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Impacts and Effects of Air Toxics
by Brian Noel, P.E.

Emissions of toxic air contaminants can result from a wide variety of industrial and commercial activities. Air toxics are those compounds that are known to cause cancer or result in other negative health effects. The January issue assesses the release and impact of toxic air contaminants.

Columns

by William H. Haak

EPA’s proposed revisions to the NAAQS process rankles scientists and environmentalists.

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Message from the President:
Bienvenue à 2019
by Michele E. Gehring, P.E.

Back In Time: January 1999
A look back at this month 20 years ago in EM Magazine.

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It is my honor and privilege to welcome you into the New Year with this my first message to you as President of the Association. I look forward to greeting you each month in EM, as well as seeing many of you throughout the year at Association events both on the local and International level. I am blessed to have a wonderful Board of Directors to help lead you this coming year, with representatives from the United States and Canada, and individuals from each of the key pillars of our membership—the regulated industry, the regulatory agencies, the academic sector, and the consultants that assist them all. Outgoing President Chris Nelson has worked tirelessly to set up our team for a wonderful year ahead, and I would be remiss if I did not thank him for his hard work and dedication to the Association.

We have an amazing slate of programs on tap for 2019, including topics on wildfires, air quality modeling, air quality measurements, thermal treatment technologies, and freight management and the environment. And this year, we take our Annual Conference across the border and through the old city wall into Quebec City, Quebec, which has been referred to as one of the most picturesque spots in North America, is an incredible and unique destination and one that we are excited to visit. So often we rely on our Canadian members to come south and speak English to participate in Association face-to-face programming. I’m happy to use this year to prove that the planes fly north, and your President can speak French as well. If you have not already registered for one of this year’s programs, my first challenge to you is to do so—whether it be the Annual Conference, one of our specialty conferences or workshops, or an upcoming webinar—please make a point to participate in some of the events that the Association is hosting. One of the key benefits of your membership is the leading technical discussions that our events showcase—don’t miss out on that!

This month’s issue of EM focuses on the topic of air toxics, which is an issue of global importance. If you are not aware, A&WMA was granted official observer status with the United Nations Framework Convention on Climate Change (UNFCCC) and I had the honor of serving on the first Association delegation that participated in the conference proceedings. What an experience—it certainly doesn’t get more “global” than that! Past-President Mike DeBusschere and I just returned from the 24th Conference of the Parties (COP) in Katowice, Poland, and I would need an entire issue of EM to share everything we took away from it. If you have not already checked out our blog and video updates from Poland, be sure to do so, they are all on the website. Also, look for future information about our journey in EM Plus and other Association publications.

As you read the articles in this month’s issue, I challenge all of you air heads out there to think about how you can continue the conversation. What other information on air quality do you want to learn about? What information on your own work and research do you want to share with our members? Please let me know by sending me an email, giving me a call, or reaching out to one of our Board members. We are here to make the Association work better and harder for you and need your feedback to do so.

Looking beyond programming, one of my main goals for 2019 is to place more of an emphasis on the mentoring and networking opportunities the Association offers. As I have already shared with some of you at regional conferences, my passion for and participation in the Association has been driven by others that reached out a hand and asked me to participate in a council or help with a program. I think many of our volunteers would express the same (Why are we here? Because someone asked us to be). As we move forward through 2019, look for me to be extending that hand and inviting you to participate many times over. I’ll also be encouraging our board members, council leaders, and local leaders to do the same. These requests are not only about getting more participation in the Association, but also about helping you develop in your own professional career. Those same people that extended a hand and asked me to participate in the Association have served as a valuable resource in my day job as well. Past-President Dallas Baker and I have chatted on multiple occasions about ways to overcome permitting challenges, and former Section & Chapters Council Chair Gleness Knauer and I actually worked from opposite sides of the table to permit a hazardous waste incineration complex. The list of relationships and benefits I gained from them could fill up the rest of this issue, but that would rob you of the top-notch technical content that the pages beyond my message hold. So, I’ll have to reserve those stories for when we meet in person. I promise you, if you find time to participate in the Association—not just pay your dues, but really participate—the return on your investment will be immeasurable.

Thank you for the opportunity to serve as President of this wonderful Association. Let’s build on the 112 years that this Association has served members throughout the world and work together to make it even bigger and better in the years ahead. Jusqu’à la prochaine fois! em
Impacts and Effects of Air Toxics

Emissions of toxic air contaminants can result from a wide variety of industrial and commercial activities. Air toxics are those compounds that are known to cause cancer or result in other negative health effects. This issue assesses the release and impact of toxic air contaminants.
Air toxics are pollutants known to cause or suspected of causing cancer or other serious health effects. On the federal landscape, air toxics are classified as hazardous air pollutants (HAPs) by the U.S. Clean Air Act and the U.S. Environmental Protection Agency (EPA). Several states have established lists of air toxics that encompass significantly more chemical compounds than the EPA-maintained HAP list. HAPs are regulated by a specific group of rules at the federal level, the National Emission Standards for Hazardous Air Pollutants (NESHAPs), and most states have specific regulations to control emissions of air toxics which focus on the projected off-site impact of air toxics emitted from industrial or commercial activity. (See the February 2017 issue of EM, https://www.awma.org/content.asp?admin=Y&contentid=278, which was dedicated to NESHAPs, for more detail.)

While environment, health, and safety managers and environmental engineers typically focus on the sources of emissions of air toxics, their control, and compliance with state and federal regulations, in this issue, we focus on the presence of air toxics outside of the facility’s fence line. The articles herein investigate some well-known air toxics and discuss a novel approach to quantifying ambient concentrations of others.

In August 2018, EPA published the results of the 2014 National Air Toxics Assessment (NATA), the sixth since 1996. The NATA is intended to assist state and local air agencies address areas which are projected to be most affected by air toxics, as well as the sources of those contaminants. For the regulated community, the NATA provides insights into the air toxics which are most impactful to human health in the United States, as well as the long-term trends for emissions of air toxics in the country. The 2014 NATA results indicate that approximately one-half of the nationwide cancer risk resulting from air toxics in the ambient air comes from formaldehyde formed from chemical reactions of other contaminants emitted to the atmosphere. Direct emissions of formaldehyde and its prevalence in common industrial and household products also contribute to the presence in the ambient air. Two insightful articles are included to examine the issue.

In the first article, “Formaldehyde—A Leading Air Toxic,” by Dr. Stephen Zemba and colleagues at Sanborn, Head & Associates, Inc., the authors provide considerable background on formaldehyde’s properties and health risks, as well as discussing sources of formaldehyde emissions and a summary of relevant data presented on formaldehyde in the 2014 NATA.

Next, Michael T. Lannan and Katherine B. Mears, both with Tech Environmental, focus on the formation of formaldehyde resulting in lean burn combustion aimed at reducing emissions of another air pollutant, nitrogen oxides, in their article “Lean-Burn Reduces NOx, but is this Benefit a Formaldehyde Concern?”. They also examine challenges associated with emissions of formaldehyde from such engines and considerations for determining realistic off site impact of those sources.

