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A close look at methane and black carbon emissions in the transport sector
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Short-Lived Climate Pollutants (SLCPs)
by Bryan Comer

In the fight against climate change, most of the focus has been placed on reducing carbon dioxide, a “long-lived” climate pollutant that contributes to warming centuries into the future. Other climate pollutants are “short-lived,” remaining in the atmosphere for a few years in the case of methane or only a few days in the case of black carbon. In this issue of EM, we explore emissions of two SLCPs in the transport sector.

Methane Emissions in the Transport Sector
by Jori Sihvonen

Addressing Aviation’s Non-CO₂ Climate Impacts: Time for Action
by Bill Hemmings

The Transition to Zero-Emission Bus Fleets in Megacities
by Ray Minjares and Francisco Posada

Black Carbon and Maritime Shipping: The Long Road to Regulating a Short-Lived Climate Pollutant
by Bryan Comer

Regulating Black Carbon Emissions in International Maritime Shipping: Can Distributed Ledger Technologies Help?
by Thomas L. Brewer

Columns
EPA Research Highlights: Protecting Communities with Safe, Sustainable Materials Management
by Carolyn Pugh

One of the U.S. Environmental Protection Agency’s (EPA) priorities is advancing sustainable materials management practices, and the management of construction and demolition debris presents a significant opportunity in terms of economic and environmental benefits.

Departments
Message from the President:
Let’s Talk Models, Measurements, and SLCPs
by Michele E. Gehring, P.E.


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

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Spring is upon us and it seems as if the success of our specialty program offerings is growing as fast as the weeds in my front yard! Our inaugural wildfires conference was more successful than we could have imagined, and our popular modeling conference once again brought together experts in air modeling programs and techniques from throughout the world. As we head into April, we are excited to see another run of our recurring air quality measurements conference and will then be hitting the gas pedal as we race toward our 112th Annual Conference & Exhibition in Québec this June. As someone who spends a significant amount of time overseeing stack tests and reviewing emission results, I know I am looking forward to the content that the measurement’s program has to offer. If you attend one of our specialty conferences and catch me roaming the halls, please pull me aside and introduce yourself. I love getting out to our meetings and events and meeting members and non-members alike.

This month, EM focuses on short-lived climate pollutants (SLCPs). While so much of the conversation tends to focus on the longer-lived climate pollutants, such as carbon dioxide, these powerful climate forcers pack quite a punch, making up for their short-lived nature with an impact that’s reported orders of magnitude above their long-term cousins. In addition, some of the SLCPs, such as black carbon and fluorinated gases, have measurable health impacts, making discussion of them important regardless of your position on the climate change portion of the conversation. Having been afforded the opportunity to attend the 24th Conference of the Parties (COP) Convention in Katowice, Poland, I heard many solutions proposed for the longer-term pollutants in the high-level meetings, but did not hear much discussion on the short-lived pollutants such as methane, fluorinated gases, and black carbon. While there were debates about pushing for a lower-methane environment, the majority of the conversation focused on carbon dioxide reductions with the elimination of fossil fuels through electric car production, coal phase-out, etc. I’m glad to see the Association giving some time to the lesser-discussed SLCPs. Our Association’s mission is aimed to promote critical environmental decision-making and without addressing all aspects of climate pollution, we would be failing in that mission.

Speaking of climate issues and COP 24, we spent some time at a recent Board of Directors meeting discussing our role on the climate stage and how best to bring added member value with our official observer status with the United Nations Framework on Climate Change (UNFCCC) COP. We are close to naming our delegates for COP 25, which will be held in Chile this coming November, and are working on guidelines for those delegates to use in making reports back to our membership. I’m interested in how you value our presence at these meetings and what sort of feedback you would like to see from them. At COP 24 in 2018, former A&WMA President Mike DeBusschere and I tweeted live from the conference and compiled a blog, technical program summaries, and even a few video updates. If you haven’t had a chance to review them, please check them out under the Industry Insights section of our website. After you have, let me know what you thought of our coverage and what you’d like to see from our delegates next time around.

As I send you on to the many pages of high-quality technical content that follow this opening, I encourage those in the climate community to think about the additional content we can bring to members on this topic. In the past, we have developed webinars on impact and adaptation and held specialty conferences on policy trends, compliance programs, and climate action initiatives. If you have an idea that you would like to see us bring to market, please send me an email, give me a call, or track down a member of our Board of Directors. We want to make sure we are bringing you valuable content and offering you opportunities to grow and succeed. Happy Spring! em
In the fight against climate change, most of the focus has been placed on reducing carbon dioxide (CO₂), a “long-lived” climate pollutant that contributes to warming centuries into the future. Other climate pollutants are “short-lived,” remaining in the atmosphere for a few years in the case of methane or only a few days in the case of black carbon. However, in this relatively short time, these pollutants have a much stronger warming effect—in the case of black carbon, a global warming potential that is 3,200-times stronger than CO₂. In this issue of EM, we explore emissions of two short-lived climate pollutants—methane and black carbon—in the transport sector and discuss ways to reduce them.
First, Jori Sihvonen discusses the air quality and climate tradeoffs of using natural gas as a transportation fuel. The author notes that while natural gas can reduce air pollution, its climate performance is undermined by even small amounts of largely unregulated fugitive methane emissions throughout the natural gas supply chain.

Second, Bill Hemmings outlines aviation’s non-CO₂ climate impacts. He explains that in addition to CO₂, airplanes emit nitrogen oxides, water vapor, and soot that create contrails and ozone that only last from minutes to days, but nevertheless worsen global warming. Therefore, the author suggests that the now is the time to reduce aviation’s short-lived climate forcers.

In the third article, Ray Minjares and Francisco Posada report on the transition to soot-free buses in megalities such as London and Santiago. They explain that these large cities are moving to cleaner bus fleets to tackle the twin problems of air pollution and climate change.

Next, in my article, I explain the long road toward regulating black carbon emissions from the international maritime shipping sector. I suggest that even though the pace of progress has been slow, the International Maritime Organization is poised to take action to meaningfully reduce black carbon emissions from ships, but the time for delay is over.

Lastly, Thomas Brewer tells us how distributed ledger technologies (DLTs), including “blockchain,” could improve enforcement and verification of environmental regulations. He also describes the potential challenges and climate tradeoffs of DLTs, including the electricity needed to power them, while explaining that DLTs will continue to find new applications as the digital revolution marches on.

We invite EM readers to reflect upon the relative attention paid to CO₂, greenhouse gases, and short-lived climate pollutants and to consider how this balance could or ought to be adjusted. Enjoy! em

Cover Story by Bryan Comer, Ph.D.

