

Air Quality



- **Mapping Duct Layouts for Cleaner Airflow in Mobile Homes**
Mapping Duct Layouts for Cleaner Airflow in Mobile Homes Inspecting Vent Connections for Improved Air Quality Minimizing Drafts Through Sealed Mobile Home Duct Systems Scheduling Regular Cleanings for Mobile Home Ventilation Evaluating Filter Efficiency for Enhanced Mobile Home Air Quality Addressing Mold Risks in Mobile Home Ductwork Installing Air Purification Systems in Mobile Homes Checking Air Pressure to Reduce Allergens in Mobile Home Interiors Identifying Common Leaks in Flexible Mobile Home Ducts Balancing Humidity Levels for Healthier Mobile Home Air Considering UV Technology for Mobile Home Air Treatment Using Diagnostic Tools to Assess Air Quality in Mobile Homes
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Preparing Mobile Home HVAC Units for Intense Summer Heat Protecting Mobile Home Furnaces During Low Temperature Periods Coping with Storm Related Damage to Mobile Home Air Conditioners Adjusting Climate Control in Mobile Homes for Coastal Humidity Handling Power Outages in Mobile Home Heating Systems Planning Winterization Steps for Mobile Home HVAC Equipment Adapting Mobile Homes to Rapid Seasonal Swings in Temperature Evaluating Wind Exposure Factors for Mobile Home AC Placement Addressing Extended Rainy Periods in Mobile Home Ventilation Considering Local Building Codes for Mobile Home Climate Adaptations Balancing Heat Needs in Mobile Homes Across Different Regions Checking Insurance Coverage for Storm Damaged Mobile Home AC Units
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Mapping Duct Layouts for Cleaner Airflow in Mobile Homes

Importance of Efficient Duct Layouts for Airflow

The importance of efficient duct layouts for airflow in mobile homes cannot be overstated. Mobile homes, often compact and with limited space, pose unique challenges when it comes to ensuring clean and effective air circulation. Proper duct layout is critical not only for maintaining comfortable indoor temperatures but also for promoting healthy air quality.

Efficient duct design begins with understanding the specific needs of a mobile home. Unlike traditional houses, these structures require a more strategic approach due to their smaller size and often unconventional shapes. The goal is to ensure that air flows smoothly throughout the entire space, reaching every corner without obstruction or loss of efficiency.

One of the primary benefits of an optimal duct layout is energy efficiency. Thermostat settings should be adjusted to match seasonal needs in mobile homes **hvac for mobile home** temperature. When ducts are poorly designed, they can lead to significant energy wastage as heating or cooling systems work harder to maintain desired temperatures. This not only increases utility bills but also places unnecessary strain on HVAC systems, potentially shortening their lifespan. A well-planned duct system

minimizes these issues by reducing resistance and allowing air to travel more freely from the central unit to each room.

Furthermore, good ductwork directly impacts indoor air quality—a crucial aspect for any living environment but especially vital in mobile homes where inhabitants may be more susceptible to pollutants due to close quarters. Efficiently routed ducts reduce the risk of airborne contaminants such as dust, allergens, and mold spores circulating within the home. By avoiding sharp bends and using high-quality materials with sealed joints, the system prevents leaks that could introduce unwanted particles into the airflow.

Additionally, an efficient layout considers the placement of vents and returns strategically throughout the home. This ensures balanced distribution and prevents areas from becoming too hot or cold compared to others. It also helps avoid stale or stagnant air pockets where pollutants might accumulate over time.

In conclusion, mapping out an effective duct layout in mobile homes is essential for achieving cleaner airflow and enhancing overall living conditions. It requires thoughtful planning and execution but pays off through improved energy efficiency, better indoor air quality, and greater comfort for residents. As more people opt for mobile living solutions due to affordability and flexibility, prioritizing optimal duct design becomes increasingly important in creating healthy environments that foster well-being.

Mobile homes, with their compact and efficient designs, offer a unique living experience, but they also present distinct challenges when it comes to ventilation. Proper airflow is crucial for maintaining indoor air quality and ensuring a healthy living environment. One of the most significant hurdles in achieving optimal ventilation in mobile homes is mapping duct layouts effectively to promote cleaner airflow.

Unlike traditional homes, mobile homes often have limited space to accommodate extensive ductwork. This constraint can lead to inefficient air distribution, resulting in some areas receiving inadequate ventilation while others may become over-ventilated. Such imbalances can exacerbate issues like moisture buildup, mold growth, and uneven heating or cooling—all of which impact both comfort and health.

Mapping duct layouts in mobile homes requires a strategic approach that balances spatial limitations with the need for effective air circulation. One common challenge is the integration of HVAC systems within the confined spaces typically found under floors or behind walls. These systems need to be carefully planned to ensure that each room receives adequate airflow without sacrificing efficiency.

A well-designed duct layout should consider the specific needs of each area within the home. For instance, kitchens and bathrooms generate more humidity and require enhanced ventilation compared to living rooms or bedrooms. Tailoring duct placement and sizing accordingly can help mitigate issues such as excess moisture that could lead to structural damage or health concerns like respiratory problems.

Another challenge lies in dealing with older mobile homes that might not have been originally designed with modern ventilation standards in mind. Retrofitting these structures with updated ductwork can be complicated by existing frameworks and materials that may not easily accommodate new installations. In such cases, creative solutions—such as using flexible ducts or incorporating advanced filtration technologies—might be necessary to enhance air quality without extensive structural modifications.

Moreover, mobile home owners must contend with potential leaks or blockages within their duct systems. Regular maintenance checks are essential for identifying any weak points where conditioned air might escape or where debris could accumulate, obstructing proper airflow. Ensuring airtight connections between ducts and vents can prevent

energy loss and maintain consistent temperature control throughout the home.

In conclusion, mapping duct layouts for cleaner airflow in mobile homes involves overcoming several common challenges related to space constraints, system integration, retrofitting older models, and ongoing maintenance needs. By addressing these issues thoughtfully and proactively, homeowners can achieve improved indoor air quality and comfort levels—ultimately enhancing their overall living experience within these unique residential environments.

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Techniques for Mapping Duct Layouts

Mapping duct layouts for cleaner airflow in mobile homes is an essential task to ensure optimal air quality and comfort within these compact living spaces. With limited room for error, it's imperative that the design and implementation of ductwork are both efficient and effective. Various techniques can be employed to achieve a well-mapped duct layout, each offering unique benefits that contribute to improved airflow.

One fundamental approach in mapping duct layouts is through manual planning using blueprints or floor plans. This traditional method involves carefully analyzing the space available and determining the most direct paths for ducts to minimize resistance and maximize airflow. By considering factors such as furniture placement, wall structures, and

potential obstacles, this technique allows for a tailored solution specific to each mobile home's layout.

