

Air Quality Event Report

A guide to how organizations are planning, preparing, and responding to events

July 2020



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About this Report

In the summer of 2019, the California Resiliency Alliance (CRA) and BRMA jointly created a survey to look at how organizations, both public and private, were planning for, preparing for, and responding to air quality events in California. The survey, distributed through the CRA and BRMA networks, contained a combination of multiple choice and free-form questions to allow the respondent to elaborate on their answers. A total of 102 valid responses were collected between July 16 and August 7, 2019, though not all respondents answered all questions.

“The air quality events we have had in California over the last couple of years have caused widespread impact; you cannot easily escape the poor air quality.”

Large healthcare org

While the survey results themselves are a sampling and not statistically significant, they do reveal interesting insights and trends on how organizations plan, prepare, and respond to air quality events in California.

At this unique time, when COVID-19 is straining resources and requiring organizations to work in new ways, protecting the health of the workforce and minimizing the impact on business has become a priority. Beyond the pandemic, there is the threat of wildfires, the public safety power shutoffs (PSPS), and air pollution. These all compound health risks, as well as an organization’s ability to deliver its products and services uninterrupted.

As the risk of air quality events increases, and they become a recognized hazard, more attention and planning will be required.

The goal of the report is to increase the understanding of the impacts of air quality events and how others are managing them; thereby, supporting organizations in their planning and preparedness efforts.

The report is broken out into the following sections:

- **The Air Quality Index (AQI)** – Covers what the AQI is and the different types of indices.
- **The Effects of Air Quality Events on People and Organizations** – Looks at air quality event impacts on health, behavior, cognitive skills, and organizations and commerce.
- **Planning for Air Quality Events** – Provides information on what organizations have formal air quality event and red flag plans and informal practices.
- **Protecting Employees/Reducing Exposure** – Identifies measures organizations are taking to protect their employees and reduce the risk of exposure.
- **Minimizing Business Impacts** – Highlights some approaches organizations are taking to minimize the impact of air quality events on businesses.
- **Monitoring Air Quality Levels** – Describes the types of tools and methods organizations use to monitor local air quality.
- **Information Sharing** – Describes the type of information an organization may communicate to its employees, the perceived usefulness of the information, and the methods used for information sharing.

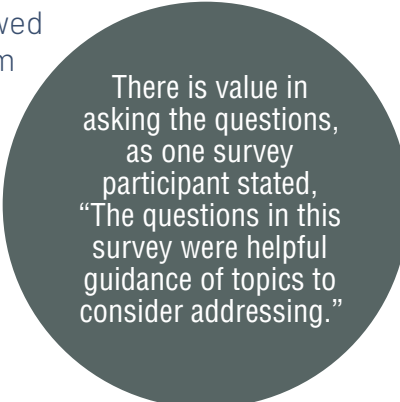
About this Report (cont.)

- **Respondents' Planning Assumptions –** Highlights expectations of the government to provide notification and guidance, employee use of personal protective equipment, and the ability of an organization to defer work.
- **Employee Opinions of what Employers Should Do –** Lists survey respondent feedback describing their perspectives on what organizations should do to address air quality events.
- **Additional Concerns About Air Quality Events –** Identifies additional concerns expressed by survey respondents.
- **Glossary –** Key terms used in this Report.
- **Appendix A: Respirator Usage in an Air Quality Event –** Highlights employer and employee obligations when respirators are used for work purposes, as well as models best suited to an air quality event.
- **Appendix B: Important AQI Usage Considerations –** Explains some key factors to be taken into account when interpreting an AQI.
- **Appendix C: Resource Collection –** Provides a collection of additional resources and tools related to air quality monitoring, events, and education.

The design of the survey allowed questions to be looked at from different perspectives such as organization size, where employees work (indoors/ outdoors), and geographic footprints of organizations. The interpretation of questions was at the discretion of respondents.

When referencing organization size, this report uses the following size groupings: Large organizations are those with more than 5,000 employees. Mid-Sized have an employee size ranging from 501-5,000 employees and Small are those with 500 or fewer employees. A few respondents answered from the perspective of their site/ facility and not the organization in its entirety.

Since the survey was completed, the COVID-19 pandemic has caused organizations to adapt workplace practices, including a strong pivot to work remotely. This may have drastically altered the processes by which organizations deliver products and services. Lasting changes from these modifications and insights gained may affect how organizations respond to air quality events in the future.



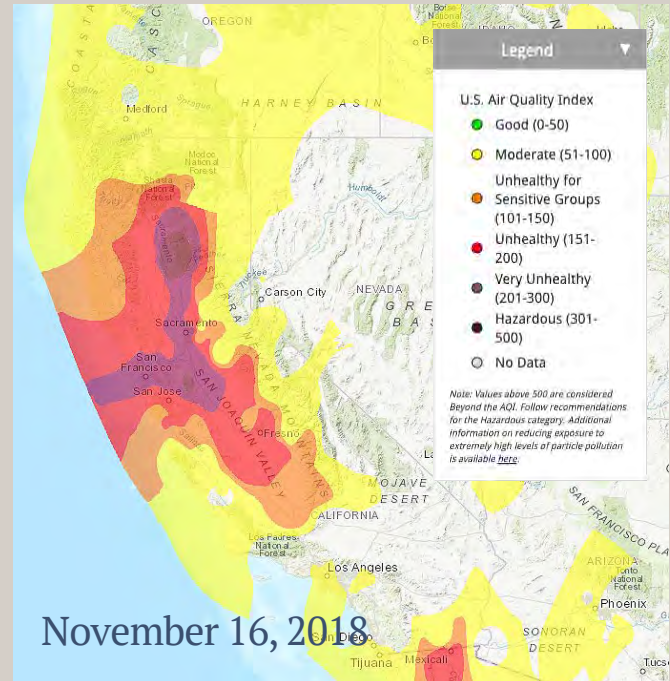
There is value in asking the questions, as one survey participant stated, "The questions in this survey were helpful guidance of topics to consider addressing."

About this Report (cont.)

In 2017, smoke from the wildfires in Southern California caused the Santa Maria–Santa Barbara area to move from being ranked as one of the cleanest cities in the United States for short-term particulate matter pollution for six years straight to rank as the 17th most polluted city in the United States that year.¹

During the November 2018 wildfires, portions of Northern California ranked as having the worst air quality in the world.² While Northern California may have ranked worst, other parts of California were not spared. Smoke from wildfires caused air quality across much of California to reach moderate and above levels. Some portions even reached the hazardous category.

While wildfires account for about 20% of the fine particulate matter emitted in the United States,³ they are not the only events that can cause air quality events. Other possible sources include refinery or other industrial fires and temperature inversions that trap pollutants and air toxins. Additionally, winds can transport pollutants for hundreds and even thousands of miles creating impacts far from the original source. This means that air quality events can be both geographically dispersed and widespread.⁴



Wildfires have made visible what is often an invisible or hard to see hazard. Past wildfires have caused days of heavy haze hanging in the air, impacting many facets of peoples' lives and the ability of businesses to operate normally. These impacts and conversations about how to respond to such events brought to light a lack of awareness from both the public and private sectors on how organizations respond to air quality events in general. At the time of the survey, the amount of research and information on this topic was limited. Since then additional work has been done around this issue, but knowledge gaps still remain.

¹ American Lung Association; State of the Air 2019: <http://www.stateoftheair.org/assets/sota-2019-full.pdf>

² Dineen, J.K; Wu, Gwendolyn; San Francisco Chronicle; Northern California air quality rated the worst in the world, conditions 'hazardous': <https://www.sfchronicle.com/california-wildfires/article/Smoke-still-plagues-Bay-Area-skies-a-week-after-13394932.php> (November 16, 2018)

³ Borgschulte, Mark; Molitor, David; Yongchen Zou, Eric; University of Illinois and Cornell University; Air Pollution and the Labor Market: Evidence from Wildfire Smoke: <https://pdfs.semanticscholar.org/0f59/3c7f1dd8aac35c8c11a6523520e2062638da.pdf> (June 2019)

⁴ Borgschulte, Mark; Molitor, David; Yongchen Zou, Eric; University of Illinois and Cornell University; Air Pollution and the Labor Market: Evidence from Wildfire Smoke: <https://pdfs.semanticscholar.org/0f59/3c7f1dd8aac35c8c11a6523520e2062638da.pdf> (June 2019)

The Air Quality Index (AQI)

The Air Quality Index (AQI) provides a metric of the level of certain pollutants in the air to allow people to make informed decisions and take steps to protect their health, or in the case of organizations, the health of their employees. The AQI scale runs from 0 (good) to 500 (hazardous). Any values above 500 are simply called “Beyond the AQI.”⁵

The scale is divided into six categories. Values at or below 100 are deemed acceptable, with those at or below 50 being considered good. When the AQI scale exceeds 100, concerns about health impacts start to emerge.

What the AQI Measures

As part of the Clean Air Act, the United States Environmental Protection Agency (EPA) sets the National Ambient Air Quality Standards

(see table below) for pollutants considered harmful to public health and the environment. The AQI looks at the five most common ambient air pollutants: ground-level ozone, particulate matter (PM₁₀ and PM_{2.5}), carbon monoxide, sulfur dioxide, and nitrogen dioxide.⁶ Not all AQIs measure all five ambient air pollutants.

Understanding the Different AQIs

AQI Daily Index – An air quality summary showing either a daily maximum or daily average number.⁷

AQI Forecast – A prediction of the day’s AQI. Forecasts are usually issued by state or local forecasters in the afternoon for the next day. Forecast AQIs might not cover all five pollutants, though most include at least ground-level ozone and particulate matter.

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and 500	Health warning of emergency conditions: everyone is more likely to be affected.

⁵ US Environmental Protection Agency; Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI): <https://www3.epa.gov/airnow/aqi-technical-assistance-document-sept2018.pdf> (September 2018)

⁶ AirNow; AQI Basics: <https://www.airnow.gov/aqi/aqi-basics/> (accessed May 2020)

⁷ US Environmental Protection Agency; Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI): <https://www3.epa.gov/airnow/aqi-technical-assistance-document-sept2018.pdf> (September 2018)

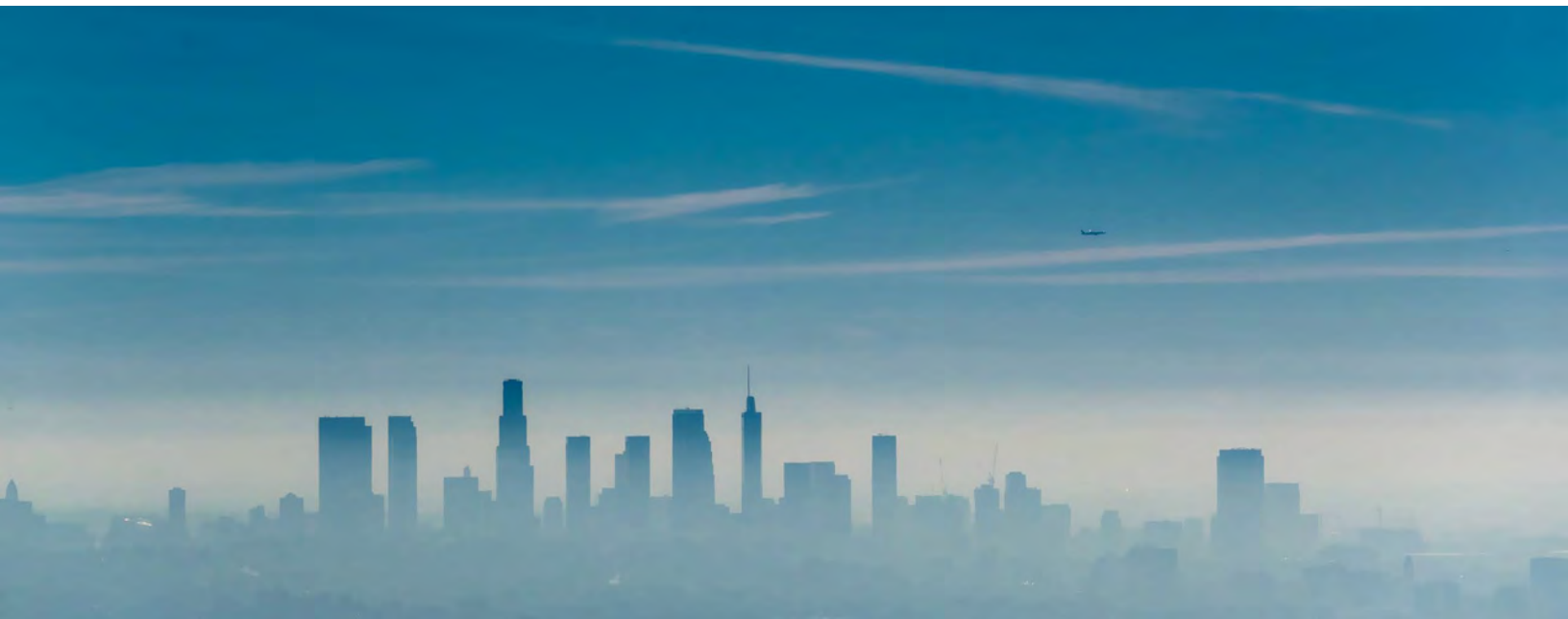
The Air Quality Index (AQI) (cont.)