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Uncertainty remains on climate credentials while natural gas is promoted as a transport fuel.
The growing interest in the idea of using natural gas as a transport fuel to tackle air quality problems and climate change in the European Union (EU) makes it important to consider emissions from throughout the supply chain. Currently, the transport sector accounts for only 2 billion cubic meters (bcm), or 0.5%, of natural gas use in the EU, but it is likely to grow, as shifting to gas is one of the several options for complying with existing and coming regulations.

The natural gas industry foresees a 15-fold growth of natural gas use—up to 30 bcm—in transport by 2030.¹ The main sectors that could see a partial shift to natural gas are the long-distance transport sectors, notably shipping and trucks, but in some countries, there is also a push to shift passenger cars and city buses to natural gas. The proposed justification varies from energy security, to local air quality, to combating climate change, depending on the stakeholder.

In the EU, between 1990 and 2012, methane emissions from natural gas operations, including pipelines, increased by 16% (data subject to high uncertainty), while overall methane emissions decreased. Now the EU accounts for 6% of global methane emissions. The EU plans to develop a methane strategy in the coming years to more consistently tackle the issue. So far, efforts to reduce methane emissions have been incomplete. For example, methane was not included as a part of the chosen atmospheric pollutants in its 2030 Clean Air Programme, the main tool to decrease industrial emissions.³

Renewable Natural Gas

In the case of the production of biomethane, or renewable natural gas (RNG), for transport, unintended methane emissions released into the atmosphere are taken into account, as biomethane needs to meet a certain GHG savings threshold measured in CO₂-equivalent. If measurements are not taken, default values are used. In 2021, this will be expanded to all biogas and biomethane, as this will a requirement under the new EU Renewable Energy Directive.⁴

Liquefied Natural Gas

The shipping industry may see a shift toward using liquefied natural gas (LNG) as a fuel, to meet the International Maritime Organization’s (IMO) sulfur and nitrogen oxides limits. Some stakeholders have unfounded expectations that LNG could also contribute to the IMO’s vision of decreasing overall emissions by at least 50% by 2050 compared to 2008. However, methane emissions remain an important problem, and significantly reduce any potential GHG savings from LNG to the extent that in some cases LNG’s carbon footprint can be worse than the existing liquid fossil fuels it is supposed to replace.⁵

Methane Emissions

Methane emissions are an important factor when evaluating whether the shift is justified on climate grounds, because methane as a chemical compound is a powerful greenhouse gas (GHG) with a global warming potential (GWP) of 28, which means methane traps 28 times more heat in the atmosphere than does carbon dioxide (CO₂) over a 100-year time period. If the climate carbon-feedbacks are included (i.e., the biological and abiological processes on land and the ocean carbon sinks), the GWP for methane increases to 34. Fossil methane’s GWP is even higher: 30 (or 36 with climate carbon feedback).

Currently, the EU imports 69% of the natural gas it consumes,² which means that the methane release during the fuel production (and transportation) stages remains outside the scope of Europe’s GHG inventory. It is understood that the EU does not set requirements on methane emissions during the production or import of this gaseous fuel. There are limited reliable data available on the natural gas supply chain in the EU; however, concerns and debate on upstream methane emissions have been growing in recent years.

In the EU, between 1990 and 2012, methane emissions from natural gas operations, including pipelines, increased by 16% (data subject to high uncertainty), while overall methane emissions decreased.
There are little data on actual real-world emissions of methane from shipping. A study by Norwegian research institute SINTEF puts the onboard methane slip on average at 3.1%, which strongly varies based on the engine technology used. This is enough to make LNG a worse option than existing marine fuels in terms of well-to-wake GHG emissions even without taking into account upstream methane leakage.

**Compressed Natural Gas**

In the case of passenger vehicles, methane emissions are not measured. Since the advent of EURO 5 emissions standards, there have been limits on total hydrocarbon and non-methane hydrocarbon emissions for gasoline and compressed natural gas (CNG) engines. For diesel vehicles, there is only a limit on total hydrocarbon and nitrogen oxides emissions. The standards relate to tailpipe emissions measured in the lab. Real-world emissions verification is not included and potential leakages before the exhaust are not included. Methane emissions are not a part of the CO₂ standard for vehicles as the metric is not CO₂-equivalent. There are currently 1.2 million CNG passenger cars on EU roads, one million of them in Italy alone.

The EURO VI standard for trucks and buses has a limit of 0.5 g/km methane emissions for positively ignited LNG and CNG trucks and buses. It is unclear if the limit applies also to diesel vehicles, such as high pressure direct injection (HPDI) LNG trucks, which have higher energy efficiency and higher unburnt methane than spark-ignition LNG engines. As for passenger cars, the metric for the vehicle standard on GHG is CO₂, and not CO₂-equivalent; so for now, methane emissions are treated as a separate category. In the EU, there are currently 7,100 CNG trucks, 1,600 thousand LNG trucks, and 20,000 CNG buses in operation.

**Summary**

Natural gas currently represents a niche transport fuel, but it may see growth led by policies around climate mitigation and improving air quality. The climate performance of natural gas powered vehicles is highly dependent on methane emissions from the vehicle and the entire supply chain, both of which are still largely unregulated and uncertain in the EU context. This applies to all modes of transport, including public transportation. Policies at EU and global levels need to consider measuring real-world methane emissions to give a more accurate view of the climate credentials of natural gas. Current policies promoting the use of natural gas have been made with incomplete and over-optimistic information on methane emissions, leading to less-than-optimal policies, not necessarily meeting their objectives.

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8. A technical summary of Euro 6/VI vehicle emission standards; ICCB Briefing; The International
Addressing Aviation’s Non-CO$_2$ Climate Impacts: Time for Action

A look at the contributions of non-carbon dioxide aviation-induced climate warming effects.
Aviation is commonly believed to account for 2% of the world’s climate problem because the sector emits approximately 2% of global carbon dioxide (CO₂) emissions. International aviation—flights between different countries—contributes about 1.3% of CO₂ emissions, while domestic emissions—flights within individual states—account for the remaining 0.7% of global aviation CO₂. But all this is only part of the picture. Aviation in fact accounts for about 5% of man-made global warming because in addition to emitting CO₂, aircraft flying at altitude impact the atmosphere in various ways and these impacts have a large, albeit transient, additional warming effect.

Contributors to Aviation Non-CO₂
The main contributors of aviation-induced warming are contrail/cirrus cloud formation, CO₂, nitrogen oxides (NOx), water vapor, sulfur oxides (SOx), and aerosols. Contrails—the streaks in the sky comprising ice crystals formed around the escaping engine exhaust—and the resultant cirrus cloud formation, traps radiation escaping from the earth and again has a warming impact. NOx emitted at altitude by incomplete jet engine combustion enhances ozone formation on a timescale of weeks to months as well as depletes methane. Overall, NOx emissions have a net warming effect.