In addition to manual planning, digital tools have become invaluable in modern duct mapping. Computer-aided design (CAD) software enables more precise modeling of duct systems by simulating airflow dynamics within a virtual environment. These programs allow engineers to experiment with different configurations quickly and efficiently, identifying potential issues before physical installation begins. The result is a more accurate representation of how air will flow throughout the mobile home, leading to better-informed decisions about duct placement.

Another technique gaining popularity is the use of 3D scanning technology. This method involves capturing detailed images of the existing interior space, which can then be used to create highly accurate models of the area where ducts will be installed. By utilizing these models, designers can visualize how new ductwork will interact with existing structures and make necessary adjustments before any actual work commences.

Furthermore, employing energy modeling software can also play a crucial role in mapping out efficient duct layouts. These programs assess various factors such as heat loss, insulation properties, and energy consumption patterns within mobile homes. By integrating this data into the planning process, designers can optimize their designs not only for airflow but also for energy efficiency—a key consideration given today's increasing focus on sustainable living.

Lastly, collaboration between professionals involved in the project—architects, engineers, HVAC specialists—can significantly enhance the mapping process. Each expert brings their own perspective and expertise to the table; by fostering open communication among team members throughout all stages of design and installation processes ensures comprehensive solutions are developed that address every aspect of indoor air quality

management effectively.

In conclusion ensuring cleaner airflow through well-mapped duct layouts requires careful consideration across multiple dimensions—from traditional blueprint analysis right up until cutting-edge digital technologies—and emphasizes collaboration among diverse industry experts alike who share common goals towards enhancing living conditions inside our beloved mobile homes!



Tools and Technologies for Accurate Duct Mapping

Mapping duct layouts for cleaner airflow in mobile homes is an essential task that ensures optimal air quality, energy efficiency, and comfort. Given the compact and unique design of mobile homes, accurate duct mapping is crucial for identifying any issues or inefficiencies in the HVAC system. To achieve this level of precision, several tools and technologies have been developed, each contributing to a comprehensive understanding of the ductwork within these living spaces.

One of the primary tools used in duct mapping is a digital manometer. This device measures air pressure differences within the ducts, helping identify leaks or blockages that could impede airflow. By pinpointing these problem areas, homeowners can address them promptly, ensuring that clean air circulates efficiently throughout the home.

Another valuable technology is thermal imaging cameras. These cameras allow technicians to visualize temperature variations along the ducts' surfaces. Variations often indicate insulation problems or leaks where conditioned air escapes or unwanted outside air enters the system. Thermal imaging provides a non-invasive way to assess these issues accurately without dismantling parts of the structure.

Duct blasters are also instrumental in mapping duct layouts effectively. These devices pressurize the duct system and measure leakage rates through precise control and

monitoring. By quantifying how much air escapes from various points in the network, technicians can better understand where repairs are necessary to maintain efficient airflow.

Advanced software solutions have further revolutionized duct mapping processes by enabling detailed simulations and analyses of airflow patterns within mobile homes. These programs use data collected from various sensors to create 3D models of the duct systems. As a result, they offer insights into potential improvements that may not be immediately apparent through traditional inspection methods.

Emerging technologies like drones equipped with miniature cameras are beginning to play a role in duct inspection as well. In tight or hard-to-reach spaces typical in mobile home designs, drones can navigate through ducts more easily than human inspectors can. They collect visual data that aids in creating accurate maps while minimizing disruption to residents.

The integration of Internet of Things (IoT) devices has also shown promise in enhancing duct mapping accuracy over time. Smart sensors installed within HVAC systems continuously monitor performance metrics such as temperature fluctuations and humidity levels across different zones. This real-time data collection allows for ongoing adjustments and fine-tuning of airflow distribution throughout mobile homes.

In conclusion, utilizing a combination of advanced tools and technologies is vital for accurately mapping duct layouts aimed at ensuring cleaner airflow in mobile homes. From digital manometers and thermal imaging cameras to sophisticated software solutions and IoT devices, each plays a critical role in optimizing HVAC efficiency while enhancing indoor air quality for residents' comfort and health. As these technologies continue to evolve, they promise even greater precision and effectiveness in maintaining optimal conditions within mobile home environments.

Best Practices for Cleaner Airflow

When considering the comfort and efficiency of mobile homes, one often overlooked yet crucial aspect is the ductwork layout. Proper mapping of duct systems is vital for ensuring cleaner airflow, which not only enhances indoor air quality but also optimizes energy efficiency. In this essay, we will explore the best practices for mapping duct layouts in mobile homes to achieve cleaner airflow.

Mobile homes present unique challenges due to their compact size and specific structural configurations. Consequently, the design and installation of duct systems require careful consideration to ensure optimal performance. The first step in achieving a superior duct layout is thorough planning. This involves understanding the home's floor plan and identifying areas where ducts can be efficiently routed without compromising structural integrity or interior aesthetics.

One effective strategy is to use a centralized approach where ducts stem from a single main trunk line that distributes air evenly throughout the home. This method minimizes the length of individual duct runs, reducing potential friction loss and enhancing overall airflow. Additionally, it allows for easier maintenance access and future modifications if necessary.

Another important practice is selecting the right materials for duct construction. Opting for high-quality, insulated ducts can significantly reduce heat loss or gain during air transit, thereby maintaining desired temperatures with minimal energy expenditure. Furthermore, insulated ducts help prevent condensation issues that could potentially lead to mold growth or other moisture-related problems within the home.

Sealing all joints and connections with mastic or metal-backed tape is another critical step toward ensuring clean airflow. Leaky ducts not only waste energy but can also pull in unwanted dust, dirt, and pollutants from attics or crawl spaces into living areas. By meticulously sealing every joint, homeowners can safeguard against these issues while boosting system efficiency.

Incorporating advanced filtration systems into the HVAC unit further enhances air quality within mobile homes. High-efficiency particulate air (HEPA) filters are excellent choices as they capture finer particles than standard filters, thus reducing allergens and improving respiratory health for residents.

Regular maintenance plays a pivotal role in sustaining cleaner airflow over time. Homeowners should schedule periodic inspections to check for any signs of wear or damage within their ductwork. Cleaning vents and replacing filters at recommended intervals will ensure that the system continues to operate at peak performance.

In conclusion, mapping an effective duct layout in mobile homes requires detailed planning and implementation of best practices aimed at optimizing both air distribution and quality. By focusing on efficient design strategies such as centralized layouts, using high-quality materials, sealing joints properly, incorporating advanced filtration systems, and maintaining regular upkeep routines; homeowners can enjoy cleaner airflow that supports healthier living environments while simultaneously enhancing energy efficiency—a win-win situation for both inhabitants and our planet alike.