Additionally, AQIs for different air pollutants use averages from different time periods. For example, ground-level ozone concentrations are expected to be the highest. For particulate matter, the forecast predicts the average 24-hour concentration for the next day.⁸

NowCast AQI – Shows “current” air quality. It allows AirNow’s current conditions to align more closely with what people are actually seeing or experiencing.⁹ This AQI is issued by the EPA and includes both ground-level ozone and particulate matter. Ground-level ozone

and particulate matter are calculated separately and the higher one is the AQI shown. NowCast uses averages from longer time spans during periods of stable air quality and shorter averages when air quality is changing rapidly, such as during a wildfire.¹⁰

None of the AQIs are an accurate reflection of actual current conditions at a specific location because of geography, weather, and algorithm constraints, though they can be a useful tool in understanding local generalities. For important considerations when using AQIs, refer to [Appendix B](#).



⁸ AirNow, Using the Air Quality Index: <https://www.airnow.gov/aqi/aqi-basics/using-air-quality-index/> (accessed May 2020)

⁹ AirNow; How is the NowCast algorithm used to report current air quality?: <https://www.airnow.gov/faqs/how-nowcast-algorithm-used-report/> (accessed May 2020)

¹⁰ AirNow, Using the Air Quality Index: <https://www.airnow.gov/aqi/aqi-basics/using-air-quality-index/> (accessed May 2020)

The Effects of Air Quality Events on People and Organizations

Air quality events affect all facets of our lives and can have direct and indirect impacts to organizations. As will be noted, air quality events do not have to reach the very unhealthy or hazardous levels for there to be impacts. This section explores the impacts of air quality events on:

- Health
- Behavior
- Cognitive Skills
- Organizations and Commerce

Air Quality Event Effects on Health

Poor air quality affects the health of individuals even at moderate levels and the effects increase as the air quality worsens. Health symptoms may start to show within a few hours of exposure for those with existing health concerns, but may be triggered in others if they are subjected to prolonged exposure.¹¹

Different pollutants have different impacts. For example, the results of one study indicated that while high particulate matter (PM) levels have a larger impact on sensitive or unhealthy groups, carbon monoxide affects both healthy and unhealthy groups similarly.¹² Research has also shown that short-term acute exposure to PM can increase illness and hospitalization rates.¹³ In regards to health, one of the significant differences between PM₁₀ and PM_{2.5} is that the fine particulates, PM_{2.5}, are small enough to not only get into the lungs, but also the bloodstream.¹⁴

“Too many unknowns on exposure, long and short term [e]ffects.”
(Small government agency)

“Long term impact to lungs.”
(Small school/higher education institution)

“Acute respiratory effects to employees with marginal, or unknown, respiratory system sensitivity.”
(Large private sector company)

Air quality events can impact the health of the workforce. People may suffer minor symptoms such as wheezing, coughing, sore eyes, or sore throat to more significant ones such as shortness of breath and respiratory tract infections. For those with serious underlying health issues, the air quality event may exacerbate chronic respiratory diseases (e.g., asthma, respiratory allergies, chronic obstructive pulmonary disease (COPD)); chronic cardiovascular diseases (e.g., blocked blood vessels leading to chest pain or heart attack); and even lead to premature death.^{15, 16}

¹¹ Chang, Tom Y.; et. al.; American Economic Journal: Applied Economics; The Effect of Pollution on Worker Productivity: Evidence from Call Center Workers in China: <https://www.aeaweb.org/articles?id=10.1257/app.20160436> (January 2019)

¹² Lavy, Victor; Ebenstein, Avraham; Roth, Sefi; NBER Working Paper No. w20648, The Impact of Short Term Exposure to Ambient Air Pollution on Cognitive Performance and Human Capital Formation: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2518738 (November 8, 2014)

¹³ Lavy, Victor; Ebenstein, Avraham; Roth, Sefi; NBER Working Paper No. w20648, The Impact of Short Term Exposure to Ambient Air Pollution on Cognitive Performance and Human Capital Formation: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2518738 (November 8, 2014)

¹⁴ Chang, Tom Y.; et. al.; American Economic Journal: Applied Economics; The Effect of Pollution on Worker Productivity: Evidence from Call Center Workers in China: <https://www.aeaweb.org/articles?id=10.1257/app.20160436> (January 2019)

¹⁵ US Climate and Health Alliance; Wildfires and Public Health: A View from the Front Lines: <https://usclimateandhealthalliance.org/wildfires-public-health-view-front-lines/> (accessed May 2020)

¹⁶ US Environmental Protection Agency; Wildfire Smoke – A Guide for Public Health Officials: <https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf> (August 2019)

The Effects of Air Quality Events on People and Organizations (cont.)

Studies have also shown that the effects of PM_{2.5} on health is not consistent across the age spectrum. It is of greater risk in early childhood, then lowers in healthy adolescents and young adults, before increasing again in middle through old age as heart and lung disease, hypertension, and diabetes increases.¹⁷

Something to note is that the impacts of exposure to poor air quality can last long after the event. Once particulate matter enters the body it can take it may take weeks or months for it to clear out of the system again. Also, the health impacts from exposure to poor air quality can leave people more vulnerable to future health shocks.¹⁸

When considering the effects of wildfires on health, there have been many studies of their impact over the short-term (daily), but limited research on the cumulative effects of these events over multiple days, weeks, or fire seasons.¹⁹ Therefore, the longer-term effects are not well understood and could have implications not previously considered.

As organizations plan for the impacts of air quality events, the short-term and long-term effects of these events on the workforce should be considered as they have direct and indirect impacts to organizations. As one respondent from a large public works company noted as an impact, "Health concerns from employees, increased sick leave usage."

Air Quality Effects on Behaviors

In addition to the impacts on health, air quality events also impact people's behaviors including worker productivity.

One study on the behavioral effects attributable to wildfires showed that workers have a tendency to stay indoors more, increase the use of air conditioners, and miss work.²⁰

Air quality has a direct impact on worker productivity, as found in a study of call center operators in China. In this case, staff completed fewer calls because they stepped away from their desk more often.²¹ They found the number of daily calls handled by a worker dropped by an average of 0.35% for every 10-unit increase in the air pollution index.²² To put this into context, for a 100 person call center taking an average of 30 calls per person per day, that translates into 10.5 fewer calls handled per day for every 10-unit increase from normal air quality. The research also showed that as the pollution levels increased so productivity dropped linearly.²³

In addition to the physical impacts of poor air quality, perceptions about air quality events can also change behaviors. While our ability to calculate and forecast air quality levels increases, our awareness of how advisories influence behavior is still limited. In one study, a third of the participants were aware of air

¹⁷ US Environmental Protection Agency; Wildfire Smoke – A Guide for Public Health Officials: <https://www3.epa.gov/airnow/wildfire-smoke/wild-fire-smoke-guide-revised-2019.pdf> (August 2019)

¹⁸ Borgschulte, Mark; Molitor, David; Yongchen Zou, Eric; University of Illinois and Cornell University; Air Pollution and the Labor Market: Evidence from Wildfire Smoke: <https://pdfs.semanticscholar.org/0f59/3c7f1dd8aac35c8c11a6523520e2062638da.pdf> (June 2019)

¹⁹ US Environmental Protection Agency; Wildfire Smoke – A Guide for Public Health Officials: <https://www3.epa.gov/airnow/wildfire-smoke/wild-fire-smoke-guide-revised-2019.pdf> (August 2019)

²⁰ Borgschulte, Mark; Molitor, David; Yongchen Zou, Eric; University of Illinois and Cornell University; Air Pollution and the Labor Market: Evidence from Wildfire Smoke: <https://pdfs.semanticscholar.org/0f59/3c7f1dd8aac35c8c11a6523520e2062638da.pdf> (June 2019)

²¹ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

²² Chang, Tom Y.; et. al.; American Economic Journal: Applied Economics; The Effect of Pollution on Worker Productivity: Evidence from Call Center Workers in China: <https://www.aeaweb.org/articles?id=10.1257/app.20160436> (January 2019)

²³ Chang, Tom Y.; et. al.; American Economic Journal: Applied Economics; The Effect of Pollution on Worker Productivity: Evidence from Call Center Workers in China: <https://www.aeaweb.org/articles?id=10.1257/app.20160436> (January 2019)

The Effects of Air Quality Events on People and Organizations (cont.)

quality advisories, but only about 10-15% said they had changed behaviors during the event. It was the study participants' *perception* of poor air quality rather than the metrics of the advisory that drove their changes.²⁴

A Canadian study assessed the behaviors of those who follow the Air Quality Health Index (AQHI, which is comparable to the Air Quality Index used in the United States). The study found that the primary reasons for checking the AQHI were a "perceived threat of adverse health effects from exposure to air pollution and the perceived benefits of health protection for self and those cared for via familial and (or) occupational duties". For those who did not check the AQHI and follow health messages, the barriers included a "lack of knowledge and time and reliance on sensory cues and media advisories."²⁵ This means that the media's messaging around air quality events will likely influence behavioral changes. Air quality events that are visible, such as the days of heavy haze mentioned in the introduction, will also likely lead to greater behavior changes than when the event is not visible.

Conscious behavior changes are also not consistent across all issuances of an air quality advisory. A study in Southern California found that while attendance at outdoor venues decreased after an advisory was issued,

the decrease was not the same if the advisory was issued for a second consecutive day. The behavior change response on the second day was smaller than on the first.²⁶

Perceptions around air quality and subtle behavioral changes driven by air quality events can have an impact on productivity in the workforce. These impacts should be considered as part of the planning process.

Air Quality Effects on Cognitive Skills

There appears to be a direct correlation between poor air quality and cognitive skills. The ability to think and act as usual varies on the level of exposure to increasing air pollution levels, thereby impacting decision-making, risk-taking, and analytical skills.

Various researchers have found connections between poor air quality and cognitive abilities:

- In exploring whether fine particulate matter (PM_{2.5}) might influence cognitive functions, analysis over a 10-year period revealed New York stockbrokers traded fewer stocks, possibly moving away from more risky investments, because their own lower cognitive ability led to more risk-averse behavior.²⁷ Similar findings were revealed for 100,000 investors at a German brokerage firm.²⁸

²⁴ Semenza, Jan C.; et.al.; Environmental Research; Public perception and behavior change in relationship to hot weather and air pollution: <https://www.sciencedirect.com/science/article/abs/pii/S0013935108000704?via%3DIihub> (July 2008)

²⁵ Radisic, Sally; et.al.; Canadian Institute of Public Health Inspectors; Environmental Health Review; Factors influencing health behaviours in response to the air quality health index: a cross-sectional study in Hamilton, Canada: <https://pubs.ciphi.ca/doi/10.5864/d2016-002> (March 16, 2016)

²⁶ Neidell, Matthew J.; National Bureau of Economic Research; The Dynamics of Air Pollution Impacts: <https://www.nber.org/reporter/2017number2/neidell.html> (2017)

²⁷ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

²⁸ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

The Effects of Air Quality Events on People and Organizations (cont.)

- Airline pilots generally performed advanced flight maneuvers, such as flying with only one engine in a flight simulator, better when exposed to lower amounts of carbon dioxide compared with higher exposures.²⁹
- Students sitting exams in rooms with lower volatile organic compound levels and lower levels of carbon dioxide received statistically significant higher test scores.³⁰
- Cognitive performance can also be impacted by restricted blood flow and circulation as a result of PM_{2.5} penetrating deep into the lungs and entering the bloodstream.³¹
- One study showed air pollution can impact the nervous system leading to: memory disturbance, tiredness, blurred vision, impacted productivity.³²

Research has shown that the cognitive impacts of these events can influence workers in ways that may not have been foreseen or even acknowledged by the employee if asked, but could lead to further business impacts.

