on a facility-by-facility basis, but each of these facilities may have problems complying with the current or a revised H₂S AAL and would be forced to install air pollution control devices (APCDs) to comply.

No final decision has been made yet on revising the current H₂S AAL. The Environmental Management Commission (EMC) and the Air Quality Committee (AQC) are/will be considering each SAB recommendation, several exemptions, and public comments. The decisions of the EMC and AQC would not affect the current control practice at the Associated terminal. If the AAL is changed to 120 ug/m³ with a 24-hr average period or remains unchanged, the Associated terminal would comply in all four of its historical configurations. If the EMC lowers the H₂S AAL to either the two lower SAB chosen threshold values (56 ug/m³ and 33 ug/m³) Associated will be forced to maintain its current control equipment consistent with the “April 2002 to present” condition.

Figure 4. Transflo Railcar hatch cover



Conclusions

The TPB has investigated the Associated terminal for approximately one year. Many lessons have been learned about the production and distribution of asphalt. Extrapolation of emissions and affected people to terminals statewide should be done with considerable caution. Facility throughput, plant design, and population density vary significantly.

Several DAQ action items have been identified. First, many of these terminals are not currently permitted. NC permit procedures are such that emissions are less than 5 ton/year and if no APCD is operated, then no air permit is necessary. Associated was brought to the attention of the TPB by persistent citizens. The result of that attention was the discovery of nontrivial H₂S emissions from terminals based on source testing.

This memorandum will be brought to the attention of the DAQ compliance workgroup. The emission factors presented below in Table 2 will be considered with respect to Toxic

Permitting Exemption Rate (TPER) and appropriate action will be taken. Based on these limited survey results, annual emissions at terminals may likely be underreported.

At least 6 terminals are currently permitted. Regional offices should look critically at emissions inventories. Of the 15 terminals in Table 3, only 2 reported any H₂S emissions in their 1999 emissions inventory. One issue is not completely resolved; sulfur content, and presumably H₂S emissions, vary based on the source of the refined crude. Material Safety Data Sheet (MSDS) sheets document less than 1% H₂S in asphalt from a Venezuelan refinery. Other MSDS show lower amounts of H₂S. However, all new (since 2002) MSDS that DAQ has seen contain strong statements about the possibility and adverse health effects to workers from exposure to H₂S from processing asphalt.

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