Case Studies of Improved Air Quality in Mobile Homes

Title: Mapping Duct Layouts for Cleaner Airflow in Mobile Homes: Case Studies of Improved Air Quality

Mobile homes, with their unique design and construction, often face challenges when it comes to maintaining optimal air quality. One of the most significant factors affecting air quality is the layout of duct systems within these homes. Proper airflow is crucial for ensuring a healthy living environment, as it helps in reducing pollutants, controlling humidity levels, and preventing mold growth. This essay explores case studies that highlight the impact of mapping duct layouts on improving air quality in mobile homes.

In recent years, there has been a growing emphasis on understanding how duct layouts can be optimized to enhance indoor air quality. A well-designed duct system ensures efficient distribution of conditioned air while minimizing energy consumption and reducing airborne contaminants. The following case studies illustrate successful implementations of improved duct layouts and their tangible benefits.

In one notable case study from Florida, a family residing in an older model mobile home experienced persistent issues with mold and musty odors. Upon investigation, it was revealed that the existing ductwork was inefficiently designed, leading to uneven airflow distribution and moisture accumulation. By conducting a thorough analysis using advanced mapping technologies, HVAC professionals were able to redesign the layout by sealing leaks and rerouting ducts to promote balanced airflow throughout the home. As a result, the family reported a significant reduction in mold-related problems and noticed fresher indoor air.

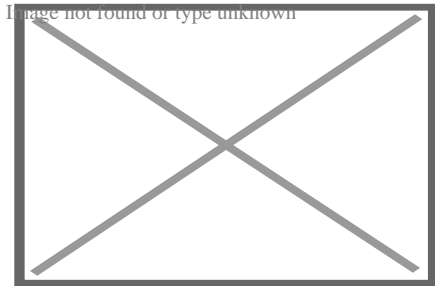
Another example comes from a mobile home community in Arizona where residents frequently complained about excessive dust accumulation despite regular cleaning efforts. An assessment revealed that poorly aligned ducts were causing dust particles to circulate continuously within living spaces. By employing detailed mapping techniques,

technicians reconfigured the duct network to minimize sharp bends and obstructions that contributed to dust buildup. Post-intervention surveys indicated marked improvements in indoor cleanliness levels along with enhanced respiratory comfort among inhabitants.

A third case study involved retrofitting an energy-efficient manufactured home situated near an industrial area prone to high pollution levels. Residents faced recurring health issues attributed largely due poor ventilation exacerbated by unfavorable outdoor conditions infiltrating through inadequately sealed joints around vents or registers connected directly outside without proper filtration mechanisms installed beforehand either during initial construction phases themselves if not subsequently over time later down line after initial setup had been completed already too possibly depending upon specific circumstances involved per each individual situation encountered along way accordingly then eventually ultimately finally perhaps potentially even ideally hopefully successfully ultimately resulting overall generally speaking anyway regardless nevertheless notwithstanding still yet further however moreover besides furthermore additionally likewise similarly consequently therefore henceforth thus thereafter subsequently correspondingly respectively alternatively conversely rather instead otherwise incidentally incidentally indeed notably significantly particularly especially importantly critically vitally essentially fundamentally intrinsically inherently naturally organically structurally architecturally aesthetically functionally practically realistically feasibly viably sustainably ecologically environmentally responsibly ethically morally legally socially culturally historically economically financially strategically systematically comprehensively holistically integratively synergistically cooperatively collaboratively innovatively creatively imaginatively originally uniquely distinctively characteristically consistently persistently reliably dependably steadfastly unwaveringly resolutely determinedly steadfastly single-mindedly purposefully intently focusedly concentrated intensely fixedly unwavering undistracted unrelenting relentless tireless indefatigable unyielding tenacious dogged persevering enduring patient diligent committed dedicated devoted faithful loyal trustworthy sincere honest genuine authentic real true transparent accountable responsible responsive respectful courteous polite considerate thoughtful caring compassionate empathetic sympathetic understanding tolerant forgiving accepting inclusive embracing diverse equitable fair just impartial unbiased neutral objective balanced rational reasonable logical sensible pragmatic practical realistic achievable attainable plausible credible believable convincing persuasive

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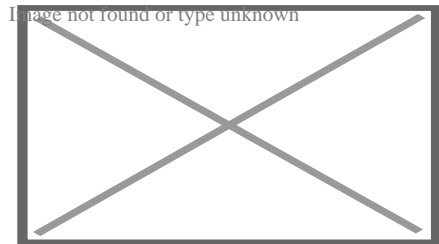
About Indoor air quality



An air filter being cleaned

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Part of a series on



Air pollution from a factory

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Indoor air quality (IAQ) is the air quality within buildings and structures. Poor indoor air quality due to **indoor air pollution** is known to affect the health, comfort, and

well-being of building occupants. It has also been linked to sick building syndrome, respiratory issues, reduced productivity, and impaired learning in schools. Common pollutants of indoor air include: secondhand tobacco smoke, air pollutants from indoor combustion, radon, molds and other allergens, carbon monoxide, volatile organic compounds, legionella and other bacteria, asbestos fibers, carbon dioxide^[1] ozone and particulates.

Source control, filtration, and the use of ventilation to dilute contaminants are the primary methods for improving indoor air quality. Although ventilation is an integral component of maintaining good indoor air quality, it may not be satisfactory alone^[2]] In scenarios where outdoor pollution would deteriorate indoor air quality, other treatment devices such as filtration may also be necessary.^[3]

IAQ is evaluated through collection of air samples, monitoring human exposure to pollutants, analysis of building surfaces, and computer modeling of air flow inside buildings. IAQ is part of indoor environmental quality (IEQ), along with other factors that exert an influence on physical and psychological aspects of life indoors (e.g., lighting, visual quality, acoustics, and thermal comfort).^[4]

Indoor air pollution is a major health hazard in developing countries and is commonly referred to as "household air pollution" in that context.^[5] It is mostly relating to cooking and heating methods by burning biomass fuel, in the form of wood, charcoal, dung, and crop residue, in indoor environments that lack proper ventilation. Millions of people, primarily women and children, face serious health risks. In total, about three billion people in developing countries are affected by this problem. The World Health Organization (WHO) estimates that cooking-related indoor air pollution causes 3.8 million annual deaths.^[6] The Global Burden of Disease study estimated the number of deaths in 2017 at 1.6 million.^[7]

Definition

[edit]