Air Quality Impacts on Organizations and Commerce

Overall organizational productivity declines when the workforce is impacted by an air quality event. This may result in potential delays to projects as staff change their work habits. Employees who typically work

outdoors may need to come indoors for longer periods, others may have to leave to care for loved ones, and others may become sick themselves (some potentially seriously so).

“Our locations are already staffed tightly. If employees choose to stay home we may not be able to operate all locations, therefore we strive to provide a safer environment than they may have at home, and if necessary will provide equipment such as masks for employees to take home for their families.”

(Small financial services organization)

“...., legal requirements, policy/procedure development, Transit service disruption.”

(Mid-Sized transportation organization)

Where an organization provides a face-to-face service with customers and/or the community, it may not be possible to maintain usual work levels. One survey respondent stated that the long-term impact to operations of an air quality event could mean the “...community [is] unable to visit City Hall to obtain needed services such as permit requests, building plan reviews, etc.” (Mid-Sized government agency). In severe cases, as shared by survey respondents, residual smoke in buildings and filters or if the HVAC system cannot be closed to outside air, building(s) may temporarily become un-occupiable due to poor air quality.

²⁹ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

³⁰ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

³¹ Lavy, Victor; Ebenstein, Avraham; Roth, Sefi; NBER Working Paper No. w20648, The Impact of Air Pollution on Cognitive Performance and Human Capital Formation: <https://core.ac.uk/download/pdf/28902979.pdf> (September 2012)

³² Lavy, Victor; Ebenstein, Avraham; Roth, Sefi; NBER Working Paper No. w20648, The Impact of Air Pollution on Cognitive Performance and Human Capital Formation: <https://core.ac.uk/download/pdf/28902979.pdf> (September 2012)

The Effects of Air Quality Events on People and Organizations (cont.)

In California, individual school districts decide when to close a school, but state guidance recommends closure when air quality hits level 5 on the PurpleAir scale, which is approximately equal to an AQI of 200.

[Guidelines for Schools and Wildfire Smoke](#)

Additionally, the closures of schools due to air quality also impacts the workforce as parents or guardians need to find alternate care or have to stay home to look after the child(ren). This need for alternate care is regardless of whether lessons are moved online or are stopped altogether.

One participant highlighted that longer closures may result in an extension of the school year, further impacting routines/schedules and in turn an organization.

A study on the effects of wildfires revealed that the loss of annual labor income resulting from wildfire smoke exposure exists in both the year that the fire occurred as well as the following year, which indicates lasting reductions in health or wages. They estimated the annual average income in a county can drop by between 0.054 and 0.080 percent.³³ To put this into perspective, for the 2017 payroll in Kern County that would equate to about \$4.6 to \$6.8 million³⁴ and for Los Angeles County it is around \$121.2 to \$179.6 million.³⁵

In the Air Quality Effects on Behaviors section, insights are shared from a study of call center workers in China. The authors of that study projected the possible increase in earnings if the same level of impact were applied to all workers in the service industry within Los Angeles County. In 2014 the county

experienced 28 day with AQI levels above 150. The researchers estimated that if those days were reduced to values below 150, it could have led to an increase of more than \$370 million for the industry simply through improved productivity.³⁶

The economic impacts of a wildfire also ripple back to the community in the form of less public sector funds and potentially more support needed to help employees.

“Long term effects. Maybe they don’t notice it right away, but it starts to [a]ffect an employee’s ability to come in to work.”

(Mid-Sized financial services organization)

“Long term exposure risks, disruption in operations.”

(Small law enforcement/EMS/fire agency)

“We work in a closed office environment, so air quality events don’t affect us much during work hours. In fact, it is probably healthier for some of our employees to work at the office, rather than telecommute at a home without central AC or heating. Air events would have an effect on commutes and I do worry if my children still have to go to school.”

(Small IT/tech company)

³³ Borgschulte, Mark; Molitor, David; Yongchen Zou, Eric; University of Illinois and Cornell University; Air Pollution and the Labor Market: Evidence from Wildfire Smoke: <https://pdfs.semanticscholar.org/0f59/3c7f1dd8aac35c8c11a6523520e2062638da.pdf> (June 2019)

³⁴ US Census Bureau; Quick Facts – Kern County: <https://www.census.gov/quickfacts/kerncountycalifornia> (accessed May 2020)

³⁵ US Census Bureau; Quick Facts – Los Angeles County: <https://www.census.gov/quickfacts/fact/table/losangelescountycalifornia/PST045219> (accessed May 2020)

³⁶ Schmidt, Silke; Environmental Health Perspectives; Brain Fog: Does Air Pollution Make Us Less Productive?: <https://ehp.niehs.nih.gov/doi/full/10.1289/EHP4869> (May 14, 2019)

Planning for Air Quality Events

Air quality events pose a threat to employee health and safety as well as business operations. While the vast majority of respondents had business continuity and emergency management plans, 79% and 92% respectively, the presence of air quality event plans was significantly less. Emergency management and business continuity plans often do not address all of the challenges presented by these events. The existence of formal plans (documented policies and procedures) and informal practices within organizations has likely evolved out of past experiences and been driven by organizational culture.

The survey queried which respondents have Red Flag Warning Plans. These warnings are issued by the National Weather Service to alert people of possible extreme burning conditions and high fire danger.³⁷ Therefore, monitoring for these warnings can also serve as an early notice of potential air quality events driven by a wildfire.

Air Quality Event Plans

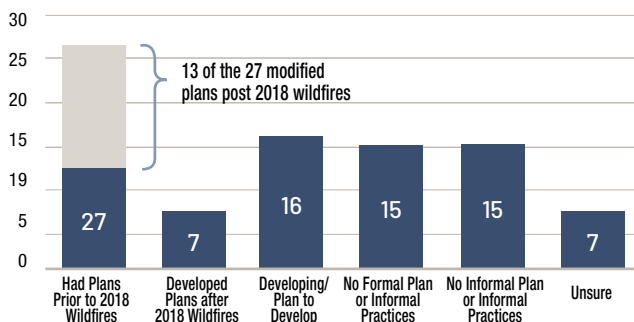
The survey posed the question “Does your organization have policies and/or procedures regarding response to air quality events?” For this question there were 87 valid responses.

Twenty-seven respondents stated they already had an air quality event plan prior to the 2018 wildfires, and of those, thirteen decided to modify their plans following those wildfires. Seven more developed their plans after the 2018 wildfires. Sixteen were either developing plans or had plans to develop them at the time of the survey. In addition, 15 stated they had some form of informal practices relating to air quality events. Together this brings the total that either had formal plans, were developing them, and/or relied on informal practices to 65 (75% of the respondents).

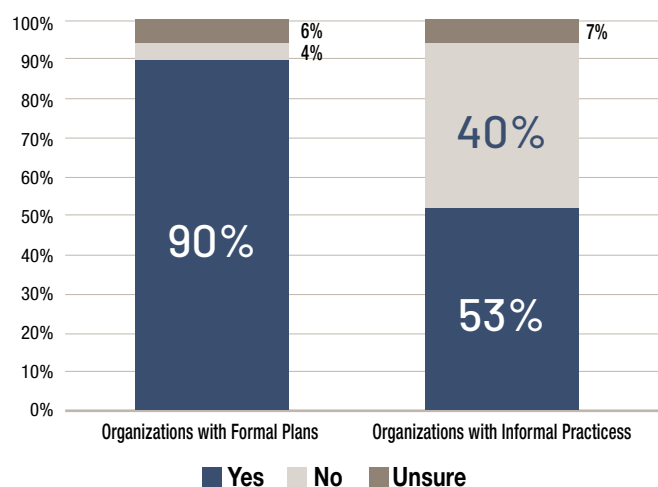
Of the remaining 25%, 15 stated they had no formal or informal practices, policies, or procedures around air quality events and 7 were unsure of what their organization had.

Designated Teams: 90% of those with formal plans at the time of the survey had a designated group/team with the authority to activate air quality event response policies and/or procedures. 6% of the respondents who stated their organization had a formal plan

Air Quality Plans



Have a Designated Team



³⁷ National Weather Service; Glossary - Red Flag Warning: <https://w1.weather.gov/glossary/index.php?word=red+flag+warning> (accessed May 2020)

Planning for Air Quality Events (cont.)

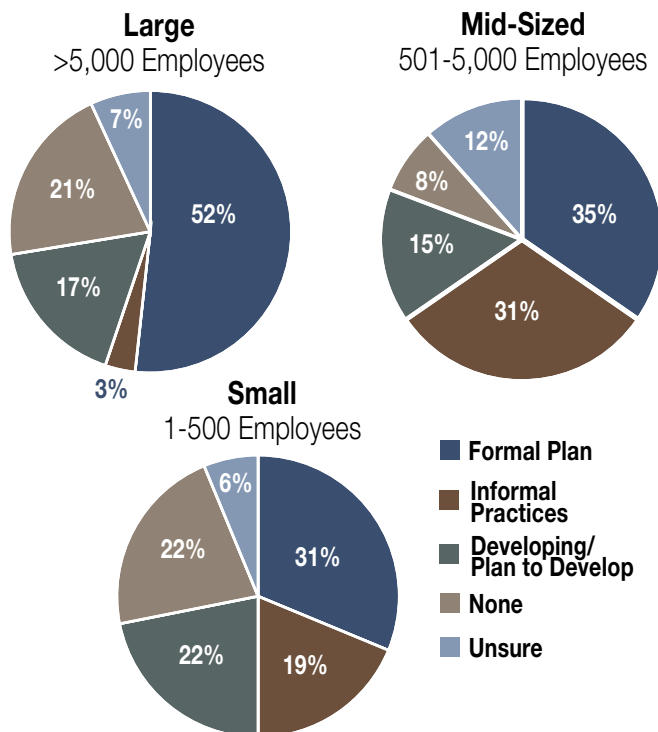
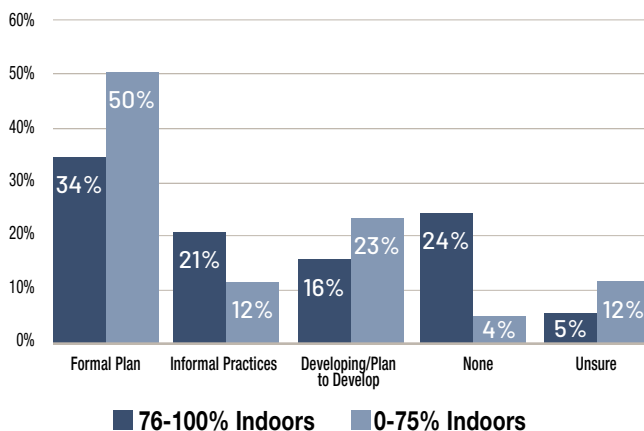
were unsure if there was a designated team. For those relying on informal practices, the percentage that had a designated team dropped significantly to 53% while the number who were unsure if they had a team remained fairly even at 7%.

Organization Size: With regard to the size of an organization, there was a trend that Large organizations were somewhat more likely to have a formal air quality event plan than Mid-Sized or Small organizations (52%, 35%, and 31% respectively). When factoring in informal practices, the percentages shifted to 55% (Large), 65% (Mid-Size), and 50% (Small), indicating that the Mid-Sized and Small organizations were more likely to rely on informal practices. For the Large employers, if they did not already have a formal plan, they were either developing or planning to develop one (17%) or did not have anything in place (21%). Across all three size groups the percentage

developing/planning to develop plans was relatively similar ranging from 15% for the Large and Mid-Sized organizations to 22% for the Small.

Where Employees Work: There seemed to be an almost inverse trend related to where employees worked (indoors or outdoors) and whether an organization had a formal air quality event plan. Organizations with all or the vast majority of their employees working indoors

Plans and Practices by Where Employees Work



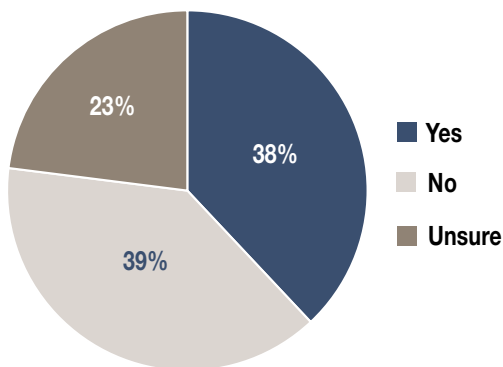
had either a greater reliance on informal practices or had no plans/practices than organizations with at least a quarter of their employees working outdoors. 50% of organizations with at least one in four of their employees working outdoors had a formal air quality event plan compared to 34% for those with a primarily indoor workforce. The number of respondents who were unsure whether their organization had an air quality event plan was higher for organizations with more outdoor workers.

Planning for Air Quality Events (cont.)