The climate impacts of CO₂ emissions are well known. CO₂ accumulates and has a very long life in the atmosphere (well over a 100 years). On the other hand, the climate impact of aviation aerosols is not currently well understood. Sulfate aerosols have a cooling effect and soot/black carbon a warming effect, while in general aerosols impact the climate by perturbing cloud formation. Overall the non-CO₂ climate impacts—NOx, contrails, cloud formation, water vapor, black carbon, etc.—have a transient lifespan, from minutes to hours/days/months. Yet, they are so powerful that, combined, they heat the planet far more every day than all the aviation CO₂ that has so far accumulated in the atmosphere since the Wright Brothers first took off.

If we accept that the world must decarbonize, then aviation must decarbonize as well. Indeed the Paris Agreement requires all Parties to reduce all emissions. This means addressing both aviation’s CO₂ and its short-lived but potent atmospheric climate effects as well. Regrettably, this statement remains an assertion only. Industry, the United Nation’s aviation body the International Civil Aviation Organization (ICAO), and even the European Union remain either in denial that aviation’s non-CO₂ effects need addressing, or are unwilling to expend the political capital necessary to start a process of mitigation.

There is certainly agreement all round that more research into these impacts is needed. A paper published in 2009 by D.S. Lee et al. remains the principal estimate of non-CO₂ effects, which were shown graphically and are reproduced in Figure 1. Figure 2 is a more recent (2017) version of Lee’s table, showing the different components of aviation-induced radiative (climate) forcing. It incorporates some updates.

Research but Act
While considerable uncertainties over impacts remain, the message is not unclear and research both in North America and Europe is ongoing to better understand and reduce the uncertainties. The U.S. Federal Aviation Administration (FAA), for instance, is directly involved through its Aviation Climate Change Research Initiative (ACCDRI). Work is concluding at ICAO to agree to engine standards for soot/black carbon (non-volatile particulate matter), including a no-backsliding standard for existing engines and one for new engine types. But the issues for new engines are complex—there is a trade-off with NOx when redesigning engines to reduce particulate matter. Cost is also an issue.

One relatively straightforward way to reduce aviation particulate matter is to reduce the sulfur content in jet fuels. Surprisingly, the average sulfur content in jet fuel in the United States has been estimated at 544 parts per million (ppm) by the FAA, way above that of road diesel. A similar situation exists in Europe. Some transatlantic discussion about reducing the sulfur content of jet fuel took place about a decade or so ago and efforts should be restarted. At about a 1% fuel cost premium, the move is feasible particularly when set against the substantial action that has been taken on health grounds to reduce sulfur in road fuels and now in shipping.

Avoiding Climate Sensitive Flight Regions
Research is ongoing into the feasibility and impacts of avoiding contrail formation by rerouting aircraft around climate sensitive areas and atmospheric conditions that give rise to this phenomenon. Accurate weather forecasting up to 12 hours before a flight would be needed to enable flight plans...
and traffic systems to adjust. Air traffic control systems would need to be coordinated to cope with the changes and above all airlines would need to accept to implement the operational changes and the added costs brought about by additional fuel burn. According to leading expert, Prof. Volker Grewe, “with a little bit of a detour, flying a bit higher or lower or north or south of that region, you can change the climate impact of aviation via the non-CO\textsubscript{2} effects dramatically, for example by more than 10% with a cost increase of less than 1%.”

Even if such an approach is feasible and would reduce climate warming impacts, others argue that given the longevity of CO\textsubscript{2} in the atmosphere, no CO\textsubscript{2} penalty can be justified. That debate has however yet to be properly had among regulators at national level and internationally at ICAO. Not the least because effective international action to address aviation CO\textsubscript{2} is hardly underway either. The ICAO offsetting scheme, CORSIA, won’t mitigate aviation kerosene usage and thus CO\textsubscript{2}, as it relies on funding emissions reduction (offsetting) projects in other sectors in developing countries. And the

It’s high time that research into aviation non-CO\textsubscript{2} impacts was accelerated and work started on developing policy options and procedures for addressing their impacts.
rules governing the environmental quality of these offset projects together with safeguards against double counting of emissions or crediting the use of unsustainable biofuels remain unresolved. At best, the CORSIA could see potentially questionable offsetting projects address some 6% of international aviation emissions from 2015 through 2050.\footnote{9}

**The EU Has Faltered on Non-CO\textsubscript{2}**

When the European Union decided in 2008 to include aviation in its Emissions Trading System (ETS), attempts were made to add a non-CO\textsubscript{2} multiplier, which would have required airlines to purchase additional emissions reduction allowances to account for non-CO\textsubscript{2} impacts. The proposal was dismissed as scientifically unsound and instead a study was undertaken for the European Commission, which recommended that a cruise NO\textsubscript{X} charge with a distance factor be introduced.\footnote{10} Unfortunately, that report is still sitting on Commission shelves. A second attempt came when revising the ETS for the period beyond 2021 through a call in late 2017 for the Commission to again assess non-CO\textsubscript{2} impacts, and if appropriate, come up with a mitigation proposal by January 2020. Regrettably, the European Commission admitted to the European Parliament last November that it hadn’t yet acted on this latest request nor indeed the one made in 2008.

It’s high time that research into aviation non-CO\textsubscript{2} impacts was accelerated and work started on developing policy options and procedures for addressing their impacts. The recent Intergovernmental Panel on Climate Change (IPCC) 1.5 °C report stressed that non-CO\textsubscript{2} emissions in pathways that limit global warming to 1.5 °C need to show deep reductions that are similar to those in pathways limiting warming to 2 °C.\footnote{11} It would help if the scientific debate over climate metrics for aviation CO\textsubscript{2} and non-CO\textsubscript{2} could be resolved. Meantime, there are no specific incentives or regulations requiring airlines to implement measures to minimize non-CO\textsubscript{2} impacts.

**Aviation Emissions Threaten the Paris Agreement**

The continued strong growth of aviation traffic and emissions shows no signs of easing up. Far more robust measures to reduce CO\textsubscript{2} impacts—accelerated uptake of technology and

![Figure 2. Components of aviation-induced radiative (climate) forcing (2017).\footnote{3}](image-url)
forcing standards, operational measures, the removal of the sector’s tax subsidies, and regulatory and industrial initiatives to drive a move to using very low carbon drop-in electrofuels are urgently needed. Offsetting in other sectors above 2020 levels is clearly insufficient. Governments need to show the way on accelerating action on both CO2 and non-CO2 impacts if the aviation sector is not to present a real and present threat to achieving the goals of the Paris Agreement.

William (Bill) Hemmings is director of aviation and shipping at Brussels-based Transport & Environment, the leading nongovernment organization working on sustainable transport issues across Europe. E-mail: bill.hemmings@transportenvironment.org.