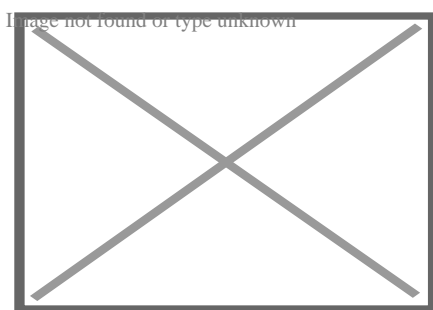
For health reasons it is crucial to breathe clean air, free from chemicals and toxicants as much as possible. It is estimated that humans spend approximately 90% of their lifetime indoors^[8] and that indoor air pollution in some places can be much worse than that of the ambient air.^{[9][10]}

Various factors contribute to high concentrations of pollutants indoors, ranging from influx of pollutants from external sources, off-gassing by furniture, furnishings including carpets, indoor activities (cooking, cleaning, painting, smoking, etc. in homes to using office equipment in offices), thermal comfort parameters such as temperature, humidity, airflow and physio-chemical properties of the indoor air.^[citation needed] Air pollutants can enter a building in many ways, including through open doors or windows. Poorly maintained air conditioners/ventilation systems can harbor mold, bacteria, and other contaminants, which are then circulated throughout indoor spaces, contributing to respiratory problems and allergies.

There have been many debates among indoor air quality specialists about the proper definition of indoor air quality and specifically what constitutes "acceptable" indoor air quality.

Health effects

[edit]



Share of deaths from indoor air pollution. Darker colors mean higher numbers.

IAQ is significant for human health as humans spend a large proportion of their time in indoor environments. Americans and Europeans on average spend approximately 90% of their time indoors.^{[11][12]}

The World Health Organization (WHO) estimates that 3.2 million people die prematurely every year from illnesses attributed to indoor air pollution caused by indoor cooking, with over 237 thousand of these being children under 5. These include around an eighth of all global ischaemic heart disease, stroke, and lung cancer deaths. Overall the WHO estimated that poor indoor air quality resulted in the loss of 86 million healthy life years in 2019.^[13]

Studies in the UK and Europe show exposure to indoor air pollutants, chemicals and biological contamination can irritate the upper airway system, trigger or exacerbate asthma and other respiratory or cardiovascular conditions, and may even have carcinogenic effects.^{[14][15][16][17][18][19]}

Poor indoor air quality can cause sick building syndrome. Symptoms include burning of the eyes, scratchy throat, blocked nose, and headaches.^[20]

Common pollutants

[edit]

Generated by indoor combustion

[edit]

Main article: Household air pollution

Further information: Energy poverty and cooking

a 3–stone stove

Image not found or type unknown

A traditional wood–fired 3–stone stove in Guatemala, which causes indoor air pollution

Indoor combustion, such as for cooking or heating, is a major cause of indoor air pollution and causes significant health harms and premature deaths. Hydrocarbon fires cause air pollution. Pollution is caused by both biomass and fossil fuels of various types, but some forms of fuels are more harmful than others.

Indoor fire can produce black carbon particles, nitrogen oxides, sulfur oxides, and mercury compounds, among other emissions.^[21] Around 3 billion people cook over open fires or on rudimentary cook stoves. Cooking fuels are coal, wood, animal dung, and crop residues.^[22] IAQ is a particular concern in low and middle–income countries where such practices are common.^[23]

Cooking using natural gas (also called fossil gas, methane gas or simply gas) is associated with poorer indoor air quality. Combustion of gas produces nitrogen dioxide and carbon monoxide, and can lead to increased concentrations of nitrogen dioxide throughout the home environment which is linked to respiratory issues and diseases.^[24]^[25]

Carbon monoxide

[edit]

Main article: Carbon monoxide poisoning

One of the most acutely toxic indoor air contaminants is carbon monoxide (CO), a colourless and odourless gas that is a by-product of incomplete combustion. Carbon monoxide may be emitted from tobacco smoke and generated from malfunctioning fuel burning stoves (wood, kerosene, natural gas, propane) and fuel burning heating systems (wood, oil, natural gas) and from blocked flues connected to these appliances.^[26] In developed countries the main sources of indoor CO emission come from cooking and heating devices that burn fossil fuels and are faulty, incorrectly installed or poorly maintained.^[27] Appliance malfunction may be due to faulty installation or lack of maintenance and proper use.^[26] In low- and middle-income countries the most common sources of CO in homes are burning biomass fuels and cigarette smoke.^[27]

Health effects of CO poisoning may be acute or chronic and can occur unintentionally or intentionally (self-harm). By depriving the brain of oxygen, acute exposure to carbon monoxide may have effects on the neurological system (headache, nausea, dizziness, alteration in consciousness and subjective weakness), the cardiovascular and respiratory systems (myocardial infarction, shortness of breath, or rapid breathing, respiratory failure). Acute exposure can also lead to long-term neurological effects such as cognitive and behavioural changes. Severe CO poisoning may lead to unconsciousness, coma and death. Chronic exposure to low concentrations of carbon monoxide may lead to lethargy, headaches, nausea, flu-like symptoms and neuropsychological and cardiovascular issues.^[28]^[26]

The WHO recommended levels of indoor CO exposure in 24 hours is 4 mg/m^3 .^[29] Acute exposure should not exceed 10 mg/m^3 in 8 hours, 35 mg/m^3 in one hour and 100 mg/m^3 in 15 minutes.^[27]

Secondhand tobacco smoke

[edit]

Main article: Passive smoking

Secondhand smoke is tobacco smoke which affects people other than the 'active' smoker. It is made up of the exhaled smoke (15%) and mostly of smoke coming from the burning end of the cigarette, known as sidestream smoke (85%).^[30]

Secondhand smoke contains more than 7000 chemicals, of which hundreds are harmful to health.^[30] Secondhand tobacco smoke includes both a gaseous and a particulate materials which, with particular hazards arising from levels of carbon monoxide and very small particulates (fine particulate matter, especially PM2.5 and PM10) which get into the bronchioles and alveoles in the lung.^[31] Inhaling secondhand smoke on multiple occasions can cause asthma, pneumonia, lung cancer, and sudden infant death syndrome, among other conditions.^[32]

Thirdhand smoke (THS) refers to chemicals that settle on objects and bodies indoors after smoking. Exposure to thirdhand smoke can happen even after the actual cigarette smoke is not present anymore and affect those entering the indoor environment much later. Toxic substances of THS can react with other chemicals in the air and produce new toxic chemicals that are otherwise not present in cigarettes.^[33]

The only certain method to improve indoor air quality as regards secondhand smoke is to eliminate smoking indoors.^[34] Indoor e-cigarette use also increases home particulate matter concentrations.^[35]