Red Flag Warning Plans

When asked whether an organization had a Red Flag Warning Plan or Procedures, 38% of respondents stated they had either a plan or procedures. 23% of respondents stated they were unsure or did not know if their organization had a red flag plan or procedures.

Have a Red Flag Warning Plan or Procedures



Interestingly, of those who were unsure, 39% self-identified as working in Emergency Management. It is worth considering that organizations may have plans, but have not socialized them among their employees.

Considerations:

- Has an impact analysis been conducted to assess how an air quality event may affect employees, facilities, and operations?
- Is a designated team needed to manage response to air quality events? If so, have they been trained and participated in exercises?
- Will the existing formal plans or informal practices provide sufficient guidance to the user to respond to an air quality event?
- If/when an air quality event occurs, are procedures in place to mitigate impacts and allow for the continuation of operations while protecting employees?
- Where a plan does exist, is there a cycle of continual improvement in place to review and update the plan(s)?
- Do the plans or practices take into account the impacts of air quality events on employee health, behavior, and cognitive skills?



Protecting Employees/ Reducing Exposure

Article 23 of the Universal Declaration on Human Rights proclaims that “everyone has the right to work, to free choice of employment, to just and favorable conditions of work and to protection against unemployment. All of the 3.5 billion workers in the world have the right to breathe clean air at their workplaces, as well as at their homes, cities and villages.”³⁸

“We’re concerned about outdoor workers who are unable to request protection or ability to protect themselves because of their vulnerable economic or immigration status. Also, for all populations, we would be interested in clarity on amount of outdoor exposure or physical exertion appropriate, if any (e.g., does “limit exposure” mean 10 or 15 minutes of exposure is ok?). Long-term impacts of exposure... some guidance mentions to watch for short-term symptoms, but that can be misleading if long-term damage is done.”

(Large government agency)

The World Health Organization (WHO) has estimated outdoor air pollution causes 4.2 million premature deaths worldwide every year among the general population, including workers.³⁹ A study published in 2018 estimates between 90,000 and 360,000 deaths per year in the U.S. are linked to air pollution.⁴⁰

In 2018 the World Health Organization held its First WHO Global Conference on Air Pollution and Health. Below is an excerpt from their conference report highlighting workplace measures to protect workers from ambient air pollution:⁴¹

- Reduction of exposure – reducing the working time outdoors, rotation of workers, restricting work during episodes of severe air pollution, including dust storms.
- Providing respiratory protection programs – appropriate respirators, fit testing, and training of workers.
- Medical surveillance of workers – medical check-ups for underlying health conditions that can worsen with exposure to air pollution – for example asthma, COPD, cardiovascular diseases (risk of heart attack and stroke).
- Health surveillance of working environment – recording levels of air pollution from government and other sources.
- Reporting cases of occupational diseases that can be caused by ambient air pollution among exposed workers (asthma, chronic obstructive pulmonary disease, lung cancer) and follow up with the employment Illness and Injury Prevention Program.

“We have N95 respirators and emergency equipment at all offices.”
(Small financial services organization)

³⁸ WHO; First WHO Global Conference on Air Pollution and Health: Improving Air Quality, Combatting Climate Change – Saving Lives: https://www.who.int/airpollution/events/conference/05_Protecting_workers_from_air_pollution_outdoors_and_indoors.pdf?ua=1 (October 29, 2018)

³⁹ WHO; First WHO Global Conference on Air Pollution and Health: Improving Air Quality, Combatting Climate Change – Saving Lives: https://www.who.int/airpollution/events/conference/05_Protecting_workers_from_air_pollution_outdoors_and_indoors.pdf?ua=1 (October 29, 2018)

⁴⁰ Dedoussi, Irene C.; Nature; Premature mortality related to United States cross-state air pollution: <https://www.nature.com/articles/s41586-020-1983-8> (February 12, 2020)

⁴¹ WHO; First WHO Global Conference on Air Pollution and Health: Improving Air Quality, Combatting Climate Change – Saving Lives: https://www.who.int/airpollution/events/conference/05_Protecting_workers_from_air_pollution_outdoors_and_indoors.pdf?ua=1 (October 29, 2018)

Protecting Employees/ Reducing Exposure (cont.)

Resource:
Cal/OSHA –
Protecting Outdoor
Workers Exposed to
Smoke from Wildfires

[Find it here](#)

Staying indoors in an adequately protected building is another way to limit exposure to an air quality event. Both the EPA and Cal/OSHA have developed guidance for maintaining private and commercial building HVAC systems, as well

as how to protect the occupants. This guidance includes analyzing the condition of each building's air conditioning and air filtration system, as well as making sure the HVAC system filters are not dirty, damaged, dislodged, or leaking around the edges.^{42,43}

As part of the survey, respondents were asked about methods their organization used to reduce indoor and outdoor employee exposure.

For the actions around minimizing exposure for indoor employees there were 82 valid responses:

- 65% provided N95 respirators. Whether or not an organization provided N95 respirators for its indoor workers varied by organization size: 71% of Large, 13% of Mid-Sized, and 64% of Small.
- 65% limit outside air intake/recirculate internal air. It is unknown what percentage of those that do not do this are unable to limit outside air intake/recirculate air because of the design of their system or age of the building. As one respondent shared, "No A/C in San Francisco, old building. Closing windows."
 - While some systems are not designed to recirculate internal air, some organizations

have identified alternate strategies. As shared by one respondent, "Our HVAC units do not recirculate, but in a true emergency we are prepared to turn off the units, to the extent possible, seal doorways, then shelter in place."

- 62% use a filtered ventilation system. Three stated they do not have a filtered ventilation system, but change their air filters more frequently during an air quality event.
- 37% increase the frequency with which they change the filters in the HVAC system.
- 14% of organizations rely on the property manager to maintain the filtered ventilation system. 40% of organizations manage their own maintenance of the HVAC system, while 8% outsource responsibility.
- 61% allowed their employees to telecommute during air quality events. The majority of these (65%) were organizations that routinely allowed their employees to telecommute. For 24%, telecommuting was only done as part of their contingency plan.
- 56% allowed for the use of alternate work locations.
- 44% shutdown events or outdoor activities. One participant shared that they close outdoor exercise facilities.

"Making sure outdoor air quality events do not become an indoor air quality event"
(Mid-Sized financial services organization)

⁴² US Environmental Protection Agency; Wildfire Smoke – A Guide for Public Health Officials: <https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf> (August 2019)

⁴³ California OSHA; Section 5142 Mechanically Driven Heating, Ventilating and Air Conditioning (HVAC) Systems to Provide Minimum Building Ventilation: <https://www.dir.ca.gov/title8/5142.html> (accessed May 2020)

Protecting Employees/ Reducing Exposure (cont.)

- 27% allow for the deferring of work projects.
- 5% removed outdoor seating tables and chairs.

One participant from a Mid-Sized financial services company also shared, "Our location in [the North Bay] also has an air purifier onsite. And we have an open service contract for air scrubbers for all our California locations."

For actions around minimizing exposure for outdoor employees, there were 62 valid responses (excluding those that skipped the questions or do not have outdoor employees).

- 74% provide some form of respirator. Of those that do provide a respirator, 85% provide an N95 respirator, 17% a P100 respirator, and 37% some other form of respirator such as N99, N100, R95, P95, P99. Some organizations provide multiple types of respirators, which is why the total is greater than 100 percent.
- 61% limit the amount of time employees work outside.
- 50% make reductions or changes in work tasks.
- 48% defer work projects.
- 44% limit physical exertion.
- 34% provide alternate work options located inside. One participant from a Mid-Sized utility company/agency shared, "We have what we call rainy day scheduled tasks and trainings. Some staff can do work indoors for a couple of days."
- 31% change work schedules.
- 11% provide temporary work shelters with air filters.

Considerations:

- Have you given due consideration to the health impacts of air quality events on employees?
- Have you considered the access and functional needs of your employees, customers, and visitors?
- Have you implemented a program to enable staff to work at an alternate location or defer work, if possible?
- Does your organization's Illness and Injury Prevention Program include content around air quality events such as the impacts of air quality on health and the appropriate use of personal protective equipment under these conditions?

Minimizing Business Impacts

In addition to asking about methods used to protect employees and minimize employee exposure, the survey also looked at practices used to minimize the business impacts of air quality events. This question had 61 valid responses.

- 54% allow for managers and supervisors to assign alternate work such as completing trainings, administrative tasks, or other indoor work during air quality events.
- 39% provide guidance for managers and supervisors on preparing for air quality events.
- 25% have mitigation plans specifically for air quality events.

While focus has been given to the health impacts of air quality events, little focus has been given to understanding the business impacts and implications of air quality events.

As two of the respondents stated:

- “I don’t think we’ve addressed this in depth.” (Small private sector company)
- “No actions have been taken to respond to this type of event.” (Large healthcare organization)

One organization shared that “Air quality events are treated similarly to air contamination due

to airborne illness and as such is part of our Pandemic Response plan.” (Small private sector company)

Allowing for Alternate Work

Air quality events can create challenges for those who work outdoors, need to care for children when schools are canceled, or have concerns about commuting. One strategy available to organizations is to allow employees to work on different tasks such as trainings, administrative tasks, or rainy day projects, some of which could potentially be done either indoors or remotely.

Slightly more than half of the respondents (54%) stated their organization allows managers and supervisors to assign alternate work.

Organization Size: Large (61%) and Mid-Sized (63%) organizations were most likely to allow supervisors to assign alternate work. For Mid-Sized organizations in contrast only 41% stated they had this option.

Having an Air Quality Event Plan: Unsurprisingly, those organizations that had an air quality event plan at the time of the survey were the most likely to allow supervisors to assign alternate work (58%). Those developing plans, relying on informal practices, or having no plans or practices were all fairly similar, 44%, 43%, and 44% respectively.

Minimizing Business Impacts (cont.)

Providing Guidance on Preparing for Air Quality Events

Because air quality events usually lack visual clues, except when there is heavy smog or wildfire smoke, it is important for everyone to understand why response measures for air quality events are essential.

Thirty-nine percent of respondents stated they provide guidance for managers and supervisors on preparing for air quality events.

Organization Size: More than half of the Large organizations (57%) stated they provided guidance on preparing for air quality events. That number drastically declined for Mid-Sized organizations (38%) and fell even further for Small organizations (23%).

Having an Air Quality Event Plan:

Organizations that had a plan or were developing one (56%) were fairly similar in their responses with regard to providing guidance on preparing for air quality events.

Mitigation Plans for Air Quality Events

While an air quality event plan may cover general response to an air quality event, this survey also asked about mitigation plans to minimize business impacts, which may not be captured as part of all plans. Overall, only 25% of respondents stated they have mitigation plans specifically for air quality events.

Organization Size: Large (26%) and Small (27%) organizations were somewhat more likely to have mitigation plans than Mid-Sized organizations (19%).

Having an Air Quality Event Plan: Of the organizations that had an air quality event plan at the time of the survey, 38% of the respondents stated they had specific mitigation plans. Those developing air quality event plans were not far behind, with 33% stating they had some form of mitigation plans compared to only 14% of those relying on informal practices in responding to air quality events. Unsurprisingly, none of the organizations that had neither formal air quality event plans nor informal practices had mitigation plans.

Considerations:

- Have you created a business continuity/continuity of operations plan that includes air quality events?
- Do you have plans in place to support staff who need to care for children in the event of school closures, and/or other dependents affected by the air quality event?
- Do you have procedures in place to reduce the likelihood of having to fully close a facility, e.g. replacement of air filters, recirculation of air, closure of external vents?

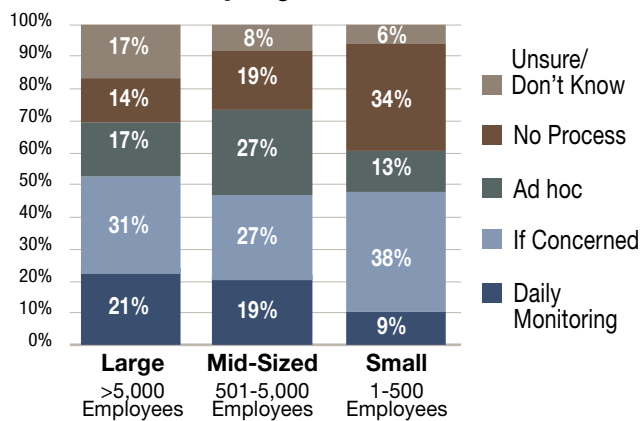
Monitoring Air Quality Levels

Threshold Levels and Frequency of Monitoring

Dealing with air quality events is not just about responding, but also monitoring conditions on an on-going basis so as to know when conditions change.