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Environmental education will drive the future

Recognize someone by nominating them for the A&WMA Exceptional Education Contributor Award. Nominations are due April 24.

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Nominations should be submitted to Robin Lebovitz, A&WMA Professional Development and Student Programs Manager at rlebovitz@awma.org by Wednesday, April 24.
Growth in urban populations demands investment in affordable and accessible transportation. Increases in economic activity demand more efficient and clean transportation. And growth in greenhouse gas emission—and the threat of an irreversible change to climate conditions—demands low-carbon modes of transportation. Urban bus fleets provide solutions to all of these challenges and can become the spark of a broader transformation for heavy-duty vehicles in general.
Despite their affordability, higher energy efficiency than gasoline powertrains, and low-carbon emissions per passenger, approximately 80 percent of new buses sold today still utilize old diesel engine technology. Diesel exhaust is a known human carcinogen, according to the International Agency for Research on Cancer. As much as 75 percent of the fine particulate matter emissions of a pre-2007 diesel bus engine in the United States, for example, consists of black carbon (or soot), an ultrafine particle that serves as a universal carrier of toxic organic compounds and penetrates into the deepest regions of the lungs. Black carbon is also a super climate pollutant, capable of warming equivalent to 3,200 times the effect of carbon dioxide over a 20-year period.

Soot-Free Engines

A “soot-free” engine meets Euro VI or equivalent (e.g., US 2010) emission levels, which can achieve a 99 percent or greater reduction in diesel black carbon emissions in real-world driving when compared against all previous generations of diesel engine technology. A diesel engine can deliver soot-free emissions through a combination of ultra-low-sulfur diesel fuels (i.e., 15 parts per million sulfur or less) and a ceramic wall-flow diesel particulate filter. Other soot-free engines include a port-fuel injection engine powered by compressed natural gas or low-carbon biogas, or a zero-emission electric drive engine.

Commercially available Euro IV and V diesel buses are not considered soot-free solutions, as they rely on a combination of in-cylinder particulate emissions control and oxidation catalysts, and lack particulate trapping and burning capabilities. Manufacturers such as Volvo and Scania have recently developed Euro V products with a diesel particulate filter for the Colombia and Iranian markets, respectively, whose soot-free emissions performance should be validated.

The long-term trajectory for urban bus fleets is the zero-emission technology pathway. Dedicated electric drive engines are a commercially viable option that deliver very low or in some cases zero carbon emissions. These include battery-electric, trolleybus electric, or fuel-cell electric engines. The high operational savings from these very efficient engines may translate in some cases to lower overall total cost of ownership compared with today’s conventional combustion engine technology.

Zero-Emission Technology Pathway

We take a look here at examples from two major cities following a dual soot-free and zero-emission technology pathway. In the near-term they are taking advantage of locally available fuels in order to deploy soot-free engines needed to mitigate the air quality and near-term climate hazards caused by older technology diesel engines. And over the long term they are implementing a plan to deliver a zero-emission bus fleet.

London Pursues a Dual Path in Low-Emission Zones

London became in 2017 the first megacity to publicly commit to reaching by 2030 the World Health Organization air quality guideline of 10 μg/m³ for fine particulate matter (PM$_{2.5}$). This decision by the local government was the result of air quality monitoring data that shows that 95 percent of Londoners live today in areas with PM$_{2.5}$ concentrations more than double the future target. Fifty percent of the emissions come from the transport sector.

To achieve its clean air goals, the City of London has adopted an ambitious plan that includes a fully zero-emission bus fleet by 2037 and the adoption of the first ultra-low emission zone staring in 2019.

In the near-term, the transport authority of London has started delivering soot-free Euro VI buses for routes located in low-emission bus zones. These zones are located outside Central London, in critical areas that are emissions hotspots where buses are large contributors to the problem. As of today, 7 of the 12 low-emission zones are served by Euro VI buses. Central London, where air quality is most critical, is considered an ultra-low emission zone (ULEZ) and zero-emission bus zone by the local government, where only Euro VI and battery electric buses (BEBs) are being deployed. Approximately 3,000 Euro VI diesel buses will be operating in this type of zone by the end of 2019, and 250 BEBs will be in operation by 2020. About 30 percent of new Euro VI buses are hybrids, providing lower emissions and fuel consumption than a dedicated Euro VI diesel engine. Older in-use buses are also targeted for retrofits that would set them at Euro VI levels.

The world’s first ULEZ will enter into effect in April 2019 in Central London and be expanded to the Greater London area by 2021. For buses, the ULEZ design requires that diesel heavy-duty vehicles meet Euro VI standards or face a
fine of £300–£100 if standards are not met. Other vehicle types such as passenger cars and light commercial vehicles are also included in the ULEZ.

**Santiago Leads the Bus Technology Transition in Latin America**

Santiago, Chile is a prime example where data-driven decisions by proactive regulators can spur technology change and result in measurable improvements in local air quality. In the 1990s, Santiago, home to 7 million people, was in non-attainment for PM$_{10}$, ozone, and carbon monoxide. This resulted in an estimated 4,000 early deaths annually at an annual social cost between US$670 million and US$1,900 million. The government resolved in 1997 to improve air quality through an air quality management plan, including better fuel quality and vehicle emission standards with a focus on public transport development and fleet renewal. Santiago became the first Latin American city in 2009 to adopt ultra-low-sulfur diesel and Euro V for its bus fleet. These and other actions have since led to reduced PM and ozone precursor emissions by almost 70 percent through 2015.

Constant growth in vehicle fleet and vehicle activity resulted in daily non-attainment of the PM$_{2.5}$ standard between 2011 and 2014. Regulators and environmentalists sprang into action again, resulting in a new air quality management plan for the city in 2017. This latest plan required both the immediate transition to soot-free Euro VI technology for all new buses, as well as the roll out of the first fleet of zero-emission buses. Santiago again leads the way as the first Latin American city to require Euro VI for its buses. Already 500 Euro VI buses have been ordered and are being manufactured in Brazil, and some have entered into operation as of January 2019. More than 3000 Euro III buses will be replaced with new Euro VI buses over the coming years.

Besides a massive and swift transition to soot-free diesel technologies, Santiago is accelerating the adoption of battery-powered electric buses. The government, in coordination with environmental non-government organizations and private sector efforts are now developing a strategy to move to 25-percent electric drive buses by 2025. Today, Santiago is receiving 200 battery-powered electric buses produced both by BYD Auto and Yutong and privately financed by the electric utility companies Engie and Enel. This model of BEB financing demonstrates the shifting finance and business models that will be needed to bring new bus technology into conventional bus fleets. An additional 500 buses will be added in a next phase.