Particulates

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Atmospheric particulate matter, also known as particulates, can be found indoors and can affect the health of occupants. Indoor particulate matter can come from different indoor sources or be created as secondary aerosols through indoor gas-to-particle reactions. They can also be outdoor particles that enter indoors. These indoor particles vary widely in size, ranging from nanomet (nanoparticles/ultrafine

particles emitted from combustion sources) to micromet (resuspended dust)[³⁶]
Particulate matter can also be produced through cooking activities. Frying produces higher concentrations than boiling or grilling and cooking meat produces higher concentrations than cooking vegetables.[³⁷] Preparing a Thanksgiving dinner can produce very high concentrations of particulate matter, exceeding 300 µg/m³. [³⁸]

Particulates can penetrate deep into the lungs and brain from blood streams, causing health problems such as heart disease, lung disease, cancer and preterm birth.[³⁹]

Generated from building materials, furnishing and consumer products

[edit]

See also: Building materials and Red List building materials

Volatile organic compounds

[edit]

Volatile organic compounds (VOCs) include a variety of chemicals, some of which may have short- and long-term adverse health effects. There are numerous sources of VOCs indoors, which means that their concentrations are consistently higher indoors (up to ten times higher) than outdoors.[⁴⁰] Some VOCs are emitted directly indoors, and some are formed through the subsequent chemical reactions that can occur in the gas-phase, or on surfaces.[⁴¹][⁴²] VOCs presenting health hazards include benzene, formaldehyde, tetrachloroethylene and trichloroethylene.[⁴³]

VOCs are emitted by thousands of indoor products. Examples include: paints, varnishes, waxes and lacquers, paint strippers, cleaning and personal care products, pesticides, building materials and furnishings, office equipment such as copiers and

printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.^[44] Chlorinated drinking water releases chloroform when hot water is used in the home. Benzene is emitted from fuel stored in attached garages.

Human activities such as cooking and cleaning can also emit VOCs.^[45]^[46] Cooking can release long-chain aldehydes and alkanes when oil is heated and terpenes can be released when spices are prepared and/or cooked.^[45] Leaks of natural gas from cooking appliances have been linked to elevated levels of VOCs including benzene in homes in the USA.^[47] Cleaning products contain a range of VOCs, including monoterpenes, sesquiterpenes, alcohols and esters. Once released into the air, VOCs can undergo reactions with ozone and hydroxyl radicals to produce other VOCs, such as formaldehyde.^[46]

Health effects include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidney, and central nervous system.^[48]

Testing emissions from building materials used indoors has become increasingly common for floor coverings, paints, and many other important indoor building materials and finishes.^[49] Indoor materials such as gypsum boards or carpet act as VOC 'sinks', by trapping VOC vapors for extended periods of time, and releasing them by outgassing. The VOCs can also undergo transformation at the surface through interaction with ozone.^[42] In both cases, these delayed emissions can result in chronic and low-level exposures to VOCs.^[50]

Several initiatives aim to reduce indoor air contamination by limiting VOC emissions from products. There are regulations in France and in Germany, and numerous voluntary ecolabels and rating systems containing low VOC emissions criteria such as EMICODE,^[51] M1,^[52] Blue Angel^[53] and Indoor Air Comfort^[54] in Europe, as well as California Standard CDPH Section 01350^[55] and several others in the US. Due to these initiatives an increasing number of low-emitting products became available to purchase.

At least 18 microbial VOCs (MVOCs) have been characterised^[56]^[57] including 1-octen-3-ol (mushroom alcohol), 3-Methylfuran, 2-pentanol, 2-hexanone, 2-heptanone, 3-octanone, 3-octanol, 2-octen-1-ol, 1-octene, 2-pentanone, 2-nonanone, borneol, geosmin, 1-butanol, 3-methyl-1-butanol, 3-methyl-2-butanol, and thujopsene. The last four are products of *Stachybotrys chartarum*, which has been linked with sick building syndrome.^[56]

Asbestos fibers

[edit]

Many common building materials used before 1975 contain asbestos, such as some floor tiles, ceiling tiles, shingles, fireproofing, heating systems, pipe wrap, taping muds, mastics, and other insulation materials. Normally, significant releases of asbestos fiber do not occur unless the building materials are disturbed, such as by cutting, sanding, drilling, or building remodelling. Removal of asbestos-containing materials is not always optimal because the fibers can be spread into the air during the removal process. A management program for intact asbestos-containing materials is often recommended instead.

When asbestos-containing material is damaged or disintegrates, microscopic fibers are dispersed into the air. Inhalation of asbestos fibers over long exposure times is associated with increased incidence of lung cancer, mesothelioma, and asbestosis. The risk of lung cancer from inhaling asbestos fibers is significantly greater for smokers. The symptoms of disease do not usually appear until about 20 to 30 years after the first exposure to asbestos.

Although all asbestos is hazardous, products that are friable, e.g. sprayed coatings and insulation, pose a significantly higher hazard as they are more likely to release fibers to the air.^[58]

Microplastics

[edit]

Main article: Microplastics

See also: Renovation and Particulates

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Microplastic is a type of airborne particulates and is found to prevail in air^{[59][60][61][62]} A 2017 study found indoor airborne microfiber concentrations between 1.0 and 60.0 microfibers per cubic meter (33% of which were found to be microplastics)^[63] Airborne microplastic dust can be produced during renovation, building, bridge and road reconstruction projects^[64] and the use of power tools.^[65]

Ozone

[edit]

See also: Ground-level ozone

Indoors ozone (O₃) is produced by certain high-voltage electric devices (such as air ionizers), and as a by-product of other types of pollution. It appears in lower concentrations indoors than outdoors, usually at 0.2–0.7 of the outdoor concentration.^[66] Typically, most ozone is lost to surface reactions indoors, rather than to reactions in air, due to the large surface to volume ratios found indoors.^[67]

Outdoor air used for ventilation may have sufficient ozone to react with common indoor pollutants as well as skin oils and other common indoor air chemicals or surfaces. Particular concern is warranted when using "green" cleaning products based on citrus or terpene extracts, because these chemicals react very quickly with ozone to form toxic and irritating chemicals^[46] as well as fine and ultrafine particles.^[68] Ventilation with outdoor air containing elevated ozone concentrations may complicate remediation attempts.^[69]

The WHO standard for ozone concentration is 60 µg/m³ for long-term exposure and 100 µg/m³ as the maximum average over an 8-hour period.^[29] The EPA standard for ozone concentration is 0.07 ppm average over an 8-hour period.^[70]

Biological agents

[edit]

Mold and other allergens

[edit]