Of the 28 who monitored “if there was a concern that day”, only 6 triggered actions at the “Unhealthy for Sensitive Groups” level (101-150) and about half (13) had a first trigger at the “Unhealthy” level (151-200). For one respondent, the first threshold was not triggered until the AQI reached Hazardous levels for the respective day.

Frequency of Monitoring Air Quality Levels by Organization Size



Organization Size: Large organizations (21%) were slightly more likely than Mid-Sized (19%) to monitor air quality levels on a daily basis. This dropped down to 9% for small organizations, which in turn were more likely to either monitor if there was a concern, or had no established process for monitoring. 17% of respondents from Large organizations were unsure how frequently their organization monitored air quality levels in comparison to 8% and 6% for Mid-Sized and Small organizations respectively.

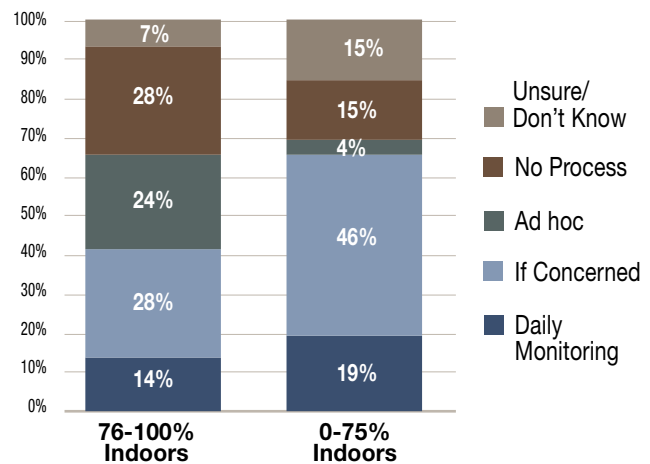
When asked, “Does your organization have policies and/or procedures to monitor for an air quality event?,” of the 87 valid responses received, 14 had policies or procedures for daily monitoring, 16 relied on ad hoc monitoring, and 28 monitored only if there was a concern about air quality that day. Twenty respondents did not have any policies or procedures for monitoring air quality events.

Where Employees Work: Organizations where at least a quarter of the employees worked outdoors were more likely to monitor on a Daily (19%) or If Concerned (46%) basis than organizations with primarily indoor employees.

In addition to asking about policies and/or procedures, the survey also asked, “What is your organization’s first threshold for when air quality event policies and/or procedures are triggered?”

Those that monitored air quality levels on a daily basis tended to have the most conservative thresholds, with 7 of the 14 triggering some form of action when the AQI reached the “Unhealthy for Sensitive Groups” level (101-150 range).

Frequency of Monitoring Air Quality Levels by Where Employees Work



Monitoring Air Quality Levels (cont.)

Organizations with a primarily indoor workforce were more likely to rely on If Concerned (28%) or Ad Hoc (24%) monitoring if they had a process. The percentage of respondents unsure about the monitoring frequency was slightly higher for those with an outdoor workforce – 19% compared to 14% for those with the majority of indoor employees.

Considerations:

- Since Cal/OSHA requires protective measures be taken for outdoor workers when AQI reaches 151 or above, how is your organization monitoring AQI levels if you have outdoor workers?
- Do you have vulnerable populations that are sensitive to air pollution?
- Based on the organization's activities, what is the frequency with which AQI should be monitored?
- What actions should be triggered at various AQI category levels (Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, Hazardous)?

One respondent specifically highlighted using AirNow's AQI data in Keyhole Markup Language (KML) format, in conjunction with Google Earth, to display air quality results.⁴⁴

Respondents specifically mentioned using the following mobile applications to monitor air quality:



South Coast Air Quality Management District app
<https://www.aqmd.gov/mobileapp>



Windy app
<https://www.windy.com/>



EnviroFlash
<http://www.enviroflash.info/>

Other methods of monitoring and notification that respondents identified include:

- Internal monitoring
- Employee notification of site-specific events
- Property management team proactively monitors indoor air quality
- Local media channels
- Subscription to local county emergency alerts

Methods for Monitoring Environmental Conditions

77% of the survey respondents used websites like AirNow and local Air Quality Resource Boards to monitor for air quality information. 52% signed up for their email alerts, and 33% relied on third-party vendor notifications.

California Air Quality Resource Boards

<https://ww2.arb.ca.gov>

California Air Basins Map

<https://ww3.arb.ca.gov/ei/maps/2017statemap/abmap.htm>

"As we have a branch within 7 miles of a major refinery and one less than 100 yards from a major freeway we also use local news sources and are signed up for text messages of emergency alerts directly from the 3 counties in which we have offices."

(Small financial services organization)

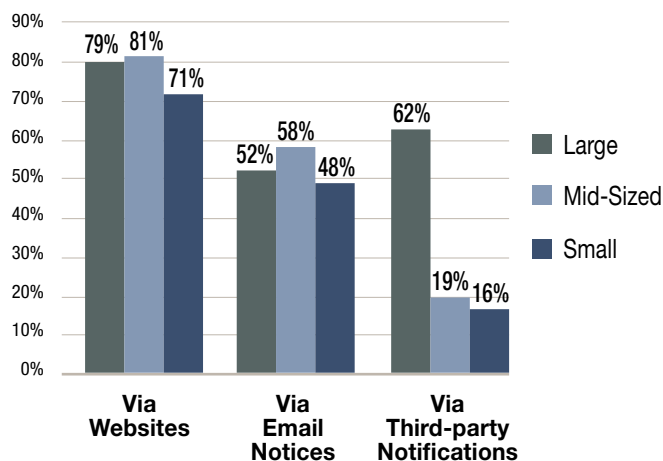
⁴⁴ AirNow; Air Quality Index (AQI) in Google Earth: https://cfpub.epa.gov/airnow/index.cfm?action=google_earth.index (accessed June 2020)

Monitoring Air Quality Levels (cont.)

One respondent (small school/higher education) advised that while the “county has multiple air basins, only two have AQI monitors” therefore, they “...established a visual determination system for unreported areas and as a last alternative, funded PurpleAir⁴⁵ devices for those areas. Working with [their] local air quality district and public health doctor [they have] determined activity recommendations for each threshold level.”

Organization Size: The size of an organization seemed to play little role in regard to the use of websites and email alerts, with only minor variations across the three size categories. A significant degree of difference was observed when it came to the use of third party vendors. 62% of Large organizations stated they used a third-party vendor in comparison to 19% for Mid-Sized organizations and 16% for Small organizations.

Methods of Monitoring Air Quality Levels by Organization Size



Where Employees Work: The use of websites, email alerts or third-party vendors varied little regardless of whether more employees worked indoors or outdoors.

Considerations:

- How nuanced and frequent do the alerts you receive need to be?
- For which geographic footprints do you need to monitor AQI levels?
- Has someone or a team been designated to monitor air quality?
- What additional steps could you take to formalize air quality monitoring that would help to protect people and prepare the workplace for an event?

Methods for Monitoring Employee Exposure

Organizations have a responsibility to protect the health of their employees. This includes understanding their exposure to air quality events.

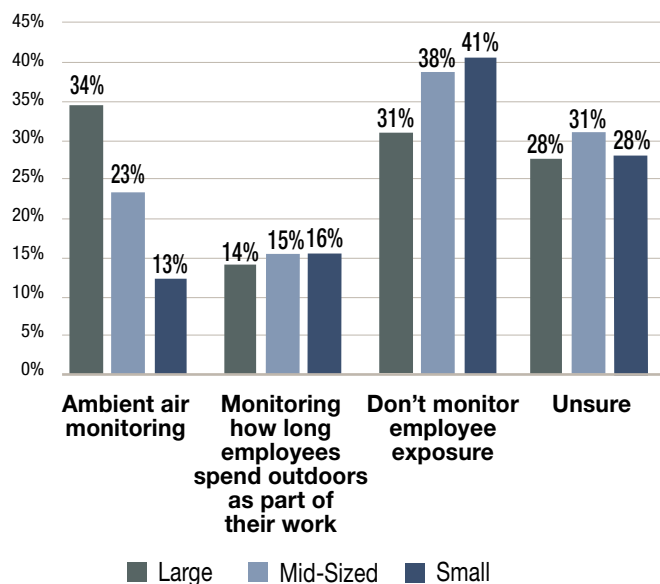
23% of respondents monitor employee exposure to poor air quality via ambient air monitoring, while 15% monitor exposure based on how long their employees spend outdoors as part of their work. 36% say they do not monitor employee exposure and 29% are unsure. Of the twenty-five individuals who were unsure, 5 self-identified as having a job function in health & safety, 8 in emergency management, and 2 that spanned both of these job functions. Given the high number of respondents who do not know if or how their employer monitors for air quality events, coupled with the role of the respondent, it would imply that the organization needs to better socialize methods they have in place, if any.

⁴⁵ Purple Air: <https://www2.purpleair.com>

Monitoring Air Quality Levels (cont.)

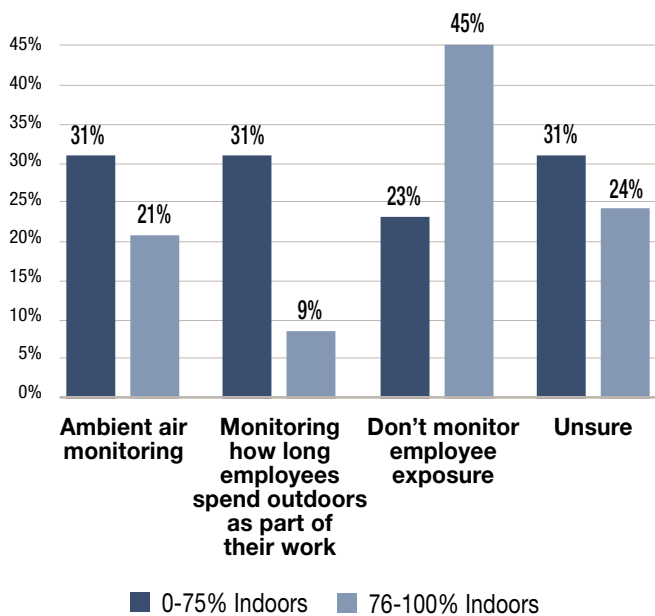
Organization Size: The greatest difference between organizations was the use of ambient air monitoring as a way to monitor employee exposure. Large organizations were more likely to use this method compared to Mid-Sized and Small organizations; 34%, 23%, and 13% respectively. There was an inverse correlation in regard to organizations that do not monitor based on size, but it was not as large.

Monitoring Employee Exposure by Organization Size



Where Employees Work: Organizations with more than 75% of their workforce indoors were less likely to monitor employee exposure. A portion of the stark difference in monitoring how long employees spend outdoors may be attributed to the fact that companies with no outdoor employees would not have a need for this monitoring. The percentage that do not monitor at all, on the other hand, was nearly double that of organizations, with at least 25% of their employees working outdoors.

Monitoring Employee Exposure by Percent of Employees Working Indoors



Considerations:

- Do your monitoring practices allow you to meet regulatory requirements to protect employees from air quality events?
- What training and education is provided to employees regarding ambient air exposure risks during air quality events?
- How are you educating employees on the measures your organization is taking to monitor events and minimize employee exposure risks?

Information Sharing

One respondent summarized many aspects of the information sharing component:

“I’m concerned that most employees would receive their information from the media, not the employer. Moreover, I’m not sure anyone here knows how to interpret air quality data.”

(Large government agency)

“That everyone has access to important information so they can take reasonable action.”

(Small property management company)

“Our customers expected us to provide them information about air quality events, and lack of clarity may have lost trust.”

(Large government agency)

“It’s not just an air quality event, in all events communication is key. We’ve informed employees of what they should have at home to take care of themselves and their families, what they should carry in their car, etc. Do they listen and follow up, probably not, but we’ve done what we can. If an employee is worried about themselves or their families they probably are not coming to work. To that end, if you make sure you’ve got all the emergency supplies on hand at the office and they are trained to use them, they may feel safer at work...”.