Evaluating off-site impact of emission sources is common practice for industrial facilities. However, evaluating the potential of the off-site impact from a historical manufacturing facility on neighboring areas presents additional challenges. Paul Scott and colleagues at CARDNO CHEM RISK in, “Air dispersion modeling for historical community exposure reconstruction—Evaluation of the approach and its uncertainties,” present a case study of another air toxic—asbestos. The case study at an asbestos-based brake manufacturer illustrates interesting impacts from various aspects of emissions from a representative manufacturing facility.

In addition to predicting off-site impact of emissions of air toxics through air dispersion modeling, some states have established monitoring programs to quantify ambient concentrations of air toxics in specific areas. While it is commonplace to utilize traditional ambient air monitoring technologies for monitoring air toxics, the U.S. Forest Service has taken a novel approach to evaluating the presence of toxic air contaminants in ambient air by studying moss in Portland, Oregon.

In this issue of EM, we reprint with permission a related story that focuses on one air toxic of high concern in “Cadmium and the Portland Moss and Air Quality Study.” This study provides interesting insight into the use of a non-traditional technique for identifying and understanding ambient levels

Air toxics are generated from nearly every type of industry and many commercial activities.

Because air toxics are generated from nearly every type of industry and many commercial activities, the potential impact of emissions of air toxics continues to be well-studied and methodologies for evaluating ambient levels of these contaminants continue to evolve. The articles in this issue provide valuable insight into this ever-changing topic. em

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7. U.S. Environmental Protection Agency decisions on the NO2 and SO2 NAAQS can be found online at: https://www.epa.gov/oh2-pollution/primary-national-air-quality-staandards-naaqs; and https://www3.epa.gov/tn/nnaqs/standards/s02/s_s02_history.html.

Impacts of Wildfires on Air Quality and Health
February 13-14, 2019 • Santa Rosa, CA

Announcing a unique conference bringing together air quality and health professionals to discuss solutions for mitigating the effects of wildfire smoke

Recent wildfires have had devastating effects on forest and range land and have caused the destruction of thousands of commercial buildings and residences. The extensive smoke from these fires often reaches great distances into rural communities and urban population centers and creates broad scale impacts on public health.

This conference will take an encompassing look at the air quality and public health impacts from wildfires by bringing together experts in multiple disciplines to share information and proposed solutions to mitigate smoke effects. This is a unique opportunity for those dealing with wildfire effects to learn from experts and professionals with recent experience. The conference will benefit land managers, state and local air pollution control agency professionals, public health officials, health care providers, and consultants.

A key goal of this meeting is to inform attendees of the latest tools, concepts and approaches to better understand and protect public health. Presenters will provide the latest research and solutions on these critical topics:

- Understanding Fire Behavior and Forecasting Smoke Movement and Impacts
- Monitoring and Measuring Smoke Impacts
- Prediction, Prevention, Assessment and Control of Health Impacts of Wildfire Smoke
- Collaboration and Communication

Register now! Sponsorship and tabletop exhibit packages are available. Go to: www.awma.org/wildfires
Spotlight on formaldehyde, a strong irritant and a well-known carcinogen, that is used in a variety of consumer products, and is commonly found in both indoor and outdoor air.
Many likely recall the pungent odor of formaldehyde from their high school biology labs as it off-gassed from specimens preserved in formalin (an aqueous solution of 37 percent formaldehyde by mass). The simplest of all aldehydes, with a chemical formula of HCHO, formaldehyde is both a strong irritant and a recognized carcinogen. Despite these well-known hazards, formaldehyde is used in a variety of consumer products, and is commonly found at low µg/m³ levels in outdoor air, and at significantly higher levels indoors in buildings with formaldehyde emission sources.

The U.S. Environmental Protection Agency’s (EPA) 2014 National Air Toxics Assessment (NATA) has identified formaldehyde as the hazardous air pollutant (HAP) that contributes more than half of the U.S. average estimate of incremental cancer risk (see Figure 1) and roughly one third of the respiratory effects hazard quotient (see Figure 2), making it arguably the leading air toxic that is regulated under Section 112 of the U.S. Clean Air Act.¹

Properties
Formaldehyde is a colorless gas at room temperature and pressure, but readily dissolves and remains in water. The reported odor thresholds for formaldehyde range from 62 µg/m³ to 1,200 µg/m³.²,³ Formaldehyde is both created and destroyed through photolysis and chemical reactions in the atmosphere, with typical half-lives estimated to be of the order of hours to days depending on solar intensity and the availability of hydroxyl radicals.²,⁴

Emission Sources
The sources that contribute to ambient formaldehyde levels are complex and involve both direct releases and indirect formation via atmospheric chemistry (see Figure 3). As discussed further on, indirect sources are now thought to be of greater overall importance, and of the formaldehyde released directly to air, biogenic emissions are estimated to dominate on a regional basis. For historical and regulatory reasons, though, anthropogenic emissions receive greater attention, and hence are discussed first. Numerous industries release formaldehyde directly to the atmosphere,⁵ including:

- Formaldehyde synthesis/production;
- Resin (binder) production and applications/use in manufactured products, such as:
  - Urea-formaldehyde (e.g., particleboard, fiberboard, indoor plywood, foam insulation, textiles, paper, surface coatings, adhesives),
  - Phenol-formaldehyde (e.g., outdoor plywood, molding compounds, insulations, foundry molds, laminates, particle board, friction materials, abrasives),
  - Polyacetal (e.g., plumbing fixtures, hardware, sporting goods), and
  - Melamine-formaldehyde (e.g., countertops, dinnerware, surface coatings);
- Synthesis of more complex organic chemicals (e.g., hexamethylenetetramine, pentaerythritol, 1,4-butanediol, trimethylolpropane, 4,4-methyleneedianiline, phthalic anhydride);
- Production of solid urea and ureaform fertilizers;
- Preservation, embalming, and disinfection uses;
- External and internal combustion of hydrocarbon-based fuels;
- Oil refineries; and
- Asphaltic concrete production and use.

Industrial sources emitted an estimated 4.6 million tons of formaldehyde in the United States in 2006.⁶ Formaldehyde is also produced inadvertently as a byproduct of incomplete combustion of hydrocarbon fuels, which encompasses numerous stationary and mobile sources.

However, anthropogenic sources account for only a small fraction of direct formaldehyde emissions to the atmosphere. As indicated in Figure 4, the U.S. EPA 2014 NATA estimates...
that biogenic sources (from vegetation) and fires account for 89 percent of the 1.3 million tons of aggregate emissions in the United States. Traditional point and non-point sources contribute only 4 percent of emissions, while on-road and non-road mobile sources account for 7 percent. The portion of non-anthropogenic emissions varies regionally, with western states such as California and Arizona exceeding 90 percent, and eastern states such as Connecticut less than 60 percent.

