October 21, 2016

Ms. Michelle Ramirez  
Office of Environmental Health Hazard Assessment  
P.O. Box 4010, MS-12B  
Sacramento, CA  95812-4010

Subject: 2016 CIC Prioritization of Asphalt Emissions Associated with Road Paving

Dear Ms. Ramirez:

On behalf of the asphalt road paving industry — represented by the National Asphalt Pavement Association (NAPA), Asphalt Institute (AI), and the California Asphalt Pavement Association (CalAPA) — we appreciate the opportunity to comment on the Office of Environmental Health Hazard Assessment’s (OEHHA) August 2016 Prioritization Notice on Chemicals for Consultation by the Carcinogen Identification Committee. In that notice, both Asphalt and Asphalt Emissions Associated with Road Paving and Asphalt and Asphalt Emissions Associated with Roofing are on the agenda for possible prioritization and preparation of hazard identification materials. As requested, our comments will focus on the scientific evidence presented in the Prioritization Notice on Asphalt and Asphalt Emissions Associated with Road Paving, henceforth identified as “Paving Asphalt Emissions;” we do not specifically comment on Asphalt and Asphalt Emissions Associated with Roofing.

In summary, based on the scientific epidemiological and toxicological evidence reviewed below,

- **Paving Asphalt Emissions should be evaluated separately from roofing asphalt emissions** due to qualitative and quantitative differences in the composition of paving and roofing asphalt emissions; and

- **Paving Asphalt Emissions should not be recommended for priority listing, but if a listing is required, it should be considered as low-priority** due to the lack of human and animal carcinogenicity evidence as well as the current industry Consent Judgement that already requires Proposition 65 warnings for asphalt paving operations.

Our comments review the International Agency for Research on Cancer’s (IARC) 2013 Monograph evaluation and additional information identified by OEHHA post IARC’s 2013
evaluation. We include two attachments at the end of this document: an executive summary of our comments, and a brief description of the industry and innovative technologies that reduce emissions during asphalt paving operations.

**IARC and NIOSH Differentiated Industrial Sector, Asphalt Type, And Impact of Application Temperature**

In 2013, IARC re-evaluated various occupational exposures to bitumen and bitumen emissions (a.k.a. asphalt in the United States), which included road paving, roofing, and mastic applications. IARC also separately evaluated different types of asphalt used in different industries: straight-run bitumen (paving), oxidized bitumen (roofing), and hard bitumen (mastic). IARC recognized in its evaluation the significant impact of temperature on bitumen emissions; in particular, that as the temperature of the asphalt increases, changes in the composition and amount of emissions occur.

“The variable physicochemical properties of the individual constituents of bitumen mean that the composition and physical form of the emissions from heated bitumens are dependent on the temperature to which the bitumen is heated.” (IARC, 2013, pp. 35–36)

There are two well-established Chemical Abstract Service (CAS) numbers for asphalt: oxidized bitumen is identified under CAS No. 64742-93-4, and straight-run or paving-type asphalts are identified under CAS No. 8052-42-4. Oxidized asphalt is used almost exclusively in the roofing sector. Paving Asphalt Emissions should be identified with CAS No. 8052-42-4. The use of different CAS numbers for different types of asphalt, typically used in different industrial sectors and heated to different temperatures, underscores the differences in the emissions potential of asphalt at different temperatures.

Similarly, in 2000, the National Institute of Occupational Safety and Health (NIOSH) recognized that:

“An analysis of the chemical data indicates that paving and roofing asphalts are qualitatively and quantitatively different; therefore, the vapors and fumes from these asphalt products also may be different. The chemical composition of vapors and fumes from asphalt products is variable and depends on . . . type of asphalt, [and] temperature . . .” (NIOSH, 2000, p. 89)

Both IARC’s and NIOSH’s statements on differentiating roofing and paving asphalt based on application temperature are supported by the Cavallari et al. (2012) study, “Temperature-Dependent Emission Concentrations of Polycyclic Aromatic Hydrocarbons in Paving and Built-Up Roofing Asphalts,” conducted by Harvard University and others. Results from this study
clearly differentiated polycyclic aromatic hydrocarbon (PAH) emissions associated with paving or roofing grades of asphalts at varying temperatures.