(Small financial services organization)

Another respondent from the Financial Services sector went so far as to say, “More than anything we would keep the lines of communication

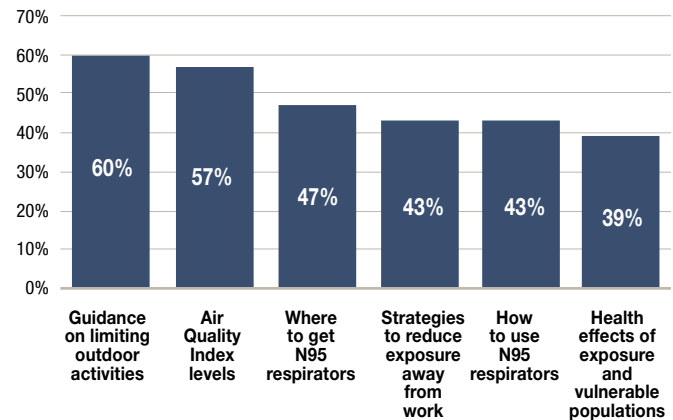
open between branches and home office via email, VOIP and cellular.”

Types of Information Shared

The survey posed the question: “What information does your organization provide employees during an air quality event?”

- 60% – Guidance on limiting outdoor activities
- 57% – Air Quality Index levels
- 47% – Where to get N95 respirators
- 43% – How to use N95 respirators
- 43% – Strategies to reduce exposure away from work
- 39% – Health effects of exposure and vulnerable populations

Information Provided to Employees



Information Usefulness

In addition to the types of information shared, the survey also asked how useful respondents found different types of information.

84% of respondents ranked information about Air Quality Index levels as being very useful, with none saying it was not useful.

“Impacts to sensitive populations and recommended actions” and “Guidance from OSHA, Public Health, and other entities on protecting workers” were about the same in

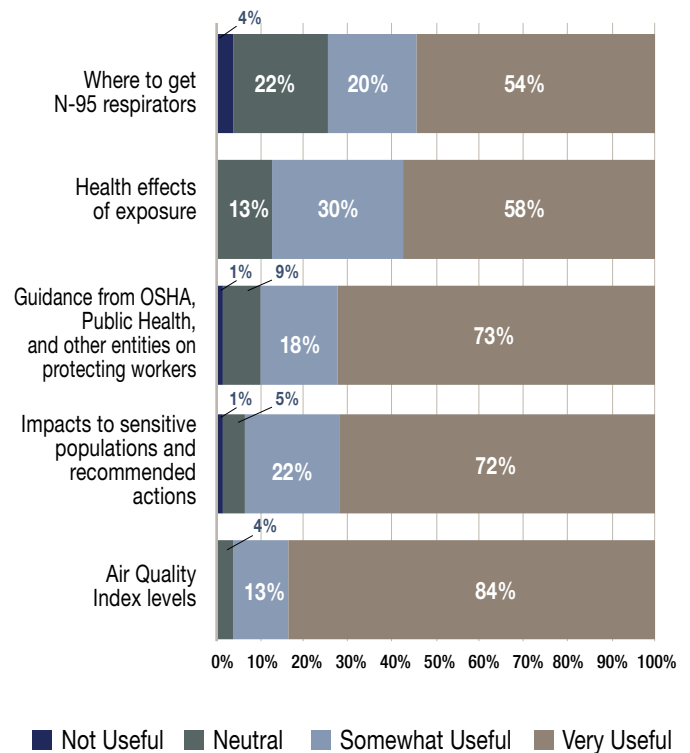
Information Sharing (cont.)

terms of being found very useful (72% and 73% respectively), somewhat useful (22% and 18% respectively), and neutral (5% and 9%). Both of these categories had a small percentage (1%) that did not see value in this information. In regard to “Health effects of exposure” and “Where to get N95 respirators” a little more than half of the participants found the information very useful (58% and 54% respectively). Interestingly enough, 30% found information about the health effects only somewhat useful and 13% were neutral about it. It is not known if the lack of usefulness was driven by the topic or the way the information is often presented.

Additional information highlighted by respondents as being useful:

- “Forecast of AQI, how the air quality is expected to change based on weather/fire conditions.” (Large private sector company)
- “Health effects to include warning signs – what to look for.” (Small non-profit)
- “Insight into what strategies other private sector organizations are taking. It is a good benchmark.” (Small private sector company)
- “If there are a lot of local business surrounding one of our locations that are either delaying opening or closing for that day, that would be a consideration to our decision.” (Mid-Sized private sector company)
- “Location of local safe spaces with “clean” air.” (Small government agency)
- “Medical guidance on who and how to use respirators.” (Large government agency)
- “What can/should be done if there is a heat event at the same time?” (Large government agency)

Information Usefulness



- “How protective is MERV 8 if your building does not have a higher level of filtration, for example?” (Large government agency) [MERV = minimum efficiency reporting value – describes the efficiency of the air filter at its lowest level of performance]
- “Is it better to walk to a filtered location, or to stay indoors without a filter?” (Large government agency)
- “Clarity on when to cancel events or school.” (Large government agency)
- “More info re duty of care of employers.” (Small private sector company)
- “Recommendations on extended exposure as not every building has access to filtered air.” (Large school / higher education institution)

Information Sharing (cont.)

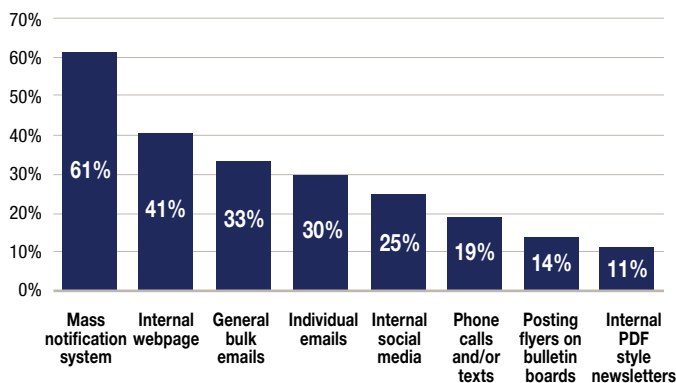
Methods for Sharing Information

There are a variety of ways organizations share information about air quality events:

- 61% use a mass notification system.
 - 41% post information to an internal website.
 - 33% send bulk email to employees – this does not include emails sent through a mass notification system.
 - 30% send individual emails to employees.
 - 25% use internal social media tools such as Slack or Jabber.
 - 19% make individual phone calls to employees or send individual text messages, not through a mass notification system.
 - 14% post fliers on bulletin boards.
 - 11% use an internal pdf newsletter.
- In addition to the general responses, some elaborated about methods they use to share information:

- “Information is provided to department leaders who then distribute it among their employees.” (Large private sector company)
- “Department and Division training.” (Mid-Sized government agency)
- “Staff meetings, check-ins.” (Large public works company)
- “Social media, digital signs.” (Small school/higher education)
- “ReddiNet.” (Small law enforcement/EMS/fire agency)
- “Location specific emails.” (Large private sector company)
- “In-person notification.” (Small non-profit)

Method via which Organizations Share Air Quality Event Information



Considerations:

- What are the language and knowledge barriers of your target audience that need to be considered in your messaging?
- How are you leveraging the communication tools and channels available within your organization?

Respondents' Planning Assumptions

The planning process includes making assumptions. The survey posed the following question with various response options available: "What planning assumptions are used for the air quality event policies and/or procedures?"

- 58% assumed local government will provide notification of an event
- 69% assumed local government will provide guidance on recommended response
- 49% assumed employees are properly using personal protective equipment
- 36% assumed their organization has the ability to defer work

Assume Local Government will Provide Notification of an Event

58% of the respondents indicated that they made the assumption that local government would provide some form of notification about an air quality event. One caveat here is that these numbers combine public and private sector organizations. Federal, State, County, and City entities may be more likely to assume guidance from local government than equally sized private sector organizations.

Where Employees Work: The percentage of employees working indoors did not make much of a difference. 57% of organizations with more than three-quarters of their workforce indoors made this assumption, compared to 58% for those with a quarter or more of their employees working outdoors.

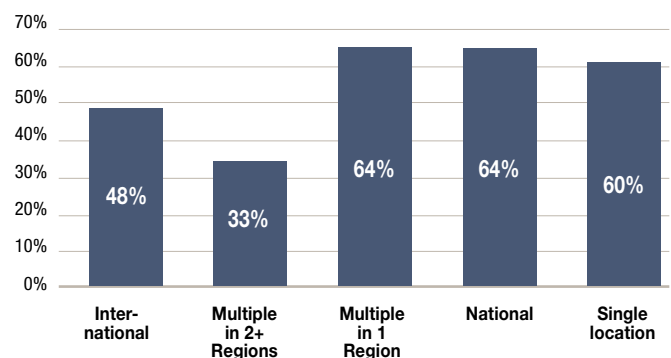
Geographic Footnote: Organizations with a national footprint, multiple locations in a single region, and single location organizations were the most likely to make this assumption (64%, 64%,

60% respectively). Only 48% of international organizations made this assumption, and the lowest was organizations with locations in two or more regions (33%).

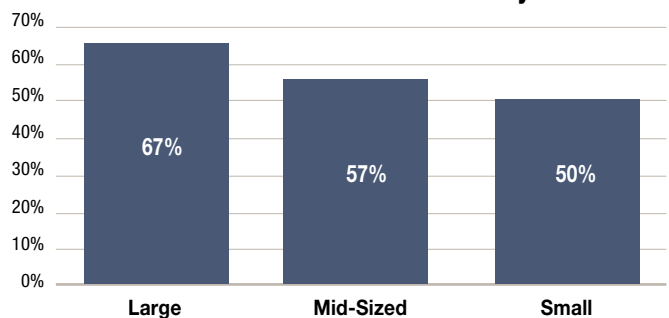
Organization Size: Interestingly enough, Large organizations (67%) were somewhat more likely to assume local government would provide notification of an air quality event. In comparison, only 50% of Small organizations made this assumption and 57% of Mid-Sized organizations.

One respondent from a Large private sector company shared that they assume that notifications of an air quality event will be through government resources, employee notifications of site specific events, and/or the property management team that proactively monitors indoor air quality.

Organizations Assuming Local Government will Provide Notification of an Air Quality Event



Organizations Assuming Local Government will Provide Notification of an Air Quality Event



Respondents' Planning Assumptions (cont.)

Assume Local Government will Provide Guidance on Recommended Response

69% of the respondents assumed local government will provide guidance on how to respond to air quality events. The data below includes responses from both public and private sector organizations.

Where Employees Work: 76% of those with more than three-quarters of their employees indoors made this assumption, compared to 54% for organizations with at least a quarter of their employees working outdoors.

Geographic Footnote: The one outlier in regard to geographic footprint was organizations with a single location, of which 80% responded that they looked to local government for guidance. The remaining organizations, ranging from those with facilities in 1 or more regions to international organizations, all ranged between 62-68%.

Organization Size: Mid-Sized and Small organizations were more likely to look to local government for guidance, 83% and 77% respectively, than Large organizations (48%).

Two of the respondents' comments included:

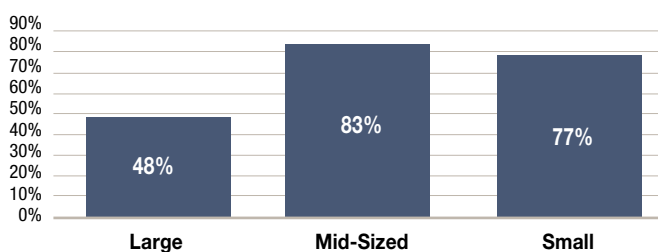
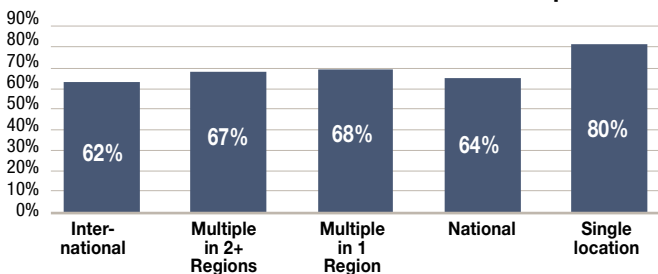
- "Don't think we monitor; think we wait for local government notification and recommendation." (Small non-profit)
- "Regional public health guidance coordination/ updates from regional air quality district." (Large government agency)

Assume Employees Properly Use Personal Protective Equipment

49% indicated that they made the assumption employees knew how to properly use personal protective equipment (PPE).

Where Employees Work: One noticeable trend was that organizations with more employees working outdoors were more likely to make this assumption. Work factors and duties requiring the regular use of PPE could be contributing to this trend. 67% of organizations with at least a quarter of their workforce outdoors assumed that their employees were using PPE correctly. In comparison, only 41% of organizations with the significant majority of their employees working indoors made this assumption.