Note, however, that even though biogenic emissions may dominate source inventories at the state level, anthropogenic emission sources tend to concentrate in urban areas and can contribute substantially to formaldehyde concentrations at the local level. The source distribution for the District of Columbia is indicative of this urbanization effect, as it is the only state/district that does not have biogenic emissions as its largest source, instead being dominated by mobile source emissions.

Formaldehyde also has indirect sources as it is produced in the atmosphere through oxidation of various hydrocarbons released from emission sources. This secondary formaldehyde formation, which is tied to the emissions of precursor hydrocarbon species, is in fact estimated to account for most of the formaldehyde present in outdoor air (as discussed below). Hence, formaldehyde shares a parallel characteristic with particulate matter in that secondary formation can contribute significantly to ambient levels.

Concentrations in Air
Formaldehyde is ubiquitous in both outdoor and indoor air, in part because of its numerous emission sources, and also due to its role in hydrocarbon chemistry and oxidation. Observations in outdoor air range from a few µg/m³ in rural areas to 10 µg/m³ and higher in urban areas due to the increased density of local emission sources (despite the general dominance of biogenic emission sources at the regional level). Although this article focuses on formaldehyde in outdoor air, indoor air often contains levels of formaldehyde an order of magnitude or more higher than found in outdoor air due to off-gassing from building materials (e.g., pressed board and similar products that incorporate formaldehyde-based resins) and emissions from indoor combustion sources such as woodstoves, fireplaces, and cooking. Salthammer summarizes reported concentrations, which for indoor environments with significant formaldehyde sources (e.g., mobile homes) are typically 30–100 µg/m³, and in some cases as high as 1,000 µg/m³.

Figure 5 depicts a national map of the concentrations of formaldehyde in ambient air modeled in the 2014 NATA study. It shows that 99.9 percent of the formaldehyde concentrations modeled across individual census tracts are less than 2.7 µg/m³. The NATA estimates indicate a geographic dependence, with higher formaldehyde concentrations predicted at southern latitudes due to greater biogenic emissions and secondary formaldehyde formation (both of which increase with temperature).
Figure 4. Formaldehyde Emissions and Source Attribution in the 2014 National Emission Inventory Used in 2014 NATA.
Figure 6 illustrates the breakdown of point source categories contributing to the national average formaldehyde concentration of 1.3 µg/m³ (as weighted by census tract populations). Secondary formaldehyde formed from atmospheric chemistry makes up 74 percent of the estimate, while direct anthropogenic sources contribute only 10 percent across the point, non-point, on-road, and non-road categories. One caveat, however, regarding the 2014 NATA estimates is that they tend to under-predict monitored formaldehyde concentrations.

Figure 7 is a scatter plot of modeled vs. monitored formaldehyde concentrations at 111 locations across 31 states. The average monitored median concentration (2.32 µg/m³) exceeds the average modeled concentration (1.38 µg/m³) by about 68 percent. Additionally, the range of monitored concentrations is more than twice as large as the range modeled in the NATA study. These differences may not reflect inaccuracy, however, as air monitoring stations are frequently located near significant emission areas where the highest ambient concentrations are anticipated, and hence may reflect a high bias with respect to averages across census tracts (which are reflected by the NATA modeled estimates).

**Toxicity and Exposure Guidelines**

At sufficient concentrations, formaldehyde is a strong respiratory and ocular irritant. Additionally, the Agency for Toxic Substances and Disease Registry (ATSDR) and the International Agency for Research on Cancer (IARC) have concluded that formaldehyde is a human carcinogen.

Nationally, the Occupational Safety and Health Administration (OSHA) 8-hr average permissible exposure limit is
920 µg/m³ and 15-minute average short-term exposure limit is 2,460 µg/m³. In consideration of formaldehyde’s carcinogenicity, the National Institute for Occupational Safety and Health (NIOSH) has established an 8-hr average recommended exposure limit of 20 µg/m³. Public health guidelines are considerably more protective than workplace standards. The current EPA regional screening levels (RSLs) for airborne formaldehyde exposure to a resident are 10 µg/m³ (based on ATSDR’s minimum risk level) to protect against irritation effects and 0.22 µg/m³ based on a 1 per million incremental cancer risk over a long-term (26 year) exposure period.

Formaldehyde toxicity is under reevaluation, as the current Integrated Risk Information System (IRIS) summary dates back to 1990. A 2010 draft IRIS toxicological review stirred considerable controversy from its proposed increase in cancer potency. The American Chemistry Council and other industry groups continue to question the scientific underpinnings of EPA’s 2010 draft report, pointing out that humans produce formaldehyde as part of their normal metabolic processes, exhaling formaldehyde in our breath at concentrations of a few µg/m³.

Evaluating potential irritation effects caused by formaldehyde is perhaps less controversial, though exposure guidelines and standards vary considerably. Uncertainties in evaluating scientific evidence translate to varying degrees of protective-ness among regulatory agencies. Table 1 summarizes relevant values of various standards or recommended guidelines for formaldehyde. Guidelines typically are based on lowest or no observed adverse effects levels (LOAELS or NOAELs) found in toxicity studies, with safety factors added to derive protective levels. A recent comprehensive literature review determined 123 µg/m³ (or 100 parts per billion, ppb) of formaldehyde is a level low enough to likely protect people from irritation (even individuals sensitive to air pollutants). Both the World Health Organization and Health Canada recommend this value as a generally protective short-term exposure limit. The value is also within or below the typical range of reported odor thresholds for formaldehyde (a point at which irritation effects might be noticed). Even so, some agencies have chosen to be even more protective in establishing irritation-based exposure guidelines. For example, ATSDR has chosen to add in additional safety factors in its minimum risk levels (MRLs).
Table 1. Irritation-based recommendations for residential guideline concentrations for formaldehyde.

<table>
<thead>
<tr>
<th>Averaging</th>
<th>Concentration (µg/m³)</th>
<th>Effect</th>
<th>Point of Departure (µg/m³)</th>
<th>Adjustment/safety factor</th>
<th>Study type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute 1 – 14 days</td>
<td>49</td>
<td>Nasal and eye irritation and the cellular makeup of nasal discharge in occupationally exposed patients with skin hypersensitivity to formaldehyde</td>
<td>490</td>
<td>9</td>
<td>Lowest Observed Adverse Effects Level (LOAEL), human study</td>
</tr>
<tr>
<td>Intermediate 15–364 days</td>
<td>37</td>
<td>Clinical signs of nasopharyngeal irritation (hoarseness and nasal congestion and discharge) and lesions in the nasal epithelium (squamous metaplasia and hyperplasia)</td>
<td>1215</td>
<td>30</td>
<td>LOAEL, animal study</td>
</tr>
<tr>
<td>Chronic ≥ 1 year</td>
<td>9.8</td>
<td>Mild irritation of the eyes and upper respiratory tract and mild damage to the nasal epithelium</td>
<td>297</td>
<td>30</td>
<td>LOAEL</td>
</tr>
<tr>
<td>-</td>
<td>620 to 1200</td>
<td>Odor threshold</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study type</th>
<th>Study type</th>
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</thead>
<tbody>
<tr>
<td>30 min</td>
<td>Odor threshold</td>
</tr>
<tr>
<td>1-hour</td>
<td>Eye, nose and throat irritation</td>
</tr>
<tr>
<td>8-Hour and longer</td>
<td>Respiratory symptoms in asthmatic children</td>
</tr>
</tbody>
</table>


| Any                            | Odor detection and sensory irritation                                 |

In developing air toxics programs, various states have addressed either or both of the irritation and cancer concerns associated with formaldehyde, often basing short-term guidelines on potential irritation effects and long-term exposure guidelines on incremental cancer risk. Table 2 summarizes the values that have been adopted in some states. Note that many formaldehyde exposure guidelines, especially those based on long-term exposure, are below typical background levels in outdoor air.