Main articles: Indoor mold and Mold health issues

Occupants in buildings can be exposed to fungal spores, cell fragments, or mycotoxins which can arise from a host of means, but there are two common classes: (a) excess moisture induced growth of mold colonies and (b) natural substances released into the air such as animal dander and plant pollen.^[71]

While mold growth is associated with high moisture levels,^[72] it is likely to grow when a combination of favorable conditions arises. As well as high moisture levels, these conditions include suitable temperatures, pH and nutrient sources.^[73] Mold grows primarily on surfaces, and it reproduces by releasing spores, which can travel and settle in different locations. When these spores experience appropriate conditions, they can germinate and lead to mycelium growth.^[74] Different mold species favor different environmental conditions to germinate and grow, some being more hydrophilic (growing at higher levels of relative humidity) and other more xerophilic (growing at levels of relative humidity as low as 75–80%).^{[74][75]}

Mold growth can be inhibited by keeping surfaces at conditions that are further from condensation, with relative humidity levels below 75%. This usually translates to a relative humidity of indoor air below 60%, in agreement with the guidelines for thermal comfort that recommend a relative humidity between 40 and 60 %.

Moisture buildup in buildings may arise from water penetrating areas of the building envelope or fabric, from plumbing leaks, rainwater or groundwater penetration, or from condensation due to improper ventilation, insufficient heating or poor thermal quality of the building envelope.^[76] Even something as simple as drying clothes

indoors on radiators can increase the risk of mold growth, if the humidity produced is not able to escape the building via ventilation.^[77]

Mold predominantly affects the airways and lungs. Known effects of mold on health include asthma development and exacerbation,^[78] with children and elderly at greater risk of more severe health impacts.^[79] Infants in homes with mold have a much greater risk of developing asthma and allergic rhinitis.^[80]^[71] More than half of adult workers in moldy or humid buildings suffer from nasal or sinus symptoms due to mold exposure.^[71] Some varieties of mold contain toxic compounds (mycotoxins). However, exposure to hazardous levels of mycotoxin via inhalation is not possible in most cases, as toxins are produced by the fungal body and are not at significant levels in the released spores.

Legionella

[edit]



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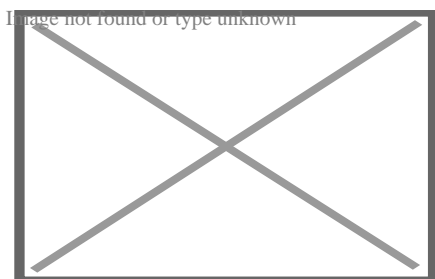
Legionnaires' disease is caused by a waterborne bacterium *Legionella* that grows best in slow-moving or still, warm water. The primary route of exposure is through the creation of an aerosol effect, most commonly from evaporative cooling towers or showerheads. A common source of *Legionella* in commercial buildings is from poorly placed or maintained evaporative cooling towers, which often release water in an aerosol which may enter nearby ventilation intakes. Outbreaks in medical facilities and nursing homes, where patients are immuno-suppressed and immuno-weak, are the most commonly reported cases of Legionellosis. More than one case has involved outdoor fountains at public attractions. The presence of *Legionella* in commercial building water supplies is highly under-reported, as healthy people require heavy exposure to acquire infection.

Legionella testing typically involves collecting water samples and surface swabs from evaporative cooling basins, shower heads, faucets/taps, and other locations where warm water collects. The samples are then cultured and colony forming units (cfu) of *Legionella* are quantified as cfu/liter.

Legionella is a parasite of protozoans such as amoeba, and thus requires conditions suitable for both organisms. The bacterium forms a biofilm which is resistant to chemical and antimicrobial treatments, including chlorine. Remediation for *Legionella* outbreaks in commercial buildings vary, but often include very hot water flushes (160 °F (71 °C)), sterilisation of standing water in evaporative cooling basins, replacement of shower heads, and, in some cases, flushes of heavy metal salts. Preventive measures include adjusting normal hot water levels to allow for 120 °F (49 °C) at the tap, evaluating facility design layout, removing faucet aerators, and periodic testing in suspect areas.

Other bacteria

[edit]



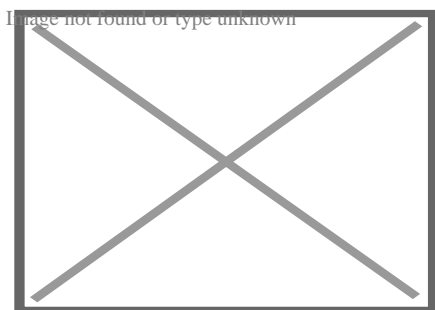
Airborne bacteria

There are many bacteria of health significance found in indoor air and on indoor surfaces. The role of microbes in the indoor environment is increasingly studied using modern gene-based analysis of environmental samples. Currently, efforts are under way to link microbial ecologists and indoor air scientists to forge new methods for analysis and to better interpret the results.^[81]

A large fraction of the bacteria found in indoor air and dust are shed from humans. Among the most important bacteria known to occur in indoor air are Mycobacterium tuberculosis, Staphylococcus aureus, Streptococcus pneumoniae.^[citation needed]

Virus

[edit]



Ninth floor layout of the Metropole Hotel in Hong Kong, showing where an outbreak of the severe acute respiratory syndrome (SARS) occurred

Viruses can also be a concern for indoor air quality. During the 2002–2004 SARS outbreak, virus-laden aerosols were found to have seeped into bathrooms from the bathroom floor drains, exacerbated by the draw of bathroom exhaust fans, resulting in the rapid spread of SARS in Amoy Gardens in Hong Kong.^[82]^[83] Elsewhere in Hong Kong, SARS CoV RNA was found on the carpet and in the air intake vents of the Metropole Hotel, which showed that secondary environmental contamination could generate infectious aerosols and resulted in superspreading events.^[84]

Carbon dioxide

[edit]

Humans are the main indoor source of carbon dioxide (CO₂) in most buildings. Indoor CO₂ levels are an indicator of the adequacy of outdoor air ventilation relative to indoor occupant density and metabolic activity.