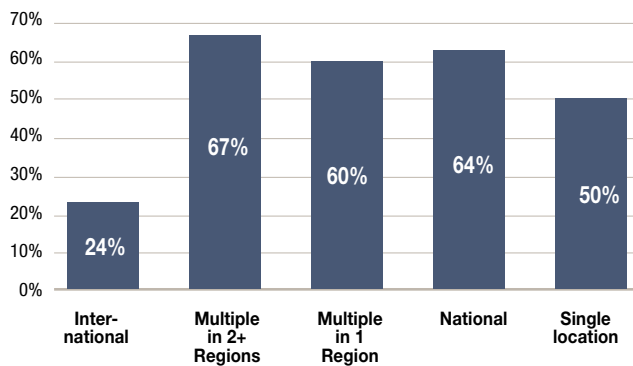
Organizations Assuming Local Government will Provide Guidance on Recommended Response



Respondents' Planning Assumptions (cont.)

Geographic Footprint: The majority of responses ranged between 62% - 68%. There was a drop for single location organizations (50%), and a more significant drop for international organizations, with only 24% assuming employees properly used PPE.

Organizations Assuming Employees Properly Use PPE



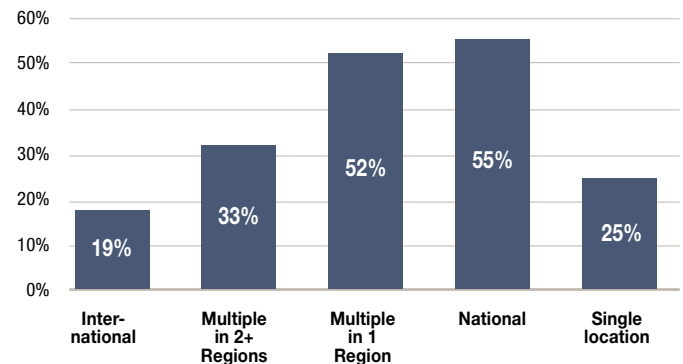
Organization Size: With regard to the size of the organization, the responses ranged from 44% for Large organizations to 53% for Small ones, with Mid-Sized organizations falling in the middle at 48%.

Assume Organization has the Ability to Defer Work

Only 36% assumed that they would be able to defer work.

Where Employees Work: 35% of organizations with three quarters or more of their employees who work indoors assumed that work could be deferred, compared to 42% for organizations with at least a quarter of their workforce outdoors.

Organizations Assuming that Work Can Be Deferred



Geographic Footprint: National organizations and those with multiple locations within a single region were the most likely to make this assumption (55% and 52% respectively). From there it dropped to 33% for organizations spanning two or more regions, 25% for single location organizations, and 19% for international organizations.

Organization Size: Small (40%) and Mid-Sized (39%) organizations were somewhat more likely to make this assumption than Large ones (30%).

One respondent made a good comment:

"Concerns that use of N95 in the workforce and general population gives [a] false sense of reassurance and does not provide adequate protection. YouTube videos showing N95 being modified for infants and children as being protective is a big problem versus other measures. [It is] difficult to control misuse."

(Small law enforcement/EMS/fire agency)

Employee Opinions of What Employers Should Do

Survey respondents were given an opportunity to identify measures that in their opinion an employer should support to reduce or limit employee exposure during air quality events:

- 78%** – employer should allow telecommuting
- 73%** – employer should provide some form of respirator:
 - 65% – employer should provide N95 respirators
 - 29% – employer should provide other respirators such as N99, N100, R95, P95, P99
 - 18% – employer should provide P100 respirators
- 63%** – employer should provide a filtered ventilation system
- 62%** – employer should limit outside air intake/ recirculate internal air
- 62%** – employer should allow alternate work locations
- 54%** – employer should exchange air filters more frequently
- 52%** – employer should limit amount of time employees work outside
- 47%** – employer should defer work projects
- 42%** – employer should help employees with limiting physical exertion
- 42%** – employer should provide alternate work options located inside

- 37%** – employer should implement a change in work schedules
- 13%** – employer should provide temporary work shelters with air filters
- 6%** – employer should remove outdoor seating tables and chairs

Additional actions employers should take:

- “Have employees be responsible adults who take care of themselves after acknowledging they have received/ read the notification from organizational leadership and appropriate authorities.” (Small private sector company)
- “Provide risk information and education.” (Large private sector company)
- “Clear advice for those who telecommute – their homes might not be any better than the office.” (Small non-profit)
- “Respirators should be provided in a limited way to those staff who must be outdoors, with fit tests and any necessary safety measures. Our organization would be helped if the state promoted the telecommuting option, to normalize this approach.” (Large government agency)



Additional Concerns About Air Quality Events

As part of the survey, respondents were provided an opportunity to list additional areas of concern related to air quality events. These have been grouped as follows:

Employee Safety

As might be expected, many respondents expressed employee safety concerns that are best described by the responses:

- “Employee safety. Impact to commuters, those already working from home or outside and how to monitor and counter the potential impact.” (Large IT/tech organization)
- “Concerned for young age groups, and for transit-riders and first/last mile commuters.” (Small government agency)
- “1. quantity of personal exposure
2. concern for those with respiratory issues
3. concern for those that may have issues that may be provoked by particles in the air.” (Small government agency)
- “How to keep employees and visitors to the facilities safe and healthy.” (Large public works organization/agency)

Facility Considerations

Respondents expressed concerns about the environment in which they work:

- “Because our office doesn’t have HVAC, we’re essentially breathing outside air during wildfire season.” (Small professional services firm)

- “I understand that it is less harmful to be in a climate controlled office than be at home.” (Large healthcare company)
- “Recommendations on extended exposure as not every building has access to filtered air.” (Large schools/higher education)
- “Currently people seek refuge in public facilities, however, not all of our facilities have the ability to seal themselves off from outdoor air to provide “clean” interior air. Investment needs to be made in public facilities to ensure that they are safe places of refuge, especially, libraries, senior centers and rec centers.” (Small government agency)

Business Impacts

Respondents indicated concerns of an air quality event could impact the business as follows:

- “How to manage service expectations.” (Large transportation organization)
- “Providing alternative work locations where feasible and providing safe facilities where citizens can go to avoid prolong[ed] exposure.” (Large public works organization)
- “How to balance worker and public safety with getting critical work done.” (Mid-Sized utility company/agency)
- “Uniform response procedures to avoid conflicts/confusion; why is there no clear standard for schools to close?” (Mid-Sized government agency)

Additional Concerns About Air Quality Events (cont.)

Face Masks and Respirators

Respondents were concerned about the most appropriate type of respirator and/or face mask to use:

- “Best respirator or mask to use, how to deal with long term air pollution from wildfire/urban smoke in an area where AC is not normal.” (Small non-profit)
- “People think wearing a dust mask makes it OK to be out for long or normal periods of time.” (Mid-Sized government agency)
- “Having lived through the air quality crisis from the north Bay fires which impacted air quality here in Silicon Valley, we are certainly concerned about what to do and where to go to get away from bad air. The availability of N95 masks was not well publicized - we heard by word of mouth about a 5-mask limit at ACE hardware stores. This should be done more officially, and availability of masks should be better distributed and clearly communicated to avoid congestion and panic.” (Small non-profit)

Information Sharing

Respondents expressed the importance of information sharing:

- “Guidance to school districts for student and staff exposure and reduced activity level recommendations for each AQI level.” (Small school / higher education)
- “Lack of government guidance on what employees should do (recommendations for PPE for what thresholds, Policy/procedure guidance).” (Mid-Sized transportation organization)
- “We would like to see state funding for community-embedded air filtration, such as in community organizations and houses of worship. We would like to see manufacturers to make low-cost box fans with filters attached, since it seems that homemade D.I.Y. versions are not considered fire safe. We would like to see healthcare providers provide guidance to those who are medically vulnerable, rather than relying on government.” (Large government agency)



Glossary

Ambient Air Monitoring – The systematic, long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding (indoor or outdoor) air.⁴⁶

Carbon Dioxide – A naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes.⁴⁷

Carbon Monoxide (CO) – A colorless, odorless gas that can be harmful when inhaled in large amounts. Carbon monoxide is released when something is burned. The greatest sources of carbon monoxide in outdoor air are cars, trucks, and other vehicles or machinery that burn fossil fuels.⁴⁸

Ground-level Ozone – Ground-level ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen and volatile organic compounds. This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight.⁴⁹

Inversion – An atmospheric condition where a layer of cooler air is trapped near the ground by a layer of warmer air above. When the air cannot rise, pollution at the surface also is trapped and can accumulate, leading to higher concentrations of ground-level ozone and particulate matter.⁵⁰

Particle Pollution/Particulate Matter (PM) –

A mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. Particulate matter includes: coarse particles (PM₁₀) with diameters that are generally between 2.5 and 10 micrometers; and fine particles (PM_{2.5}) with diameters that are 2.5 micrometers and smaller. For comparison, the average human hair is about 70 micrometers in diameter – making it about 30 times larger than the largest fine particle.⁵¹

Volatile Organic Compounds (VOC) – Organic chemical compounds able to evaporate under normal indoor conditions. Many VOCs form ground-level ozone by “reacting” with oxygen molecules, such as from carbon monoxide, in the presence of sunlight. VOCs can be both indoor and outdoor air pollutants.⁵²

Wildfire Smoke – The composition of wildfire smoke is primarily made of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organic chemicals, nitrogen oxides, and many other trace elements. Smoke composition can vary, depending on the fuel type, fire temperature, and wind conditions.⁵³

⁴⁶ US Environmental Protection Agency; Managing Air Quality - Ambient Air Monitoring:

<https://www.epa.gov/air-quality-management-process/managing-air-quality-ambient-air-monitoring> (accessed May 2020)

⁴⁷ US Environmental Protection Agency; Vocabulary Catalog - Climate Change Terms: https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=Glossary%20Climate%20Change%20Terms (updated September 9, 2013)

⁴⁸ US Environmental Protection Agency; Particle Pollution and Your Patients' Health - Glossary for Air Pollution Terms in Particle Pollution and Your Patients' Health: <https://www.epa.gov/pmcourse/glossary-air-pollution-terms-particle-pollution-and-your-patients-health> (accessed May 2020)

⁴⁹ US Environmental Protection Agency; Particle Pollution and Your Patients' Health - Glossary for Air Pollution Terms in Particle Pollution and Your Patients' Health: <https://www.epa.gov/pmcourse/glossary-air-pollution-terms-particle-pollution-and-your-patients-health> (accessed May 2020)

⁵⁰ US Environmental Protection Agency; Particle Pollution and Your Patients' Health - Glossary for Air Pollution Terms in Particle Pollution and Your Patients' Health: <https://www.epa.gov/pmcourse/glossary-air-pollution-terms-particle-pollution-and-your-patients-health> (accessed June 2020)

⁵¹ US Environmental Protection Agency; Particulate Matter (PM) Pollution - Particulate Matter (PM) Basics: <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics> (accessed May 2020)

⁵² US Environmental Protection Agency; Technical Overview of Volatile Organic Compounds: <https://www.epa.gov/indoor-air-quality-iaq/technical-overview-volatile-organic-compounds> (accessed July 2020)

⁵³ US Climate and Health Alliance; Wildfires and Public Health: A View from the Front Lines: <https://usclimateandhealthalliance.org/wildfires-public-health-view-front-lines/> (accessed May 2020)

Appendix A: Respirator Usage in an Air Quality Event

Note: The information provided here is not a substitute for following applicable laws, and/or seeking professional legal advice.

By law, employers are required to provide a respirator to each employee when necessary to protect the health of that employee, and, in doing so, must establish and maintain a written respiratory protection program and worksite-specific procedures to be overseen by a qualified administrator. Procedures must include how the respirator is cleaned/disinfected, stored, inspected, and generally maintained, so its use does not present a health hazard to the user. The particular respirator provided to the employee must be both applicable and suitable for its intended purpose.

Before an employee uses a particular respirator, a medical evaluation must be performed in advance to determine user suitability. Each employee must then be fit tested to determine the make, model, style, and size of respirator that fits correctly before they perform their work, and training given to ensure its proper use, removal, and disposal.⁵⁴

For an individual needing fit testing, consider buying a respirator from a reseller that provides fit testing services, as well as training on how to put it on and take it off.