Impacts from Specific Sources and Implications for Air Permitting

The breakdown of sources that contribute to the average NATA formaldehyde concentration in ambient air (Figure 6) suggests that impacts from individual point sources may be small. However, our recent experience indicates that certain sources, such as large stationary internal combustion engines that potentially release significant amounts of formaldehyde near ground-level, when assessed through dispersion modeling may produce predicted concentrations of formaldehyde that exceed state guidelines. A lack of published emission factors may be the reason behind delayed regulatory recognition of formaldehyde, but we have recently noticed increased state awareness in source permitting and have applied project-specific risk assessments to better evaluate formaldehyde impacts.

To our knowledge, secondary formaldehyde production from precursor volatile organic compound emissions has not yet been examined in source permitting, but research on reactive plume dynamics suggests the possibility of significant near-source contributions to localized atmospheric
formaldehyde concentrations. On a regional basis, concerns over formaldehyde transcend individual source impacts due to the large fraction of biogenic emissions. Additionally, public health concerns over formaldehyde should focus on indoor sources, as indoor air can contain concentrations of formaldehyde many times greater than found outdoors. There is considerable debate ongoing, however, regarding formaldehyde toxicity, particularly its carcinogenicity at typical atmospheric concentrations.

**Table 2. State air toxics standards and guidelines.**

<table>
<thead>
<tr>
<th>State</th>
<th>Short-Term Standard or Guideline</th>
<th>Annual Average Standard or Guideline (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Averaging Period</td>
<td>Concentration (µg/m³)</td>
</tr>
<tr>
<td>CA</td>
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<td>55</td>
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<tr>
<td></td>
<td>8 hr</td>
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</tr>
<tr>
<td>CT</td>
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<td>GA</td>
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<td>12</td>
</tr>
<tr>
<td></td>
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<tr>
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<tr>
<td>MI</td>
<td>24 hr</td>
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<td>NH</td>
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<td>TX</td>
<td>1 hr</td>
<td>15</td>
</tr>
<tr>
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<td>24 hr</td>
<td>15</td>
</tr>
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<tr>
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<td>0.167</td>
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</table>

**References**


Stephen G. Zemba, Lisa Damiano, Heather Little, Jeffrey Doris, and Matthew Estabrooks are all with Sanborn Head and Associates, Inc. E-mail: szemba@sanbornhead.com.
This article considers the generation of formaldehyde during lean-burn processes, in particular, to how much can one be exposed without a significant level of concern?
To reduce oxides of nitrogen (NOx), many small biogas facilities operate their engines in a fuel lean configuration. Although selective catalytic reduction (SCR) is the best available method to reduce NOx, at a small facility whose size is limited by material availability, it is often cost-prohibitive to employ SCR technology. In this case, the next best NOx control is to lower the combustion temperature by configuring an engine to run fuel lean, commonly called “lean-burn”. However, lean-burn creates products of incomplete combustion, such as formaldehyde.

Formaldehyde is used in many household products and building materials as a preservative and adhesive. Dissolved in water, it helped preserve that frog for dissection in biology class. It is also used as a preservative in foods. A small amount can go a long way. Formaldehyde also occurs naturally in the environment. It is quickly broken down in the air in the presence of sunlight and carbon dioxide, generally within hours. It dissolves easily in water, but does not last long there, either. Humans and most other living organisms make small amounts as part of normal metabolic processes.

When dissolved in water it is called formalin, which is commonly used as an industrial disinfectant, and as a preservative in funeral homes and medical labs. It can also be used as a preservative in some foods and in products, such as antiseptics, medicines, and cosmetics. Sometimes, although formaldehyde is not directly used, substances that release formaldehyde are. These have been found in cosmetics, soaps, shampoos, lotions and sunscreens, and cleaning products.

Despite its many uses, formaldehyde is considered a harmful compound, so the two primary questions are: How could one be exposed? And…to how much can one be exposed without a significant level of concern? The first question deals with formaldehyde formation, dispersion potential, and half-life. The second deals with the realities of exposure (i.e., time, terrain, sensitive groups, etc.).

**Formaldehyde from Combustion**

Formaldehyde can be added as a preservative for food, but it can also be produced as the result of cooking and smoking. Interestingly, the reason why smoking creates formaldehyde is the same reason why a lean-burn engine creates formaldehyde. When lighting a cigarette, the goal is to create a smoldering, smoke-generating burn and not to completely oxidize it. The only way to achieve this is to partially-burn the components of the cigarette. Similarly, in an internal combustion engine, lowering the temperature slows the conversion of nitrogen and excess oxygen in the combustion chamber, creating less thermal NOx. Again, lower combustion temperatures result in more organic products of incomplete combustion, specifically formaldehyde.

This infamous compound was a major health concern in the 1970s, when it was widely used in urea formaldehyde foam insulation (UFFI). Concerns about off-gassing in homes that were insulated and tightened during the oil crisis to save energy led to numerous studies about the possible health effects of short- and long-term exposure. In the short-term, formaldehyde can cause watery or burning in the eyes, nose or throat, along with coughing, wheezing, nausea, or skin irritation. Although uncomfortable, the effects often dissipate quickly after exposure. Unfortunately, exposure is not limited to the short-term. Formaldehyde presence in the news, and its abundance in household use, has led to a number of federal and state regulations restricting formaldehyde exposure.

By 1987, the U.S. Environmental Protection Agency (EPA) assigned the compound its status as a probable carcinogen. Also in 1987, the Occupational Safety and Health Administration (OSHA) established a federal standard that reduced the 8-hr workday exposure limit from 3 parts per million (ppm) to 1 ppm. By 1992, the OSHA standard was reduced to 0.75 ppm. Since then, formaldehyde usage in insulation, as well as in other household products, has been drastically reduced.

While these worker thresholds were clearly designed to limit high-end exposure, they did not necessarily address the concern with individuals in their households that were exposed to lower levels whom may have respiratory conditions, or were infirmed in other ways. As a result, individual states, each in their own way, took the federal worker thresholds and applied safety factors to come up with their own screening threshold levels of exposure for the general public. For example, the Massachusetts 24-hr exposure threshold is two orders of magnitude lower than the 1992 OSHA 8-hr threshold.