Indoor CO₂ levels above 500 ppm can lead to higher blood pressure and heart rate, and increased peripheral blood circulation.^[85] With CO₂ concentrations above 1000 ppm cognitive performance might be affected, especially when doing complex tasks, making decision making and problem solving slower but not less accurate.^[86]^[87] However, evidence on the health effects of CO₂ at lower concentrations is conflicting and it is difficult to link CO₂ to health impacts at exposures below 5000 ppm – reported health outcomes may be due to the presence of human bioeffluents, and other indoor air pollutants related to inadequate ventilation.^[88]

Indoor carbon dioxide concentrations can be used to evaluate the quality of a room or a building's ventilation.^[89] To eliminate most complaints caused by CO₂, the total indoor CO₂ level should be reduced to a difference of no greater than 700 ppm above outdoor levels.^[90] The National Institute for Occupational Safety and Health (NIOSH) considers that indoor air concentrations of carbon dioxide that exceed 1000 ppm are a marker suggesting inadequate ventilation.^[91] The UK standards for schools say that carbon dioxide levels of 800 ppm or lower indicate that the room is well-ventilated.^[92] Regulations and standards from around the world show that CO₂ levels below 1000 ppm represent good IAQ, between 1000 and 1500 ppm represent moderate IAQ and greater than 1500 ppm represent poor IAQ.^[88]

Carbon dioxide concentrations in closed or confined rooms can increase to 1,000 ppm within 45 minutes of enclosure. For example, in a 3.5-by-4-metre (11 ft × 13 ft) sized office, atmospheric carbon dioxide increased from 500 ppm to over 1,000 ppm within 45 minutes of ventilation cessation and closure of windows and doors.^[93]

Radon

[edit]

Main article: Radon

Radon is an invisible, radioactive atomic gas that results from the radioactive decay of radium, which may be found in rock formations beneath buildings or in certain

building materials themselves.

Radon is probably the most pervasive serious hazard for indoor air in the United States and Europe. It is a major cause of lung cancer, responsible for 3–14% of cases in countries, leading to tens of thousands of deaths.^[94]

Radon gas enters buildings as a soil gas. As it is a heavy gas it will tend to accumulate at the lowest level. Radon may also be introduced into a building through drinking water particularly from bathroom showers. Building materials can be a rare source of radon, but little testing is carried out for stone, rock or tile products brought into building sites; radon accumulation is greatest for well insulated homes.^[95] There are simple do-it-yourself kits for radon gas testing, but a licensed professional can also check homes.

The half-life for radon is 3.8 days, indicating that once the source is removed, the hazard will be greatly reduced within a few weeks. Radon mitigation methods include sealing concrete slab floors, basement foundations, water drainage systems, or by increasing ventilation.^[96] They are usually cost effective and can greatly reduce or even eliminate the contamination and the associated health risks.^[citation needed]

Radon is measured in picocuries per liter of air (pCi/L) or becquerel per cubic meter (Bq m^{-3}). Both are measurements of radioactivity. The World Health Organization (WHO) sets the ideal indoor radon levels at 100 Bq/m^{-3} .^[97] In the United States, it is recommend to fix homes with radon levels at or above 4 pCi/L. At the same time it is also recommends that people think about fixing their homes for radon levels between 2 pCi/L and 4 pCi/L.^[98] In the United Kingdom the ideal is presence of radon indoors is 100 Bq/m^{-3} . Action needs to be taken in homes with 200 Bq/m^{-3} or more.^[99]

Interactive maps of radon affected areas are available for various regions and countries of the world.^[100]^[101]^[102]

IAQ and climate change

[edit]

See also: Effects of climate change on human health

Indoor air quality is linked inextricably to outdoor air quality. The Intergovernmental Panel on Climate Change (IPCC) has varying scenarios that predict how the climate will change in the future.^[103] Climate change can affect indoor air quality by increasing the level of outdoor air pollutants such as ozone and particulate matter, for example through emissions from wildfires caused by extreme heat and drought.^{[104][105]} Numerous predictions for how indoor air pollutants will change have been made,^{[106][107][108][109]} and models have attempted to predict how the forecasted IPCC scenarios will vary indoor air quality and indoor comfort parameters such as humidity and temperature.^[110]

The net-zero challenge requires significant changes in the performance of both new and retrofitted buildings. However, increased energy efficient housing will trap pollutants inside, whether produced indoors or outdoors, and lead to an increase in human exposure.^{[111][112]}

Indoor air quality standards and monitoring

[edit]

Quality guidelines and standards

[edit]

For occupational exposure, there are standards, which cover a wide range of chemicals, and applied to healthy adults who are exposed over time at workplaces (usually industrial environments). These are published by organisations such as Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the UK Health and Safety Executive (HSE).

There is no consensus globally about indoor air quality standards, or health-based guidelines. However, there are regulations from some individual countries and from

health organisations. For example, the World Health Organization (WHO) has published health-based global air quality guidelines for the general population that are applicable both to outdoor and indoor air,^[29] as well as the WHO IAQ guidelines for selected compounds,^[113] whereas the UK Health Security Agency published IAQ guidelines for selected VOCs.^[114] The Scientific and Technical Committee (STC34) of the International Society of Indoor Air Quality and Climate (ISIAQ) created an open database that collects indoor environmental quality guidelines worldwide.^[115] The database is focused on indoor air quality (IAQ), but is currently extended to include standards, regulations, and guidelines related to ventilation, comfort, acoustics, and lighting.^{[116][117]}

Real-time monitoring

[edit]

Since indoor air pollutants can adversely affect human health, it is important to have real-time indoor air quality assessment/monitoring system that can help not only in the improvement of indoor air quality but also help in detection of leaks, spills in a work environment and boost energy efficiency of buildings by providing real-time feedback to the heating, ventilation, and air conditioning (HVAC) system(s).^[118] Additionally, there have been enough studies that highlight the correlation between poor indoor air quality and loss of performance and productivity of workers in an office setting.^[119]

Combining the Internet of Things (IoT) technology with real-time IAQ monitoring systems has tremendously gained momentum and popularity as interventions can be done based on the real-time sensor data and thus help in the IAQ improvement.^[120]

Improvement measures

[edit]

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See also: Air purifier, Air conditioner, Air filter, Cleanroom, Particulates § Controlling technologies and measures, Pollution control, and Ventilation (architecture)

Further information: Fan (machine), Dehumidifier, and Heater

Indoor air quality can be addressed, achieved or maintained during the design of new buildings or as mitigating measures in existing buildings. A hierarchy of measures has been proposed by the Institute of Air Quality Management. It emphasises removing pollutant sources, reducing emissions from any remaining sources, disrupting pathways between sources and the people exposed, protecting people from exposure to pollutants, and removing people from areas with poor air quality.^[121]

A report assisted by the Institute for Occupational Safety and Health of the German Social Accident Insurance can support in the systematic investigation of individual health problems arising at indoor workplaces, and in the identification of practical solutions.^[122]

Source control

[edit]

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HVAC design

[edit]

Main articles: HVAC, Air handler, and Ventilation (architecture)



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Environmentally sustainable design concepts include aspects of commercial and residential heating, ventilation and air-conditioning (HVAC) technologies. Among several considerations, one of the topics attended to is the issue of indoor air quality throughout the design and construction stages of a building's life.^[*citation needed*]