There are two main types of respirators:⁵⁵

1. Air-purifying respirators, which use filters, cartridges, or canisters to remove contaminants from the air you breathe;

2. Atmosphere-supplying respirators, which provide you with clean air from an uncontaminated source.

During air quality events, many people choose to voluntarily wear N95 respirators. Per the Occupational Safety and Health Administration (OSHA), “an N95 respirator is an air-purifying negative pressure respirator equipped with an N95 filter. If the filter is an integral part of the facepiece, or the entire facepiece composed of the filtering medium, the respirator is also considered a filtering facepiece respirator.”⁵⁶

In the case where an employee chooses to voluntarily wear a respirator, the employer is not obliged to include the use of the respirator as part of the organization’s respiratory protection program. However, they are required to make sure the employee is not wearing one that is dirty or contaminated, and its use will not in itself prevent the wearer from being able to perform their work in a safe manner. The employer is obligated to provide each employee with information about the wearing of a respirator.⁵⁷

The responsibility then falls to the employee to:

1. Follow manufacturer’s instructions on use, maintenance, cleaning and care, and warnings regarding any limitations of the respirator;
2. Select a respirator that has been certified for use to protect against the particular contaminant in question;

⁵⁴ OSHA – Standard Number 1910.134 – Respiratory Protection: <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134> (accessed June 2020)

⁵⁵ OSHA – Transcript for the OSHA training video entitled Respirator Types: https://www.osha.gov/video/respiratory_protection/resptypes_transcript.html (accessed June 2020)

⁵⁶ OSHA – Standard Number 1910.134 – Numerous questions on filtering facepiece/dusk mask respirators: <https://www.osha.gov/laws-regs/standardinterpretations/2011-11-22-0> (November 22, 2011)

⁵⁷ OSHA – Appendix D to Sec. 1910.134 (Mandatory) Information for Employees Using Respirators When Not Required Under the Standard – <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134AppD> (accessed June 2020)

Appendix A: Respirator Usage in an Air Quality Event (cont.)

3. Wear a respirator that is fit for purpose (i.e., one that filters dust particles will not protect against gases, vapors, fine particulate matter);
4. Maintain their respirator so someone else does not inadvertently wear it.

Selecting a Respirator⁵⁸

There are a variety of different types of respirator available in the market.

The “**N**” denotes the mask is **N**ot oil-resistant. The term “95” indicates the respirator is capable of filtering out 95% of particles sized 0.3 microns. A mask rated N99 or N100 means it will filter 99% and 99.97% respectively of particles sized 0.3 microns.

Some respirators are labeled “**P**” for oil-**P**roof, and “**R**” for oil-**R**esistant. For example, a P100 mask can filter 99.97% of particles (rounded up to 100).

An N95 respirator is generally considered the best option as more oil-resistant ratings and higher numbers make it more difficult to breathe.

When purchasing a respirator, ensure that:

- It will protect from the particular contaminant that the employee is to be protected from.
- The packaging is marked with “NIOSH” which stands for the National Institute for Occupational Safety and Health, a part of the CDC. NIOSH stresses strictly following “the cautions, limitations and restriction of use provided with the respirator.”⁵⁹

- The fit and size is suitable – both facial hair and face shapes may cause fit problems.

To get the full benefit of the filter mechanism, they need to be fit tested.

A KN95 has the same filtration as an N95 respirator, but is geared towards markets in Asian countries and is sized for an Asian profile face. It may not perform adequately during a fit test with a person of a different demographic. The KN90 is similar in fit to a KN95, but is not as efficient as it filters out less particles. Note: Neither KN95 or KN90 respirators are NIOSH certified but under certain conditions (e.g., COVID-19) they may be authorized for use.

N and KN masks that do not properly fit act more like a surgical mask than a respirator.

Additionally, if individuals are concerned about their pet’s lungs, there is guidance on the Dog Pollution Mask website:

<https://www.dogpollutionmask.com/>

Rules & Regulations and Prolonging the Life of Respirators during a Pandemic

At the time of publication of this report, and due to the COVID-19 pandemic:

- OSHA rules and regulations around use of respirators have been updated: <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134>
- The Centers for Disease Control and Prevention (CDC) has developed strategies for prolonging the life of respirators. The guidance can be found at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy/index.html>

⁵⁸ Molekule – Is the N95 Face Mask the Best Solution for Wildfire Smoke?: <https://molekule.science/are-n95-face-masks-best-for-smoke-air-pollution/> (November 19, 2018)

⁵⁹ Center for Disease Control and Prevention, Respirator Fact Sheet <https://www.cdc.gov/niosh/npptl/topics/respirators/factsheets/respfact.html> (accessed June 2020)

Appendix B: Important AQI Usage Considerations

Local geography and wind patterns can influence how pollutants move and where they concentrate. Like water, air flows around objects changing its direction and speed based on what it encounters. Occasionally, like puddles, it can pool in areas.

The AQI is a calculation based on air sensor readings in an area. The more sensors in the area the better the calculations. Additionally, in the US towns and cities with 350,000 or fewer inhabitants are not required to report AQI data, though many do.⁶⁰

AQI forecasts may vary by reporting area in that they may be seasonal (summer/winter), cover a different range of days, include only some of the standard pollutants, and/or be reported as either a number or simply an AQI category (e.g. unhealthy).⁶¹

The calculations for each of the pollutants do not all use the same time interval. For example, the standard AQI for ground-level ozone uses an 8-hour index while particulate matter uses a 24 hour index.⁶²

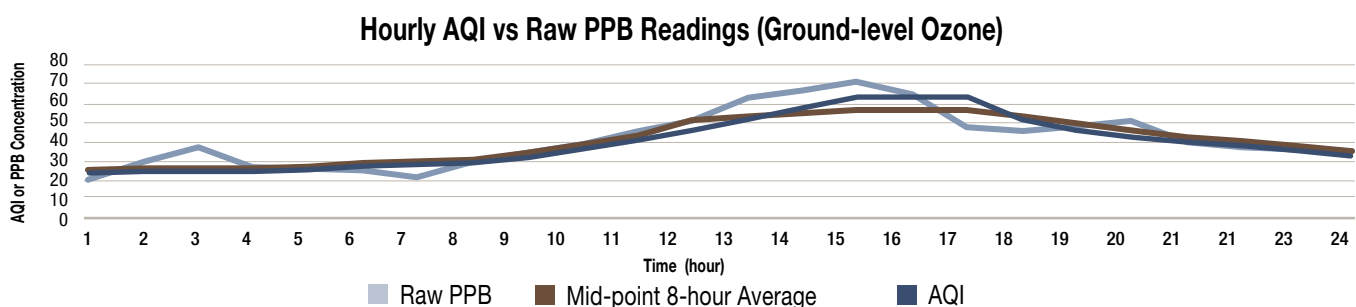
This graph is a simplified illustrative example of how AQI readings can lag behind the Raw PPB⁶³ readings because of the mid-point averaging method used.⁶⁴ In this example for ground-level

ozone, one can see the differences between the Raw PPB data line, the Mid-Point Averages, and the AQI values spanning a 24 hour period.⁶⁵

The general AQI does not indicate which of the pollutants measured is high, unless it is an AQI for a specific pollutant. AirNow does allow users to view specific AQIs for a few select pollutants. The AQI also does not include other pollutants or air toxins that might be present.

None of the AQIs are an accurate reflection of actual current conditions at a specific location because of geography, weather, and algorithm constraints, though they can be a useful tool in understanding local generalities. As an example, let us take two locations less than a mile apart within a city. One is upwind of a facility that has a backup generator running while the other is downwind. The actual concentration of pollutants at each location will be different even if the AQI for the overall area is the same. The more complex an environment is in regard to topography and buildings, the more likely it becomes that there will be increased local variances. Additionally, because AQIs are averages, there is a time delay.

[View EPA Map of AirData Air Quality Monitors](#)



⁶⁰ AirNow, Using the Air Quality Index: <https://www.airnow.gov/aqi/aqi-basics/using-air-quality-index/> (accessed May 2020)

⁶¹ AirNow, AirNow API - Frequently Asked Questions: <https://docs.airnowapi.org/faq#reportingAreaForecasts> (accessed June 2020)

⁶² US Environmental Protection Agency; Technical Assistance Document for the Reporting of Daily Air Quality - the Air Quality Index (AQI): <https://www3.epa.gov/airnow/aqi-technical-assistance-document-sept2018.pdf> (September 2018)

⁶³ PPB = parts per billion, a measure of pollution concentration

⁶⁴ Mid-Point 8-hr Average is the average of the values from the preceding 4 hours, the current hour, and the next 3 hours.

⁶⁵ AirNow; AirNow Tech Discussion Forum - Daily and Hourly AQI - Ozone: <https://forum.airnowtech.org/t/daily-and-hourly-aqi-ozone/170> (accessed May 2020)

Appendix C: Resource Collection

Air Quality Monitoring Links

AirNow Website: <https://www.airnow.gov>

AirNow App (EPA)

- Apple Store: <https://apps.apple.com/us/app/epa-airnow/id467653238>
- Google Play: <https://play.google.com/store/apps/details?id=com.saic.airnow>

California Air Quality Resource Boards Website:
<https://ww2.arb.ca.gov>

California Air Basins Map Website:
<https://ww3.arb.ca.gov/ei/maps/2017statemap/abmap.htm>

PurpleAir: <https://www2.purpleair.com>

AirNow Fire & Smoke Map:
<https://fire.airnow.gov>

Alerts & Email Notifications

EnviroFlash Email Alerts:
<http://www.enviroflash.info>

South Coast Air Quality Management District app:
<https://www.aqmd.gov/mobileapp>

Windy App: <https://www.windy.com/>

Educational Resources

Air Quality Guide for Particle Pollution (EPA):
https://www.airnow.gov/sites/default/files/2020-03/air-quality-guide_pm_2015.pdf

Air Quality Guide for Ozone (EPA):
https://www.airnow.gov/sites/default/files/2020-03/air-quality-guide_ozone_2015_0.pdf

Air Quality Guide for Nitrogen Dioxide (EPA):
<https://www.airnow.gov/sites/default/files/2018-06/no2.pdf>

Reduce Health Risks in Areas With Wildfire Smoke (EPA): <https://www.airnow.gov/sites/default/files/2020-02/reduce-health-risks-with-wildfire-smoke-508.pdf>

Effects of Common Air Pollutants (EPA):
<https://www.airnow.gov/sites/default/files/2018-03/common-air-pollutants-2011-lo.pdf>

State of the Air 2019 (American Lung Association):
<http://www.stateoftheair.org/assets/sota-2019-full.pdf>

Indoor Air Quality

California Department of Public Health Indoor Air Quality Resources Page:
<https://www.cdph.ca.gov/Programs/CCDCPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx>

EPA Indoor Air Quality Resources Page:
<https://www.epa.gov/indoor-air-quality-iaq>

EPA – How Does Wildfire Smoke Affect Indoor Air Quality?:
https://www.epa.gov/indoor-air-quality-iaq/wildfires-and-indoor-air-quality-iaq#_How_does_wildfire

Additional Reports

Wildfire Smoke: A Guide for Public Health Officials (EPA), Revised 2019:
<https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf>

Smog—Who Does It Hurt? What You Need to Know About Ozone and Your Health (EPA):
<https://www.epa.gov/sites/production/files/2015-06/documents/smog.pdf>

Wildland Fire Science (EPA Science Matters): https://www.epa.gov/sites/production/files/2019-11/documents/science_matters_wfs_web_tagged.pdf

OSHA – Respirator Types: https://www.osha.gov/video/respiratory_protection/resptypes_transcript.html

Other Resources

Interactive Map of Air Quality Monitors (EPA):
<https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors>

AirNow – The Air Quality Flag Widget:
<https://www.airnow.gov/air-quality-flag-program-widget/>

This Report has been made Possible through a Partnership between the CRA and BRMA

California Resiliency Alliance | www.CAresiliency.org

The CRA is a 501C(3) non-profit empowering local and regional resiliency through cross-sector information sharing and partnerships. Our members span the public, private, and NGO sectors and have responsibilities in a diverse array of fields including emergency management, business

continuity, physical security, cyber security, and public health. The organization's three focus areas are: **Connecting people and organizations** to build a network of networks, empowering local resiliency efforts; **Supporting Business Operations Centers** in local emergency operations centers to connect the public and private sectors during times of crisis; and **Sharing information**, tools, and resources across sectors to facilitate regional resiliency coordination and planning.



BRMA | www.BRMA.com

Founded in 1993, BRMA is Northern California's largest business recovery association. Our mission is to educate, inform and inspire people working in business continuity, organizational resiliency, and risk management, with the following goals and objectives:

Educate – Support the continued development and advancement of members' relevant skills, techniques, and approaches;

Inform – Provide our members access to subject matter knowledge and increase awareness of relevant topics and events;

Inspire – Provide inspiring opportunities for professional networking, mentoring and interaction among members, subject matter experts and leaders in our profession; and

Network – Ensure members can actively engage in our thriving association, offering numerous opportunities to grow and benefit from a network of active members.



BRMA

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