Besides immediate environmental and climate benefits, which are expected to reach 500,000 tons of carbon dioxide reductions, the total cost of ownership of these electric buses on some routes can be 20 percent lower than previous diesel buses. The transition to electric bus operation for a system with the reach of Transantiago requires proper planning, including bus and route selection, duty cycle determination, and vehicle simulation. Such planning has been necessary in partnership with international technical experts to develop route-based bus performance models. In this way, Santiago will be able to deploy the most suitable bus technology to meet the operational requirements of its bus routes.

**The Technology Transition Begins Now**

Bus fleets are targets for large-scale investment. They can provide affordable, low-carbon, and energy-efficient transport in major urban areas. But despite their advantages, the vast majority of new buses today utilize older technology diesel engines that continue to contribute to harmful air pollution and other environmental hazards. Continued technology stagnation, particularly in rapidly developing emerging economies, will accelerate the health and environmental
The Transition to Zero-Emission Bus Fleets in Megacities by Ray Minjares and Francisco Posada

The burden of bus fleets in urban areas as investments in bus fleets continue to grow.

When megacities such as London and Santiago adopt a strategy to deliver lower air pollution and energy consumption in the transportation fleet, they invest in clean technology for their heavily utilized urban buses. The results can be surprising: in London today a Euro VI diesel bus produces lower aggregate emissions than a Euro V or Euro VI diesel car. These results are proof that investments in public transport deliver large-scale public benefits.

Fleets must prepare for constant technology change over the coming decades. Our current and future environmental challenges demand near-term incorporation of soot-free technology and a long-term transition to zero emissions.

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Identifying black carbon’s contribution to maritime emissions and the lengthy process to control it.
If it were a country, the international maritime shipping sector would be the sixth largest greenhouse gas (GHG) emitter, producing more emissions than Germany. In April 2018, the United Nations’ International Maritime Organization (IMO) agreed to an initial climate strategy that aims to cut GHG emissions at least 50% below 2008 levels by 2050. But, as written, the strategy ignores a pollutant that is second only to carbon dioxide (CO2) in driving global warming: black carbon.

Black carbon is a small, dark particle that is emitted when fuel burns incompletely. It’s about 100-times smaller than the width of a human hair, small enough that it can penetrate deep into the lungs where it contributes to lung and heart disease and early death.

In addition to its health impacts, black carbon is a potent climate forcer. Although as a “short-lived climate pollutant” it stays in the atmosphere for only a few days or weeks, in that short time, it can have a dramatic impact on the climate. Black carbon strongly absorbs sunlight, directly heating the atmosphere. When it falls on snow and ice, it accelerates melt, revealing darker land or water beneath, including in remote regions of the world, like the Arctic.

While there are other sources of black carbon, including land-side transportation, residential heating, and industrial energy use, shipping in and near the Arctic emits black carbon that can deposit directly on sea ice, and icebreakers are the only source that can emit black carbon in the ice pack itself.2

**IMO’s Black Carbon Plan**

If black carbon is such a big problem, why isn’t it included in IMO’s GHG strategy? There were two arguments for omitting it. First, during the negotiations, several oil-producing countries argued that black carbon is not a “gas” and therefore it should not be included in a GHG strategy. Presumably, the point of a GHG strategy is to reduce climate pollution in all forms, whether or not it’s a gas or a particle. Black carbon is the second largest contributor to shipping’s climate impacts, representing 7–21% of CO2-equivalent emissions from the global shipping sector on a 100-year and 20-year timeframe, respectively.3 The second argument for excluding black carbon from the climate strategy was that IMO is already (slowly) working to decide if it should regulate black carbon emissions from ships.

In 2011, the IMO began considering how it might reduce shipping’s impacts on the Arctic. Back then, the idea was that because black carbon is a short-lived climate pollutant, curbing emissions would provide an immediate climate benefit. But the process has dragged on. IMO’s black carbon work plan involved three initial steps: (1) define black carbon; (2) identify appropriate ways to measure black carbon from ship engines; and (3) identify appropriate ways to control black carbon from ships.

The IMO agreed on a definition of black carbon in 2015, even though black carbon had already been defined in a 2013 peer-reviewed paper authored by 31 leading scientists;4 in the end, IMO adopted that definition. It took another three years for IMO to agree on appropriate ways to measure black carbon, which it did in 2018. Thankfully, identifying appropriate black carbon control measures took only one year, as IMO just agreed that there are up to 41 appropriate ways to control black carbon from ships, including using cleaner
burning fuels and capturing black carbon in diesel particulate filters, similar to those already used on nearly every diesel truck in the developed world.

Much of the progress in recent years on black carbon can be attributed to dedicated research from marine engine manufacturers, as well as the governments of Canada, Denmark, Finland, Germany, Japan, the Republic of Korea, and the United States. Researchers have presented their results at annual technical workshops convened by my organization, the International Council on Clean Transportation (ICCT). These workshops bring together researchers, scientists, government officials, shipbuilders, engine manufacturers, and civil society to build stakeholder consensus on defining, measuring, and controlling black carbon so that faster progress can be made at the IMO.3

Now that the technical work has been done, the political work begins. We know that ships are an important and growing source of black carbon emissions and they’re the only source that can sail to the Arctic and deposit black carbon exactly where you don’t want it: on the snow and ice. Let’s take a look at some policy options.

Regarding fuel quality, the fastest way to immediately cut black carbon emissions is to switch from residual fuels, such as heavy fuel oil (HFO), to distillate fuels, which reduces black carbon by 33%, on average.7 Using distillate fuels also enables the use of diesel particulate filters, which remove more than 90% of black carbon from the exhaust.8 Other marine fuels, such as liquefied natural gas (LNG), emit nearly zero black carbon, but require specialized LNG-engines and lifecycle methane leakage concerns mean that LNG may solve one problem (black carbon) but exacerbate another (methane). Other alternative fuels, such as methanol, bio-oils, and hydrogen, emit low or zero black carbon, but these fuels are not widely used in the sector because traditional marine fuels are much less expensive; that may change as climate policies emerge.

Efficiency regulations for new ships under IMO’s Energy Efficiency Design Index (EEDI) are expected to continue to become more stringent and, by consequence, new ships will

Furthermore, in a recent special report, the Intergovernmental Panel on Climate Change (IPCC) says that black carbon emissions must fall across all sectors at least 35% from 2010 levels by 2050 if we are to have any chance to limit global warming to 1.5 °C.6

**The Future of Black Carbon Regulation**

Given the urgent need to reduce climate pollution from all sectors, will the IMO actually regulate black carbon?