Cavallari et al. (2012) observed that, in a laboratory headspace analysis, there were only a few detections of one individual 4-ring PAH in paving asphalt emissions at typical paving temperatures (≈300°F). This was not the case for roofing asphalt emissions at typical roofing application temperatures (≈400°F). As many independent studies corroborate these findings, emissions of 4-ring or greater PAHs from paving asphalt are practically non-existent at typical paving application temperatures and are quite different compared to emissions from roofing asphalt at the typically higher roofing application temperatures.

**We therefore request that Paving Asphalt Emissions are evaluated separately from roofing asphalt emissions for prioritization.**

**Epidemiological and Toxicological Evaluation of Paving Asphalt Emissions**

In OEHHA’s August 2016 Prioritization Review, the agency provides a summary table regarding evidence of carcinogenicity for mixed types of asphalt. We reviewed the summary table for applicability to Paving Asphalt Emissions. If OEHHA identified a positive association (checked box) for one of the categorized endpoints, we identify whether or not that endpoint is applicable to Paving Asphalt Emissions.

**Exposure: Limited/Occupational**

We agree with OEHHA’s assessment that Paving Asphalt Emissions do not pose a widespread exposure potential. IARC identified that:

“[h]uman exposure to bitumens and their emissions comes almost exclusively from occupational exposure during manufacture and use of the products.”

(IARC, 2013, p.36)

As noted, emissions during asphalt paving are only encountered in an occupational setting and for a very short duration during the initial phase of the application process. After the pavement is compacted, less than 30 minutes after application, there are no further emissions and traffic is often allowed back on the new pavement within a few hours.

In addition, over the past decade the paving industry has seen dramatic reductions in occupational emissions of paving asphalt through both paving machine ventilation controls and technologies like warm-mix asphalt (WMA), which reduces the paving asphalt application temperature. Furthermore, adherence to both the American Conference of Governmental Industrial Hygienists (ACGIH) TLV® and California’s Division of Occupational Safety and Health’s (Cal/OSHA) Permissible Exposure Limit (PEL) for asphalt fume ensures appropriate
occupational protection; paving asphalt emissions are well below these occupational exposure limits.

Human Data: Analytical

OEHHA’s assessment indicates there are a number of analytical epidemiological studies that have investigated the impact of asphalt emissions on human cancers. IARC’s 2013 evaluation clearly identifies that Paving Asphalt Emissions do not pose a human carcinogenic hazard, finding:

“there is inadequate evidence in humans for the carcinogenicity of occupational exposures to bitumens and bitumen emissions during road paving.” (IARC, 2013, p. 203)

OEHHA also identifies three epidemiological studies published since the 2013 IARC Monograph evaluation. However, these studies are either not applicable to paving asphalt, were previously reviewed by IARC (underlying studies), or show excessive confounding as identified below.

- Zanardi et al. (2013) studied workers in an asphalt roofing-roll factory, pre- and post-asbestos usage. Roofing asphalt is typically an oxidized asphalt product processed at temperatures much higher than that of paving applications. The process description, provided by the study authors in their external background information, indicates the processing of and subsequent exposure to roofing asphalt emissions are not relevant to Paving Asphalt Emissions.

- Rota et al. (2014) conducted a meta-analysis of industrial exposures to PAHs associated with a variety of industries, including two studies that focused on asphalt workers (Behrens et al., 2009; Zanardi et al., 2013). However, the Behrens et al. (2009) study was previously evaluated by IARC and confounding factors were identified; the other study (Zanardi et al., 2013) is reviewed above.