Today, the majority of formaldehyde health concerns are related to the unknowns of long-term exposure. The National Cancer Institute states, “Although the short-term health effects of formaldehyde are well known, less is known about its potential long-term health effects.” Because of the unknowns, additional safety factors for long-term exposure are also applied on top of the safety factors previously applied to the short-term thresholds to protect vulnerable populations. This further reduced the allowable exposure, resulting in a very conservative allowable threshold.

The allowable exposure, with all these safety factors included, may no longer apply to the common individual. For example, the upper end of formaldehyde determined to be in human breath is 1.7 parts per billion (ppb). By comparison, the Massachusetts annual threshold exposure limit in ambient (outdoor) air is 0.06 ppb; one and a half orders of magnitude lower. How could one’s breath be higher than the exposure...
The answer is simply that the comprehensive exposure level is a screening threshold that has many, many safe assumptions included to address all, not specific situations.

**Indoor Exposure versus Ambient Exposure**
When discussing formaldehyde exposure, or really any air toxic exposure, there is typically an important distinction between occupational exposure regulation thresholds and ambient air exposure thresholds. Occupational exposure regulations, mandated by OSHA are standards designed to protect workers whom work directly or indirectly with formaldehyde typically over 8 or 10 hours. Ambient thresholds are often derived with the worker exposure safety factors to protect the infirm, and often include one or more factors for longer exposure.

What is not always discussed is whether the potential exposure is from an indoor source, an outdoor source, or a combination of indoor and outdoor sources. Many “ambient thresholds” are really thresholds that consider safety factors for continuous exposure for those that are homebound (i.e., always in one place). In practice, that type of exposure cannot apply to all receptor locations.

**Determining Exposure Potential**
To demonstrate compliance with screening thresholds, facilities are often tasked with determining the maximum concentration through dispersion modeling of these compounds at discrete receptor locations and comparing them to the ambient thresholds. This is often called examining “blind” exposure. Blind exposure is continuous exposure that does not consider any of the possible factors that may limit actual exposure potential.

However, if the continuous blind exposure results indicates a potential exceedance, then there are more steps that can be taken to demonstrate that the actual exposure is below the allowable exposure without making physical or operational modifications to a facility. These include, 1) considering that terrain may limit the ability for one to be continuously exposed, 2) actual potential time on-site, 3) rain effectively “scrubbing” emissions, 4) receptor types (i.e., assisted-living homes, daycares, etc.), 5) system down-time, and 6) atmospheric oxidation.

Often instead, the first option to attempt to minimize exposure is to simply raise the stack. While it costs money to install a taller stack, there is clearly a direct environmental benefit too, so often a proponent may simply opt to raise the stack height, rather than to explore the aforementioned factors that affect exposure potential. Unfortunately, in complex terrain situations, it may be impossible to achieve favorable results if the maximum concentration is simply hitting the side of a hill at a higher elevation every time a new stack height is considered.

**Project Examples with Exposure Adjustments**
In one recent project, formaldehyde exposure potential was addressed by establishing a combination of stack height adjustments and determining the exposure potential at certain receptors. In this case, the stack was lowered and the maximum emission potential at the preferred height was actually higher in the final preferred run, than in the initial runs. The higher concentrations were favorable because the stack height was adjusted in such a way so that the maximum impacts were directed toward a rock cliff that could not be developed as a habitable area. Therefore, it was not possible for there to be daily, much less annual, exposure on the cliff. By maximizing emissions at an unoccupied area, it was possible to minimize emissions at other areas with occupancy, and therefore, the true annual exposure potential was less.

In another project, the facility could not meet the annual ambient criteria with constant emission parameters. It was clear that adjusting the stack, flow, or release diameter, etc., simply moved the problem from one occupied area to another. To demonstrate compliance, the facility simply demonstrated that the system would not run with the same flow parameters at all times. While the goal was to maximize output under one set of operating parameters, in reality, there will be times when the system could not operate at peak performance. By formally committing to these normal process fluctuations, the facility was able to operate “normally” and demonstrate compliance.
In another case, a farm digester project, we were able to convince the regulators that the specific safety factors included for those with respiratory conditions did not apply, as long as the local individuals (i.e., the healthy farmers and their staff) agreed that they understood that they were going to be exposed at levels intended for healthy individuals only.

Finally, as mentioned in the introduction, consideration that formaldehyde is not inert was included. It is estimated that it can be broken down up to 50 percent in 60 minutes. While the conditions must be right for this reaction, if one considers that formaldehyde is reactive, then the likelihood that someone could be exposed on an annual basis should be less than the simple maximum of the modeling results. In this case, an agreed upon number of exceedances of the screening thresholds was deemed appropriate to demonstrate that there is not adverse exposure potential.

**Conclusion**

Screening tools are great for showing that a concentration is lower than the ambient thresholds. However, if they are not met initially, it does not necessarily mean that dispersion modifications are required. One should examine potential dispersion improvements hand-in-hand with actual potential exposure factors.

The answer to the question, “lean-burn reduces NOx, but is this benefit a formaldehyde concern?,” is typically no, when one considers actual exposure potential, and not simply emission potential.

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Air Dispersion Modeling for Historical Community Exposure Reconstruction: An Evaluation of the Approach and Its Uncertainties

by Paul K. Scott, Matthew M. Abramson, Jennifer L. Bare, and Christy A. Barlow

A case study evaluation using the AERMOD model to estimate air concentrations for a historical exposure reconstruction of community exposures to a hypothetical manufacturer of brakes containing asbestos.
Widespread industrial asbestos use began in the early 1900s resulting in asbestos being incorporated into thousands of commercial and consumer products. Historical manufacturing of these asbestos-containing products have resulted in intermittent environmental release of asbestos into surrounding communities. While some facilities may have historical industrial hygiene measurements available, in the absence of these data, estimation of airborne concentrations may be necessary using facility information on the consumption of asbestos, types of emissions, and presence of air pollution control devices. While these estimates will be limited by the availability of historical information, this type of historical exposure reconstruction can produce bounding estimates of community exposure over time that are better than those based on limited or no measured air sampling data. AERMOD, the U.S. Environmental Protection Agency’s (EPA) preferred model for a wide range of regulatory applications in all types of terrain, is often used for this purpose.

This article describes a case study using the AERMOD model to estimate air concentrations for a historical exposure reconstruction of community exposures to a hypothetical asbestos-containing friction product manufacturer (e.g., a brake manufacturer). To better understand how uncertainties in the selection of model parameters may affect the results, a sensitivity analysis was performed that included varying the modeled asbestos particle size, changing the fugitive emission model type, using different methods to calculate the emission rate from asbestos handling, and evaluating the impact of control technologies. A similar approach could also be adapted for other chemicals and facility types in order to estimate historical air concentrations in the absence of an adequate historical air sampling database.