That remains to be seen. We expect IMO delegates to start discussing potential black carbon control policies in 2020. It’s not clear what type of policy IMO member states and organizations will propose. If we look to the past, IMO has regulated fuel quality for all ships, set efficiency requirements for new ships, and limited emissions from new ships.
burn less fuel and emit less black carbon than their predecessors. Eventually, new ship efficiency standards may be so stringent that ships will use low-carbon and zero-carbon fuels that dramatically reduce all types of emissions, including black carbon. But the pace of new ship efficiency improvements and fleet turnover is too slow to rapidly reduce black carbon from the sector.

A black carbon emission standard is another option. The IMO could set a black carbon standard for international ships when operating in particularly sensitive areas such as the Arctic or, given that emissions of black carbon outside the Arctic can affect the Arctic environment, the standard could apply to all ships. Ships could comply by using low-black carbon fuels or aftertreatment technologies such as diesel particulate filters. In the past, IMO has regulated nitrogen oxide emissions from new marine engines. There are no emissions standards that apply retroactively to existing ships. While it would be more politically palatable to regulate engines on new ships, the whole idea of regulating black carbon is to immediately reduce this short-lived climate pollutant. An emission standard would therefore need to apply to at least some portion of the existing fleet to be effective at reducing shipping’s climate impacts and its impacts on the Arctic.

**Summary**

Whatever the outcome, it will be several years until a black carbon control policy takes effect. New regulations require amending an international treaty called the International Convention for the Prevention of Pollution from Ships (MARPOL), and the fastest timeline between proposing an amendment and a new regulation entering into force is nearly two years. If IMO can move quickly, I reckon a black carbon regulation will be in effect by 2023, 12 years after IMO started this process. Better late than never, but we could have taken action much sooner. There can be no more delay. We’ve defined black carbon, we’ve agreed on appropriate ways to measure it, and we’ve identified several good ways to control it. The last step is to act. Here’s hoping for full steam ahead.

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Regulating Black Carbon Emissions in International Maritime Shipping: Can Distributed Ledger Technologies Help?

This article is derived from the author’s ongoing research on regulatory policies concerning air polluting emissions in the international maritime shipping industry, with a special focus on the potential for distributed ledger technologies to support those policies. This research is part of a broader interest in black carbon emissions in transportation—as a climate change problem, as well as a public health problem and a food production problem. Relevant publications are indicated in the article’s references.
Black carbon (BC) emissions are an important component of particulate matter (PM) from ships in international commerce; PM from ships causes hundreds of thousands of premature deaths per year and reduces the production of rice, wheat, and other grains by hundreds of thousands of tonnes. BC maritime emissions are also a contributor to global warming.¹

Because they occur as particle matter, not gas, BC emissions pose distinctive regulatory issues. For instance, the “soot” emitted by the diesel engines that currently power nearly all ships contains both BC—a global warming agent—and organic carbon (OC)—a global warming coolant. Since the BC/OC ratio is about 9/1, the diesel-emitted soot is clearly a net warming agent (for which diesel particulate filters are an effective technological solution, but only at small scales such as tugboats thus far).²

Port authorities in several countries have established regulations limiting ships’ BC emissions. The European Union (EU) has begun a mandatory BC data collection program in European ports. The United Nations’ International Maritime Organization (IMO)’s member states have sponsored many studies of BC emissions issues and IMO may introduce BC regulatory policies in the next several years (Editor’s Note: For more on BC regulation, see the article by Bryan Comer elsewhere in this issue).³

These and other regulations—existing and prospective—at many levels of governance have generated interest in the potential application of distributed ledger technologies (DLTs). DLT applications may be especially useful to support verification of emission monitoring systems and thus to enhance the empirical basis for enforcement processes.⁴ Despite the shortcomings of DLTs, there are a priori reasons suggesting that DLTs offer the potential to support such regulations. In fact, DLTs are already under development to support IMO and international regional regulations of the sulfur content of marine fuels and greenhouse gas emissions,⁵ and DLTs are also being developed for applications to international shipping supply chains.⁶

**DLT Basics**

Distributed ledger technology is a generic term that encompasses many types of IT platforms, including blockchain for instance.⁷ The core concept of DLTs is that digital ledgers—as records of transactions of diverse types—can be coordinated to create a distributed system in which participants can verify and share the information in the ledgers.

It is important to distinguish between crypto currency applications such as Bitcoin, on the one hand, and a wide range of other kinds of applications, which are fundamentally different. The latter include, for instance, applications that process health records, property ownership records, food production and distribution, electricity distribution, tax records, passport and visa records, contracts of various types, and the provenance of art works.

International maritime logistics processes pose a variety of challenges that make DLTs appealing—at least on an a priori basis. Ideally, a DLT system creates a more accurate, trusted, transparent, and efficient record. These features of DLTs offer the prospect of supporting the role of verifying compliance and enforcement of emissions regulations.

**Concerns about DLTs**

However, there are at least two main concerns about DLT applications in general that are directly relevant to applications in international maritime shipping—one based on the use of electricity to power large numbers of computers and thus the carbon footprint of the system, and the other based
on the need to establish the correspondence of information in the system in relation to the off-line facts of real physical or other transactions actually occurring in the “outside world”.

In the DLT literature, the former arises as a result of “mining” operations in which a participant searches for the mathematical equation that is needed to verify the process of adding transactions to ledgers, with a reward of the system’s tokens (a digital asset with value in the system) for a successful miner. The latter is referred to as the “last mile” problem. In common discourse, I prefer to refer to the former as an “energy consumption and environmental sustainability issue” concerning internal validation, and the latter as an “external validity” issue.

The energy consumption and environmental sustainability problem has been especially acute for the Bitcoin system, which has been calculated to produce carbon emissions at a level as of November 2018 between that of Bolivia and Portugal. Again, it is important to distinguish between such an issue for cryptocurrency applications, in which mining operations involve extraordinarily complex and voluminous calculations and thus computer time. For an application focused on maritime regulations, where the intention is to reduce the industry’s global warming emissions, the volume and sources of electricity being used to power the DLT support system are clearly a central concern. To date, the DLT development projects for emission regulations or more narrowly-defined logistical issues have been sensitive to these energy consumption issues, but it remains to be fully documented how successful they have been.

The “last mile” or “external validity” issues have received much less attention—at least in publicly available sources. An option for solving the problem would be to use the Secretariat of the IMO to serve as a trusted intermediary to confirm the correspondence. Though this would be counter to the decentralization that is a core feature of DLT systems, the possibility of a “hybrid” arises—one that would combine some features of a distributed ledger system and a centralized international organization system. This would be a way to address the observation that “the usefulness” of blockchain technology “still critically depends on trusted intermediaries to effectively bridge the ‘last mile’.”