  - Regarding Behrens et al. (2009), IARC previously identified this study as part of its multicenter epidemiological study, which included mixed-industrial exposures to asphalt: paving, roofing, and mastic. IARC reviewed Behrens et al.’s results and concluded the study: “. . . showed an excess of deaths from alcoholism, non-malignant respiratory diseases and liver cirrhosis, indicating that both alcohol and tobacco habits were in excess . . .” (IARC, 2013, p.100). As a result of this type and level of confounding, as well as the non-specific industry allocation to exposure, results from Behrens et al. (2009), and its findings associated with the Rota et al. (2014) meta-analysis, are not causative nor applicable regarding Paving Asphalt Emissions.
Zanardi et al. (2013) was identified above as relevant to roofing asphalt exposure and therefore not applicable to Paving Asphalt Emissions.

- Wagner et al. (2015) conducted a meta-analysis of PAH-exposed workers and the risk of larynx cancer. The only asphalt study analyzed by Wagner et al. (2015) was a 2003 European asphalt worker epidemiological study by Boffetta et al. As noted by Wagner et al. (2015, Box 1), “road construction with coal tar-based binding material” was an occupation associated with high PAH exposure. What is not noted by Wagner et al. (2015) is that the use of coal tar-based pavements was common in some European countries more than four decades ago. In the United States, however, coal tar-based pavements have not been used except for in some experimental pavements constructed in the 1980s (as part alternative binder testing in response to the energy crises of the 1970s and early 1980s). Results from Boffetta et al. (2003) and similar studies that do not distinguish between asphalt paving and coal tar-based paving prompted IARC to re-evaluate Asphalt Paving Emissions with a focus on isolating the impact of coal tar and other confounding factors. IARC re-evaluated Boffetta et al.’s 2003 study in 2010 and concluded:

“We found no consistent evidence of an association between indicators of either inhalation or dermal exposure to bitumen and lung cancer risk. A sizable proportion of the excess mortality from lung cancer relative to the general population observed in the earlier cohort phase is likely attributable to high tobacco consumption and possibly to coal tar exposure, whereas other occupational agents do not appear to play an important role.” (Olsson et al., 2010, p. 1418)

Therefore, the conclusions of Wagner et al. (2015) have no relevance to past or current U.S.-based asphalt paving operations and is not applicable to Paving Asphalt Emissions.

Animal Data: Two or More Studies; Tumor Initiation/Promotion or Co-carcinogenicity Studies

While OEHHA’s assessment indicates that a number of animal carcinogenicity studies have been conducted on asphalt and asphalt fractions, none of the studies identified show a positive association between Paving Asphalt Emissions and animal carcinogenicity. Each study identified by OEHHA as relevant to Paving Asphalt Emissions was previously reviewed by IARC and found to be either not appropriate, confounded, or non-causative.

Therefore, we respectfully urge OEHHA to rely on IARC’s findings relative to the review of the entire body of scientific animal carcinogenicity studies. IARC stated:

“there is inadequate evidence in experimental animals for the carcinogenicity of straight-run bitumens [and fume condensates].” (IARC, 2013, p. 203)
Other Relevant Data: Genotoxicity; Carcinogenic Metabolites; Other

OEHHA’s assessment identifies a number of other data types, all of which were previously reviewed by IARC (2013). Unfortunately, because referenced citation information is not provided in OEHHA’s document, it is difficult to address potential discrepancies associated with any of the study findings identified. For example, in many of OEHHA’s listed study descriptions, it is uncertain whether mechanistic findings were associated with roofing, paving, or other types of asphaltic material. Case in point are studies that identify impacts associated with fume condensates at temperatures up to 316°C, well above both paving and roofing application temperatures. Similarly, some of the studies listed by OEHHA identified mechanistic impacts of asphaltic materials like asphalt painting, which is not considered similar to paving asphalt. Regarding some of the genotoxicity findings reported by OEHHA in road pavers, it is unknown whether the influence of smoking was controlled in these studies; the original source reference would need to be reviewed to see whether indeed there were genotoxic impacts that could be attributed to Paving Asphalt Emissions.