Baseline Modeling
AERMOD was used to estimate historical ambient airborne asbestos concentrations resulting from a hypothetical manufacturer of asbestos-containing friction products that operated between 1965 and 1989 (see Figure 1). The technical details for this evaluation, including the hypothetical facility description, are presented in Abramson et al. Although this hypothetical manufacturer does not have a defined location, in accordance with EPA guidance for particulate matter, five years of meteorological data from the early sixties collected in Hartford, CT, were used because these data were available and historically there have been many facilities in the state that manufactured asbestos-containing products.

The air concentration estimates for all emission sources were modeled to account for particle deposition and depletion. The default particle size parameters associated with asbestos were used, which include the mass mean aerodynamic particle diameter of 0.3 microns and the assumption that 85 percent of the asbestos fibers were considered fine. Annual average airborne concentrations were estimated for a receptor grid extending 2,000 m from the center of the manufacturing building with 1.8-m flagpole heights. Annual average concentrations were reported by geographical quadrants (NE, SE, SW, and NW) and by distance bands (<500 m; 500 – <1,000 m; and 1,000 – <2,000 m).

Emission rates for each source and year were estimated by applying an emission factor, as detailed below, to the amount of asbestos assumed to be used.
in product manufacturing. All emissions were assumed to be continuous for this evaluation (i.e., 24 hours per day, 7 days per week). In lieu of site-specific information, the hypothetical facility was assumed to use an amount of asbestos per year equal to the total amount of asbestos processed each year in the U.S. friction industry divided by the number of facilities known to manufacture asbestos for that year for 1965 through 2003. Three types of sources were evaluated:

1. **Unloading and loading of asbestos.**
   Emissions from the unloading and loading of asbestos from a 26-foot box truck onsite were modeled. The annual emission rates were estimated using EPA’s AP-42 emission factor from Section 11.28 for vermiculite transferring of 0.013 kg of PM$_{2.5}$ emitted per Mg processed.

2. **Waste disposal dumpster.**
   Asbestos waste from the facility was assumed to be disposed of in a 20-cubic yard dumpster that was emptied for offsite disposal on a regular basis. The percentage of scrap asbestos that was disposed of in the dumpster was set equal to around 3 percent of the total amount used per year. The AP-42 emission factor from Section 13.2.4 for aggregate handling and storage piles was used to estimate emissions.

3. **Facility emission source.**
   Fugitive emissions from the building prior to the installation of a baghouse in 1975 were modeled as a volume source with a release height equal to the building height. These fugitive emissions were assumed to be from manufacturing activities and to be emitted from windows, doors, and other openings prior to the installation of local exhaust ventilation that would have been emitted from a common stack. Based on an asbestos sources and emissions inventory from 1968 for various industries, controlled asbestos emissions for friction product manufacturing were 6 lb/ton processed, assuming 95 percent particulate controls. Assuming this control efficiency, uncontrolled emissions were estimated to be 120 lb/ton processed. Assuming the friction manufacturer installed a baghouse as a control measure in 1975, baghouse emissions were modeled as a point source with asbestos emissions of 0.019 lb emitted per ton used assuming a control efficiency of 99.99 percent of 0.019 lb emitted per ton was used.

**Modeling Results**

As shown in Figure 2, the annual average airborne concentrations for the receptor band closest to the facility (<500 m from the sources) were higher than the concentrations at distances further away from the building. Variability in concentrations between quadrants was attributed to the
dominant wind direction in the meteorological data set being from the northwest. Figure 3 shows that estimated annual airborne concentrations prior to 1975 were dominated by the fugitive emissions from the facility, while after 1975, the estimated concentrations were the result of the unloading and loading emissions with the contributions associated with baghouse facility emissions and the dumpster being nearly negligible.

As seen in both Figures 2 and 3, the introduction of the baghouse in 1975 decreased overall asbestos emissions associated with facility operations and therefore the exposure potential of the community related to the hypothetical manufacturer decreased substantially. As such, the emissions associated with the unloading and loading of asbestos become the main contributor to the estimate air concentrations after baghouse installation.

Sensitivity Analysis
To compare the results for each of the sensitivity scenarios with the baseline results, the average air concentration from 1965 to 1989 was calculated for each direction and each receptor band. Figure 4 presents the factor change in average airborne concentrations from 1965 to 1989 for receptors located <500 m across all directions for each parameter changed in the sensitivity analysis. While not presented here, in general, the trends seen for the receptors for each direction and each distance category were similar.

Particle Size
The particle size characteristics of asbestos fibers suggest that the aerodynamic diameter may be 2.5 to 5 times larger than the actual diameter and that there is a weak dependence on length. Therefore, for the sensitivity analysis, the particle distribution was varied to have a mass mean aerodynamic particle diameter of 0.75 microns with 78 percent of particles considered fine based on a 2.5 times increase in mean diameter. While it was expected that the increase in particle size would substantially change the air concentration with distance from the facility, the adjustment did not result in substantial changes in the concentrations (Figure 4).

Fugitive Building Emission Type
While the fugitive building source was modeled as a volume source for the baseline scenario to simulate emissions of material from windows and other openings, these uncontrolled emissions could be modeled as a point source. Therefore, in the sensitivity analysis, the fugitive building source was modeled as a point source located at the center of the facility with the same emission rate as the baseline scenario. This change in source type increased the average air concentration by almost a factor of 3.

Unloading and Loading Emission Factor
The emission factor used in the baseline model scenario for unloading and loading was selected from the AP-42 documentation on vermiculite processing. Although vermiculite is qualitatively similar to asbestos, other AP-42 documents provide estimates for the mass of particulate released during loading and unloading activities. In this sensitivity analysis, the maximum and minimum emission rates were used.

Decreasing the emission factor for the unloading and loading scenario to the minimum emission factor value decreased the average air concentration by only a small amount (0.265 f/cc to 0.258 f/cc), as seen in Figure 4. However, increasing the unloading and loading emission factor to the maximum caused a substantial increase in the average air concentration (0.265 f/cc to 0.640 f/cc). The cause for this difference is that the percent contribution to the average air concentration due to unloading/loading emissions increases substantially from baseline with the use of the maximum emission factor, from 3 percent to 60 percent.
Pollution Control Scenario
The baseline model scenario assumed that the hypothetical facility installed a baghouse in 1975 with uncontrolled emissions prior to this date. However, baghouses may have been installed at earlier dates and it is likely that emissions were controlled to some degree prior to the installation of the baghouse. Therefore, in the deterministic sensitivity analysis, two scenarios were considered: (A) emission control processes were implemented in 1968 that controlled emissions by 95 percent until 1975, when the baghouse was installed; and (B) the baghouse was installed in 1970, but no emission control processes were implemented prior to the installation.

Due to these emission rate reductions, the average air concentration from 1965 to 1989 was decreased by approximately three-fold and two-fold for scenario A and scenario B, respectively (Figure 4). Facilities that were able to implement pollution controls earlier may have been able to significantly reduce the potential exposure of the community compared to those that did not implement such controls. In general, the model assumptions that had the largest impact on the results in order of effect were the choice of source type for facility emissions, the choice for the unloading/loading emission factor, and the assumption related to the timing and effectiveness of pollution controls at the facility. The change in particle size assumption had no apparent impact on the estimate air concentration.