**DLT System Design Issues and Options**

Although the details of these and other technical issues are beyond the scope of this article, it is possible to note here key DLT system design issues and options. One issue is the extent to which existing non-DLT data collection systems that are already in place and operational could perhaps be coordinated with a DLT emission regulation system—for instance, real-time satellite-based ship tracking systems, plume sensors mounted on surveillance airplanes, or bridges or other coastal areas to monitor the chemical content of ships’ emissions.

Yet another issue concerns the inter-operability with other DLT systems of a DLT system that supports an emission regulation regime. The other DLT systems could include not only systems involved in international shipping logistics and other possible maritime applications, but also national and international regulatory systems concerning emissions in other industries such as harbor-side, land-based transportation systems and cargo-handling equipment and processes.

In any case, what about possible linkages between an international maritime emission regulatory system and greenhouse gas emission trading systems? Could there be DLT maritime emission “tokens” that could have value as a credit in the European Emission Trading System? If the International Civil Aviation Organization (ICAO) actually implements its announced plan to create a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which will not be mandatory until 2028, what kind of linkages could be established between the shipping and aviation systems?

**Implications for Environmental Managers**

A new era of questions about the applications of DLTs to environmental issues has already begun. There has surely been much “hype”—and confusion and disappointment—about specific applications and the underlying information technology. However, the continuing and rapidly expanding development activity focused on a wide range of industry operations and government policies suggests that DLTs need to be “on the radar screens” of environmental managers in many industries, not only maritime shipping but transportation industries generally. Indeed, environmental managers in most industries in all economic sectors—manufacturing, agricultural, services and government—need at least to be aware of developments and at most become experts in some technical aspects of the diverse applications that may be directly pertinent to their own individual and organizational interests.

DLTs seem likely to have transformative impacts on many managerial processes in most industries, and those technologies
will be regarded as part of the larger ongoing digital revolution involving the internet of things and artificial intelligence. In the midst of such a revolution, it is essential for environmental managers to develop a realistic perspective on the implications for business and government.

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In Next Month’s Issue...

Air Quality Monitoring

U.S. Environmental Protection Agency (EPA) requirements for air monitoring are a critical feature of the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants and also provide important information about other pollutants. Intensive monitoring campaigns help support analyses of local and regional air pollution issues. Articles featured in the May issue will describe current issues and recent developments in air monitoring and their implications for air management.

Also, next month... Look for a special spotlight on waste management in the May and June issues, with planned articles that will consider landfill leachate problems, zero waste as an achievable goal, food waste challenges and opportunities, and waste-to-biofuels conversion in Canada.

em • The Magazine for Environmental Managers • A&WMA • April 2019
One of the U.S. Environmental Protection Agency’s (EPA) priorities is advancing sustainable materials management practices, and the management of construction and demolition debris presents a significant opportunity in terms of economic and environmental benefits.
Construction and demolition debris (CDD)—or the solid waste generated by construction and demolition projects—represents a significant portion of total solid waste flow in the United States. Each year, CDD disposal facilities receive between 230 and 530 million metric tons of waste, primarily materials like concrete, wood, metal, asphalt, drywall, masonry products, and land-clearing debris (e.g., tree stumps or rocks). Managing these quantities of debris is a huge task, and there are environmental and health risks associated with the process. Common problems include odor issues, landfill fires, and leachate leaks that can impact groundwater quality.

Sustainable materials management, or a systemic approach to using and reusing materials more productively over their entire life cycles, can alleviate certain risks by diverting waste from landfills. Materials recovery is an important aspect of that, and CDD recovery is a promising avenue for economic, environmental, and social benefits.

EPA researchers support sustainable materials management planning by providing practitioners with information, guidance, and tools. EPAs waste management research portfolio works to meet the needs of a broad range of stakeholders, but it can be difficult for individuals to locate the information they need. A recently released EPA report, “Sustainable Materials Management Options for Construction and Demolition Debris,” summarizes five years’ worth of CDD research to help practitioners, regulators, and other stakeholders find information on research relevant to them. The research topics range from best management practices for reducing odor issues at landfills to improving life-cycle analysis for waste materials, and can inform decision-making at national, regional, and local levels.

The report highlights a “methodology” to estimate the quantity, composition, and management of CDD in the United States, which offers improved estimates of nationwide CDD generation. Although EPA has tracked and estimated municipal solid waste flows for more than 30 years, until recently, CDD estimates were not included. Historically, few states have reported CDD data, and the few estimates that were made were done using a materials flow analysis approach. These estimates were low and did not typically include debris generated by large infrastructure projects like construction and demolition of roads, bridges, and airports. Now, several states do track and report CDD generation.

The newly developed method of estimating CDD generation incorporates these reported measurements and extrapolates the rest from indicators such as the number of building permits issued, providing a better understanding of the life cycles of CDD materials.

Other research highlighted in the report include best management practices to prevent and control hydrogen sulfide (H₂S) and reduce sulfur compound emissions. This research can help support landfill owners and managers as they make choices that can ultimately cause or prevent their landfills from jeopardizing human health or creating nuisances like strong odors. Hydrogen sulfide is a poisonous, flammable gas with a powerful, rotten-egg odor at low concentrations. It can be produced by either material solid waste or CDD waste, and once formed it is difficult to eradicate. Since H₂S is slightly heavier than air, it tends to pool near ground-level where people are susceptible to breathing it in. At high levels, it can cause olfactory paralysis and go undetected, potentially causing respiratory distress or even death. Because of this, landfill managers must take preventative measures and cannot solely rely on odor complaints as a primary indicator.

CDD landfills are particularly vulnerable to H₂S issues as they often receive waste material that includes gypsum drywall, which is high in sulfur. Other factors contributing to H₂S formation include organic materials like wood, sulfurous industrial sludges, moisture, and anaerobic conditions. EPA scientists researched and compiled best management practices for CDD disposal sites to reduce H₂S emissions, including liquids management, minimizing the area of the landfill that is actively accepting waste, using daily cover, and diverting drywall from landfill.

H₂S Calculator App

The research resulted in the creation of EPAs H₂S Calculator App. The app user enters a few basic inputs for conditions at a given site and receives a worst-case-scenario estimate of H₂S formation. Next, the user is directed to a simple guided checklist of management options. While the app was designed with landfill owners and managers in mind, it has potential as a tool for first responders in the wake of hurricanes or other disasters, as debris is rapidly removed, sorted, and, if possible, stored for reuse.

The research findings highlighted in EPAs report will help push forward the practice of CDD sustainable materials management, a field ripe with opportunities to increase community sustainability and vibrancy. Data gaps and
opportunities for further research were emphasized throughout the report, including the need for a large-scale market analysis of CDD diverted from landfills. As the state of available knowledge and data progresses, sustainable materials management can become more widely, safely, and efficiently practiced, benefiting the health of ecosystems and communities. 

More Information

The H₂S Calculator App is available for download. For more information about the H₂S Calculator App, contact Carol Staniec at staniec.carol@epa.gov.