Current Industry Consent Agreement Already Requires Proposition 65 Warnings Associated With Paving Asphalt Operations

In 2005, the asphalt paving sector entered into a Consent Judgment (California v. Blue’s Roofing Co. Inc., 2005) with the State of California to provide appropriate warnings under Proposition 65 for “asphalt, sand, diesel engine exhaust, and other materials . . .” (see California v. Blue’s Roofing Co. Inc., 2005, Exhibit C). At the time, IARC’s 1985 Monograph (IARC, 1985) had concluded that only certain extracts of asphalt posed a carcinogenic hazard, specifically: “Extracts of steam-refined and air-refined bitumens are possibly carcinogenic to humans (Group 2B).” IARC’s findings were (and continue to be) designated as a Proposition 65 chemical by OEHHA as “Bitumens, extracts of steam-refined and air-refined.” Other findings in the 1985 IARC Monograph regarding asphalt conclude that “Bitumens are not classifiable as to their carcinogenicity to humans (Group 3).”

The U.S. asphalt paving industry does not use steam- or air-refined bitumens nor extracts of those materials during asphalt paving applications and are already required to warn for exposure to asphalt under Proposition 65.

Paving Asphalt Emissions Should Not Be Prioritized

Over the past three decades of scientific and regulatory agency review, there has been no indication of a human or animal carcinogenic effect from exposure to Paving Asphalt Emissions.

In 2000, the National Institute for Occupational Safety and Health (NIOSH) recognized industry differences in the use of and exposure to different types of asphalt. In its Hazard Review (NIOSH, 2000), the agency concluded that:
“the collective data currently available from studies on paving asphalt provide insufficient evidence for an association between lung cancer and exposure to asphalt fumes during paving.” (NIOSH, 2000, p. 95)

IARC’s 2013 evaluation reviewed the state of science associated with asphalt emissions. The three newer studies OEHHA identified are consistent with those findings. As IARC states:

“there is inadequate evidence in humans for the carcinogenicity of occupational exposures to bitumens and bitumen emissions during road paving.” (IARC, 2013, p. 203)

Since the paving asphalt industry’s 2005 Consent Judgement, Proposition 65 warnings continue to be posted and communicated regarding the potential hazard of asphalt and other materials used during asphalt paving applications. No additional benefit would be gained by listing Paving Asphalt Emissions.

In addition, the industry’s on-going implementation of both engineering controls and WMA to reduce emissions, coupled with existing regulatory occupational exposure limits, ensure worker exposure to Paving Asphalt Emissions remain very low and will continue to be reduced.

In conclusion, based on the totality of scientific epidemiological and toxicological evidence’ which does not identify a cancer hazard; the existing requirement for Proposition 65 warnings during paving asphalt operations; an existing Cal/OSHA PEL for asphalt emissions to protect workers in an occupational setting; and the IARC- and NIOSH-acknowledged need to differentiate emissions based on application temperature, Paving Asphalt Emissions should not be recommended for priority listing by the Carcinogen Identification Committee; however, if a listing is required, it should be considered as low-priority.

Sincerely,

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References:


Paving Asphalt Emissions: Stakeholder Comments re: CIC Prioritization of Asphalt Emissions — page 9 of 12

Attachment I: Executive Summary

Comments of the
National Asphalt Pavement Association
California Asphalt Pavement Association
Asphalt Institute

Before the
Carcinogen Identification Committee
Office of Environmental Health Hazard Assessment

“Prioritization Notice on Asphalt and Asphalt Emissions Associated with Road Paving”

October 21, 2016

Paving Asphalt Emissions should be evaluated separately from roofing asphalt emissions.
- In 2013, IARC concluded, “The variable physicochemical properties of the individual constituents of bitumen mean that the composition and physical form of the emissions from heated bitumens are dependent on the temperature to which the bitumen is heated.”