Conclusion
The use of air dispersion modeling to estimate historical community exposures to asbestos can be a valuable tool in the absence of historical sampling data and for extended exposure periods of interest. The sensitivity analysis presented here demonstrates the importance of site-specific emission information to characterize potential emission sources. Any implementation of this methodology should use the best available site-specific information, particularly when pollution control methods were implemented.

References
This article is an extract from the larger 2016 U.S. Forest Service study, “Elemental Atmospheric Pollution Assessment via Moss-Based Measurements in Portland, Oregon,” and is reprinted with permission by the U.S. Forest Service, Pacific Northwest Research Station (http://www.fs.fed.us/pnw/research/moss/cadmium.shtml).
Initiated in 2013, the Portland Moss and Air Quality Study set out to learn if moss might be a useful “bio indicator” for assessing exposure to polycyclic aromatic hydrocarbons in Portland, Oregon. The study evolved when laboratory analyses of the moss samples revealed surprising hotspots of high concentrations of heavy metals and other elements known to cause human health problems. To learn more, the scientists started with cadmium, a top concern of the Oregon Department of Environmental Quality (DEQ). Placement of an air monitor near one hotspot measured cadmium and arsenic at levels that greatly exceeded health benchmarks.

The cadmium portion of the moss study revealed that moss is an effective bio indicator of cadmium levels in the air. This finding had immediate impact: the Oregon DEQ and the Oregon Health Authority held public meetings to alert residents and businesses of the situation. The two sources of the cadmium and arsenic stopped emitting those pollutants, and a new state program, “Cleaner Air Oregon,” was created to overhaul the state’s industrial air toxics regulatory standards.

The Connection between Moss and Air Pollution
Moss has been used to detect air pollution in forests since the 1960s. Moss doesn’t have roots; it’s like a sponge, absorbing moisture and nutrients from the air, as well as contaminants. These contaminants are stored in the moss tissues, making them a living record of pollution levels in the surrounding environment. Because some species of moss are very sensitive to air pollution, they are indicators of good or bad air quality. If certain sensitive species are declining, it’s an indication that the air quality is declining.

Moss in Urban Forests—Indicators of Localized Emissions
What can we learn from forests in urban areas, home to 80 percent of the U.S. population? Over the past decade, the Pacific Northwest Research Station has spent more time studying the trees that grow in cities. In 2013, Forest Service scientists began investigating the ability of urban forests to mitigate air pollution. They wondered if moss might be a useful bio indicator for assessing exposure to polycyclic aromatic hydrocarbons in Portland, Oregon. These compounds are potent environmental toxins linked to health problems such as heart disease and cancer. These toxins are found in car and truck exhaust, other fossil-fuel emissions, and wood smoke.

How were the Moss Samples Collected?
Using a grid-based random sampling strategy, the scientists set out in a minivan armed with a ladder and collection equipment. They gathered 346 samples of Lyell’s orthotrichum (Orthotrichum lyellii), a moss species that grows abundantly on the trunks and branches of hardwood trees across Portland. The samples were collected from December 2 to December 23, 2013, keeping the timeframe narrow to avoid confounding effects. The samples were then processed and analyzed in a laboratory.

Expanding the Study
For this study, the scientists collected moss samples around Portland using methods that took into account the complex urban setting. As the study developed, they decided to have the moss samples tested for heavy metals as well as polycyclic aromatic hydrocarbons. Other organizations involved in the study included Drexel University, Portland State University, and the Oregon DEQ.

After analyzing the polycyclic aromatic hydrocarbons, the science team turned to the lab results for 22 elements, including heavy metals. The scientists started with cadmium, a top concern of the Oregon DEQ because a 2011 DEQ study found discrepancies between predicted and observed concentrations of the metal at Portland’s one permanent air-quality monitoring site. Cadmium, which is used primarily in nickel-cadmium battery manufacturing, electroplating, and stained-glass production, is linked to health problems such as kidney disease and cancer.

When the scientists looked at the lab results for cadmium, levels in some of the moss samples seemed very high compared to some of the other samples. In fact, the distribution of the cadmium data revealed two major hotspots centered on the two largest stained-glass manufacturers in Portland.

The science team also took a closer look at concentrations of
arsenic and selenium in the moss samples. These two elements are co-emitted with cadmium during some industrial processes such as stained-glass manufacturing. Including these secondary elements at this stage of the analysis helped the team more definitively identify one of the stained-glass manufacturers as the source of one cadmium hotspot.

But what exactly did that mean for moss as a bio indicator? Do high levels of cadmium in moss mean there are high levels of cadmium in the air? Past research suggested a correlation, but the strength of the relationship was unknown.

**Data from Air Quality Monitor Validates Moss Data**

To know if the high cadmium levels measured in moss surpassed state benchmarks and potentially posed health risks, the scientists needed to compare moss data with cadmium levels measured in the air. In October 2015, the Oregon DEQ placed an air quality monitor near the largest cadmium hotspot indicated by the moss samples and gathered data for about a month. This monitor revealed that cadmium and arsenic emissions were 49 and 159 times higher than state benchmarks, respectively. Meanwhile, the scientists collected 25 additional moss samples in the vicinity to bolster the moss dataset.

By using data from the Oregon DEQ monitor from October and three other monitors in use for other projects, the scientists found there was a strong correlation between high levels of cadmium in the moss and high levels of cadmium in the air. Although moss and air cadmium could only be compared at four sites, these preliminary results suggest that moss may be a very accurate bio indicator of atmospheric cadmium.

**Working on Two Fronts: Public Outreach and Scientific Publication**

While the research team was sharing these preliminary results with partners, residents at community meetings, and reporters, the team was also working to have the cadmium findings from this innovative study published in a scientific journal. Publishing is an important part of the scientific process. To be published, the findings and the methods used for the statistical modeling and spatial analysis must be reviewed and validated by other scientists. Upon publication, these methods become a scientifically defensible technique that can be used in other parts of the country or world to protect public health.

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EPA Continues to Revise and Streamline NAAQS Review Process

In late 2018, the U.S. Environmental Protection Agency (EPA) announced plans to revise and streamline its process for reviewing the National Ambient Air Quality Standards (NAAQS) under the U.S. Clean Air Act (CAA). Each of these proposed changes ties back to former EPA Administrator Scott Pruitt’s May 9, 2018, policy memorandum, entitled “Back-to-Basics Process for Reviewing National Ambient Air Quality Standards”. Pruitt’s memo came shortly after President Trump’s “Presidential Memorandum for the Administrator of the Environmental Protection Agency on Promoting Domestic Manufacturing and Job Creation,” dated April 12, 2018. In that memorandum, Trump directed the EPA Administrator “to take specific actions to ensure efficient and cost-effective implementation of the NAAQS program”.