For more information about the EPA Research Highlights column, contact Ann Cornelius Brown, U.S. Environmental Protection Agency (EPA), Office of Research and Development, Research Triangle Park, NC; phone: 1-919-541-7818; e-mail: brown.ann@epa.gov.

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Past-President Victor H. Sussman, P.E., passed away on October 28, 2018. He was 88.

After graduating college with a bachelor's degree in engineering, Sussman's first job was as an industrial hygiene engineer for the New York State Department of Labor. The department's chief engineer at that time was Art Stern (a Past President of the Association, 1975–1976). The 1955 Federal Air Pollution Act authorized the Public Health Service (PHS) to perform studies of air pollution. The PHS hired Stern to develop this program at the Taft Center in Cincinnati. Stern later hired Sussman to join his staff. After six months of training, Sussman was assigned to work with the Los Angeles Air Pollution Control District (LAAPCD). The then-director of LAAPCD, S. Smith Griswold (also a Past President, 1962–1963), assigned Sussman to work with LAAPCD engineers on a study of emissions from oil refineries.

In 1958, Sussman joined the Pennsylvania Department of Environmental Resources as Director of the Bureau of Air Pollution Control. He remained with the Bureau until 1972. While working as Bureau Director, he also served as Chair of the State and Territorial Air Pollution Program Administrators for two years, as a member of the Board of Trustees of the American Academy of Environmental Engineers, and as a member of the U.S. Environmental Protection Agency's (EPA) National Air Pollution Control Techniques Advisory Committee.

In 1972, Sussman joined Ford Motor Company in Dearborn, MI, as Director of the Environmental Quality Office, where he remained until he retired in 1994. His office was responsible for all environmental matters affecting Ford's manufacturing and other facilities and was credited with directing some of the earliest pollution control initiatives at the company.

An A&WMA member since 1951, Sussman was extremely active within the Association. He served as President (1969–1970), received the S. Smith Griswold Outstanding Air Pollution Control Official Award (1984), and was both an Honorary and Fellow Member. It was on Sussman's urging that the Association established the Annual Critical Review program in 1971, in an attempt to inject science and logic into state and local regulatory air resource management reviews, following the creation of EPA. He was appointed chair of Association’s Special Publications Committee, and the first review, “National Air Quality Standards for Automotive Pollutants” by J.M. Heuss, G.J. Nebel, and J.M. Colucci, was published in 1971.

In an interview for a “Member Minute” article that appeared in the November 2007 issue of EM, Sussman was asked “What does A&WMA membership mean to you?,” he replied: “A&WMA has always provided a platform for all points of view.” This was something about which he cared deeply.

In addition to his work in public health and environmental quality, Sussman was involved in many organizations, including EPA’s Training Program (adjunct faculty); UNESCO (consultant for air pollution studies in Iran and Brazil); Temple University’s School of Pharmacy (faculty member); University of Pittsburgh (lecturer); and Pennsylvania State University (lecturer). He also authored numerous articles and texts on environmental issues. During his time at Ford, he served as president of the Dearborn Chamber of Commerce, as well as the Dearborn Golf and Country Club. In his leisure time, Sussman enjoyed golf, swimming, and classical music.

Personal Memories and Condolences

“He was famous for his great sense of humor. Vic was one of the pioneers in our field and directed the earliest pollution control initiatives at Ford Motor Company.” – John G. Olin, President (1983–1984)

“Vic did a lot for the Association. He was a mentor and a role model. We will miss him deeply.” – Edith Ardiente, President (2005)

“He was President of the Association when I was still a student. Although I only had the opportunity to meet and talk with him at annual meetings, I saw how much he loved the Association.” – Anthony J. Buonicore, President (1994–1995)


“Vic was a legend in his own time. I first met Vic in 1972 during an air pollution episode at the flats of Cleveland when he was with Ford and I was with the air pollution unit of the Ohio Department of Health.” – Peter Hess, President (2006)

“Vic loved quotes such as: ‘For every complex problem, there is an answer that is clear simple and wrong.’” – Jim Sussman, brother
Twenty years ago, the impending new millennium—Y2K—was making headline news across the globe. The April 1999 issue of EM focused on one particular aspect: The Y2K bug. While there had been much discussion of how Y2K problems may affect banking, utilities, defense systems, and manufacturing, relatively little had focused on environmental protection systems and public safety. In the cover story article of the April issue, EM shone light on the topic with a look at the potential environmental implications of the Y2K bug.

In the article, The Y2K Bug: Environmental Management Challenges and Legal Implications, Dixie Lee Laswell considered the potential environmental and legal consequences of the Y2K bug, the federal government’s response to it, and steps companies could take to combat its effects. The overarching fear was that many operations designed to protect human health and the environment might have Y2K date problems that could trigger safety-related system malfunctions, toxic releases, and contamination.

Quoting from the article: “Although the Y2K bug sounds more like the star of a science fiction movie, this bug is real. Officials in the private sector and in government readily acknowledge its existence, although no one knows exactly what to expect from it. If there is one thing upon which everyone agrees, it is that the January 1, 2000, deadline cannot be renegotiated. Hence, it is essential for companies to conduct both technical and legal Y2K assessments as soon as possible to avoid huge liabilities and headaches in the next century. Awareness, prevention, and contingency planning now will help minimize the risk of environmental disaster at the stroke of midnight, Friday, December 31, 1999.”

In another article, Strategic Framework for Risk Management and Planning in Industrial Settings, by Wilhelm Kross and Martin Whittaker, the authors explored the means by which strategic management considerations may be integrated into the risk assessment process, and presented ideas on how integrated risk analyses could be used as value-added management tools.

Quoting from the article: “The consequences of a good decision are often forgotten, but the consequences of poor decisions for industrial operations (from planning to development, operation, decommissioning, and closure) are likely to make headline news and be managed when a crisis occurs. Worse still, poor decisions or weak management systems are often not reviewed once the plan is implemented, as planners and managers tend to focus more readily on identifying solutions to apparent problems rather than analyzing deep-rooted historic mistakes.”

Elsewhere in this issue, Dan Bemi reflected on how permanent total enclosure (PTE) had gained acceptance as a cost-effective means of complying with volatile organic compound (VOC) control regulations, despite a number of PTE design challenges, in Permanent Total Enclosures Used to Capture VOCs in Process Air Streams.

Quoting from the article: “Another popular misconception concerning PTE use is that the operator environment is compromised because of the concentration of contaminants in the reduced work area. This may be true in a poorly designed PTE; however, with appropriate room-air changes, a well-designed ventilation pattern, and, in some cases, the addition of a closed-loop air conditioning system, the air quality within the enclosure is often far better than pre-PTE conditions.”

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