- In 2000, NIOSH stated, “An analysis of the chemical data indicates that paving and roofing asphalts are qualitatively and quantitatively different; therefore, the vapors and fumes from these asphalt products also may be different. The chemical composition of vapors and fumes from asphalt products is variable and depends on . . . type of asphalt, [and] temperature . . . “NIOSH recognizes the difference of paving and roofing asphalt based on application temperature. CAS numbers differentiate asphalt emissions based on temperature.”

Exposure to paving asphalt emissions occurs exclusively during an occupational setting.
- In 2013, IARC determined, “[h]uman exposure to bitumens and their emissions comes almost exclusively from occupational exposure during manufacture and use of the products.”

Neither human nor animal evidence indicates that Paving Asphalt Emissions pose a carcinogenic hazard.
- In 2013, IARC established, “there is inadequate evidence in humans for the carcinogenicity of occupational exposures to bitumens and bitumen emissions during road paving;” and
• “[T]here is inadequate evidence in experimental animals for the carcinogenicity of straight-run bitumens [and fume condensates].”

Asphalt Paving Emissions continue to be well-regulated, controlled, and reduced.
• Asphalt Paving Emissions are currently regulated through an ACGIH TLV® and Cal/OSHA Permissible Exposure Limit and are addressed under a Proposition 65 Consent Judgement (California v. Blue’s Roofing Co. Inc.).

• Asphalt Paving Emissions continue to be controlled and reduced in occupational settings through the use of paver engineering controls and deployment of warm-mix asphalt.

Asphalt and Asphalt Emissions Associated with Road Paving should not be recommended for Priority Listing by the Carcinogen Identification Committee based on the scientific evidence.
Attachment II: Production, Application, and Controlling Asphalt Paving Emissions

Asphalt pavement material or mix is used to construct roadways, airfields, and other hardscapes, and is typically composed of about 95 percent mineral aggregate and 5 percent paving asphalt bitumen (CAS No. 8052-42-4). The bitumen functions as a glue to bind mineral aggregates into a cohesive mix. The pavement materials are typically mixed at a temperature of approximately 300°F in an industrial facility and trucked to a roadway construction site where it is applied using specialized machines. An asphalt paving crew typically consists of two or three individuals associated with a paving machine operation, two or three laborers with rakes and lutes that help further distribute the pavement material after it exits the paving machine, and two or three individuals operating individual rolling machines to compact the pavement to its final density.

Over the past two decades, the U.S. paving industry has intensively engaged in reducing bitumen emissions surrounding paving operations. Beginning in 1996, the asphalt pavement industry partnered with NIOSH, labor unions, and FHWA to explore opportunities to minimize paving asphalt emissions through the application of engineering controls. This effort led to a voluntary agreement with NIOSH to install such control systems on all highway-class paving machines manufactured in the U.S. after July 1, 1997 (NIOSH, 1997). In 2006, NIOSH conducted a follow-up study that identified the successfulness of these engineering controls which are now incorporated on most highway-class pavers in the U.S. (Mickelsen et al., 2006).

As noted in our comments, application temperature is widely recognized as a significant parameter affecting paving (and other) asphalt emissions. Over the past decade, warm-mix asphalt (WMA) was developed as an additional innovative method to reduce paving asphalt emissions at its source. These technologies allow asphalt to be produced and applied at lower temperatures than conventional asphalt mixes. Most important, WMA has the potential to virtually eliminate emissions surrounding paving workers. Reductions of up to 50 percent in asphalt paving emissions have been documented with the use of WMA technology (Mejias-Santiago & Osborn, 2014). Over the course of five years (from 2009 to 2014), WMA use has increased more than five-fold and now represents almost one-third of the total asphalt pavement tonnage placed on U.S. roadways (Hansen & Copeland, 2015).

Through active innovation over the past two decades, Paving Asphalt Emissions continue to be reduced; in some cases even below detectable levels.
Attachment II: References