When then-Administrator Pruitt’s memorandum was released, it appeared at first glance that many of the statements that were made around more strictly adhering to statutory NAAQS review timelines were aspirational and non-controversial. However, current Acting EPA Administrator Andrew Wheeler’s chosen approach to trimming perceived fat from the process by eliminating what some view as critical scientific review will likely only deepen the schism between the agency and environmentalists.

In late August 2018, EPA issued a highly technical guidance memorandum concerning ozone contribution thresholds and interstate ozone transport under CAA Section 110. This “good neighbor” guidance may also serve to simplify the agency’s ozone NAAQS review process.
CAA Section 109 requires EPA to review the NAAQS for each criteria pollutant every five years. Due to the inherent complexity of the task (which Congress likely failed to fully grasp in 1970), NAAQS reviews are typically not completed “on time,” and have often taken substantially longer than five years. In October 2018, EPA issued a draft integrated review plan (IRP) designed to guide the agency through its next mandated review of the ozone NAAQS. As outlined in the IRP, EPA intends to complete its current review of the ozone NAAQS in less than two years.

Process changes proposed by EPA include a compressed review timeline, aborting the planned formation of a panel of approximately 25 scientific experts who were to be tasked with advising the agency on the NAAQS review, and overlapping the public notice and comment periods with review by the Clean Air Scientific Advisory Committee (CASAC) of EPA’s Science Advisory Board. All of the changes will likely invite accusations from environmentalists that the agency is conducting its review in an arbitrary and capricious manner without sufficient reliance on the advice of external scientific experts. This could lead to later legal challenges when the agency’s final decision with respect to the ozone NAAQS is promulgated in late 2020 (per the IRP’s accelerated timeline). Those opposed to EPA’s final decision may also allege that the public notice and comment period is somehow flawed given the concurrency of the CASAC and public review periods (with the public not having the full benefit of CASAC’s prior review).

Additional legal challenges not directly related to the speed with which EPA ultimately reaches its decision on the ozone NAAQS could stem from what is likely to be increased agency consideration of both background (naturally-occurring) ozone concentrations and international transport of ozone and its precursors from outside of the United States. While Section 179B of the CAA allows states to offer proof that NAAQS attainment is being influenced by emissions originating outside of the United States, its application in practice has typically been limited to emissions from sources in Canada or Mexico that were alleged to have impacted physically adjacent states.

President Trump’s April 2018 memorandum to EPA strongly suggested that states could now allege impacts from emissions as far away as Asia. With respect to background ozone, both the President’s memorandum and Pruitt’s companion memo argue that the NAAQS have advanced such that stationary and mobile source impacts (which can be regulated) are indistinguishable from background ozone from natural sources (which cannot be regulated). Either could help to form a basis for EPA to leave the current ozone NAAQS unchanged.

**Revised EPA ‘Good Neighbor’ Interstate Ozone Guidance (and the Resulting Controversy)**

In late August 2018, EPA issued a highly technical updated guidance memorandum to states on how the agency will evaluate interstate ozone emissions under the CAA’s “good neighbor” provisions. Section 110 of the CAA requires that an upwind state’s state implementation plan (SIP) include statutory or regulatory mechanisms to regulate emissions, “which will contribute significantly to nonattainment in, or interfere with maintenance by” downwind states with respect to any NAAQS. The agency’s August 2018 guidance memo tweaks the methodology that may be used by both EPA and states to identify and subsequently screen upwind states for downwind impacts that might necessitate further action.

EPA’s four-step framework for determining interstate good neighbor obligations involves: (1) identifying downwind receptors with NAAQS attainment or maintenance issues; (2) screening upwind states to determine which, if any, warrant further analysis; (3) identifying upwind emission reductions (if any) that may be necessary to aid downwind states; and (4) ensuring that upwind states adopt appropriate enforceable measures to reduce or eliminate their downwind impact. The agency’s new guidance changes the screening threshold to be utilized in Step 2, above, in determining which upwind states may require further review in Steps 3 and 4. Specifically, EPA is replacing the previous screening threshold of 0.70 parts per billion (ppb) or 1 percent of the 2015 ozone NAAQS with a new contribution threshold of 1 ppb. Arguably, air quality is not directly impacted by the change. The only difference that will result is at what level of impact an upwind state might be held accountable for NAAQS attainment or maintenance issues in downwind states.

Given the technical nature of EPA’s guidance and its niche applicability, it was unlikely that the general public would ever become aware of the memorandum or the proposed change. Media reports emerged in late October 2018, however, alleging that the agency (by and through its revised guidance) was surreptitiously signaling states to “pollute more”. As noted, above, this is not strictly accurate as downwind states remain responsible for ozone NAAQS compliance—and for adopting SIPs to either attain or maintain compliance with the NAAQS. No “additional” ozone emissions should result as necessary reductions would come (in total) from either upwind or downwind states. Emission reductions and SIP revisions necessary to model attainment or maintenance will remain unchanged. The only possible difference is where those emission reductions and SIP revisions might come from.

**Note from the Editor:** For more in-depth coverage of this topic, read the September and December 2018 issues of *EM* online at www.awma.org/em. em

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The focus of the January 1999 issue of EM was environmental justice. Still a controversial concept today, back in 1999, environmental justice sparked spirited discussion among lawmakers, attorneys, regulators, industry executives, and community groups. In this issue of EM, the topic was discussed by two guest authors: one arguing that environmental justice harms people by denying economic prosperity, the other defending environmental justice as a marker of fairness to all, regardless of race or economic status.

In the first article by Jeffrey S. Heath, “Environmental Justice: Deterrent to Economic Justice,” the author says that for many, the American Dream is fundamentally an economic dream, one of prosperity. Environmental justice, the author asserts, hinders this dream for everyone because it thwarts the influx of industry and jobs into economically depressed areas. Furthermore, he contends, the environmental justice movement adversely affects public health.

Quoting from the article: “Social equality is a building block of our nation and must be vigilantly protected and ensured. However, asking EPA or state and local environmental agencies to maintain that vigilance is not wise. Federal and state environmental agencies are staffed and trained to administer environmental laws and regulations. It is their mission to ensure that environmental statutes are implemented and that permits issued to industry have appropriate limits and controls to ensure public health and safety. It is not the mission, nor do they have the appropriately trained staff, to administer social policy matters.”

In the second article by Denise D. Feiber, “Environmental Justice: A Fledgling Voice for Fairness,” the author states environmental justice means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial or other operations. While stricter regulations might be a bitter pill for industry to swallow and some businesses might be negatively affected by environmental justice mandates, fairness to residents in neighboring communities must be considered, says the author.

Quoting from the article: “Although there is contradictory information about the health impacts of pollution on human health and the environment, upon observation it is difficult to deny the negative impacts minority populations and low-income populations are enduring because of their proximity to industrial facilities. Environmental justice is about fairness. So, what is there about the environmental justice initiative that needs to be defended? I agree it would be unfortunate if a legitimate project was stopped because of the power of a well-organized activist group, but is that a reason to wipe the environmental justice directive off the books or to rewrite it so that it cannot interfere with industry when they are meeting minimum regulatory requirements?”

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