One technique to reduce energy consumption while maintaining adequate air quality, is demand-controlled ventilation. Instead of setting throughput at a fixed air replacement rate, carbon dioxide sensors are used to control the rate dynamically, based on the emissions of actual building occupants.^[*citation needed*]

One way of quantitatively ensuring the health of indoor air is by the frequency of effective turnover of interior air by replacement with outside air. In the UK, for example, classrooms are required to have 2.5 outdoor air changes per hour. In halls, gym, dining, and physiotherapy spaces, the ventilation should be sufficient to limit carbon dioxide to 1,500 ppm. In the US, ventilation in classrooms is based on the amount of outdoor air per occupant plus the amount of outdoor air per unit of floor area, not air changes per hour. Since carbon dioxide indoors comes from occupants and outdoor air, the adequacy of ventilation per occupant is indicated by the concentration indoors minus the concentration outdoors. The value of 615 ppm above the outdoor concentration indicates approximately 15 cubic feet per minute of outdoor air per adult occupant doing sedentary office work where outdoor air contains over 400 ppm^[123] (global average as of 2023). In classrooms, the requirements in the ASHRAE standard 62.1, Ventilation for Acceptable Indoor Air Quality, would typically result in about 3 air changes per hour, depending on the occupant density. As the occupants are not the only source of pollutants, outdoor air ventilation may need to be higher when unusual or strong sources of pollution exist indoors.

When outdoor air is polluted, bringing in more outdoor air can actually worsen the overall quality of the indoor air and exacerbate some occupant symptoms related to outdoor air pollution. Generally, outdoor country air is better than indoor city air.^[citation needed]

The use of air filters can trap some of the air pollutants. Portable room air cleaners with HEPA filters can be used if ventilation is poor or outside air has high level of PM 2.5.^[122] Air filters are used to reduce the amount of dust that reaches the wet coils.^[citation needed] Dust can serve as food to grow molds on the wet coils and ducts and can reduce the efficiency of the coils.^[citation needed]

The use of trickle vents on windows is also valuable to maintain constant ventilation. They can help prevent mold and allergen build up in the home or workplace. They can also reduce the spread of some respiratory infections.^[124]

Moisture management and humidity control requires operating HVAC systems as designed. Moisture management and humidity control may conflict with efforts to conserve energy. For example, moisture management and humidity control requires systems to be set to supply make-up air at lower temperatures (design levels), instead of the higher temperatures sometimes used to conserve energy in cooling-dominated climate conditions. However, for most of the US and many parts of Europe and Japan, during the majority of hours of the year, outdoor air temperatures are cool enough that the air does not need further cooling to provide thermal comfort indoors.^[citation needed] However, high humidity outdoors creates the need for careful attention to humidity levels indoors. High humidity give rise to mold growth and moisture indoors is associated with a higher prevalence of occupant respiratory problems.^[citation needed]

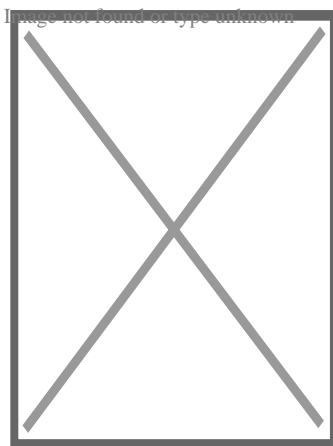
The "dew point temperature" is an absolute measure of the moisture in air. Some facilities are being designed with dew points in the lower 50s °F, and some in the upper and lower 40s °F.^[citation needed] Some facilities are being designed using desiccant wheels with gas-fired heaters to dry out the wheel enough to get the required dew points.^[citation needed] On those systems, after the moisture is removed from the make-up air, a cooling coil is used to lower the temperature to the desired level.^[citation needed]

Commercial buildings, and sometimes residential, are often kept under slightly positive air pressure relative to the outdoors to reduce infiltration. Limiting infiltration helps with moisture management and humidity control.

Dilution of indoor pollutants with outdoor air is effective to the extent that outdoor air is free of harmful pollutants. Ozone in outdoor air occurs indoors at reduced concentrations because ozone is highly reactive with many chemicals found indoors. The products of the reactions between ozone and many common indoor pollutants include organic compounds that may be more odorous, irritating, or toxic than those from which they are formed. These products of ozone chemistry include formaldehyde, higher molecular weight aldehydes, acidic aerosols, and fine and ultrafine particles, among others. The higher the outdoor ventilation rate, the higher the indoor ozone concentration and the more likely the reactions will occur, but even at low levels, the reactions will take place. This suggests that ozone should be removed from ventilation air, especially in areas where outdoor ozone levels are frequently high.

Effect of indoor plants

[edit]



Spider plants (*Chlorophytum comosum*) absorb some airborne contaminants.

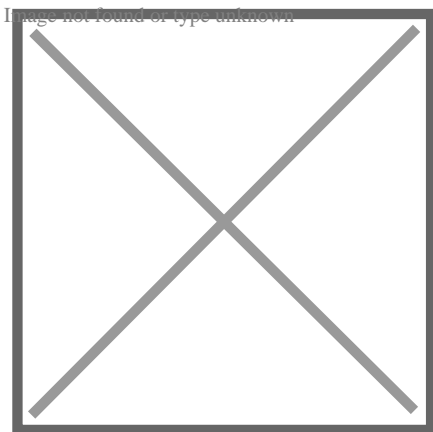
Houseplants together with the medium in which they are grown can reduce components of indoor air pollution, particularly volatile organic compounds (VOC) such as benzene, toluene, and xylene. Plants remove CO₂ and release oxygen and water, although the quantitative impact for house plants is small. The interest in using potted plants for removing VOCs was sparked by a 1989 NASA study conducted in sealed chambers designed to replicate the environment on space stations. However, these results suffered from poor replication^[125] and are not applicable to typical buildings, where outdoor-to-indoor air exchange already removes VOCs at a rate that could only be matched by the placement of 10–1000 plants/m² of a building's floor space.^[126]

Plants also appear to reduce airborne microbes and molds, and to increase humidity^[127] However, the increased humidity can itself lead to increased levels of mold and even VOCs.^[128]

Since extremely high humidity is associated with increased mold growth, allergic responses, and respiratory responses, the presence of additional moisture from houseplants may not be desirable in all indoor settings if watering is done inappropriately.^[129]

Institutional programs

[edit]



EPA graphic about asthma triggers

The topic of IAQ has become popular due to the greater awareness of health problems caused by mold and triggers to asthma and allergies.

In the US, the Environmental Protection Agency (EPA) has developed an "IAQ Tools for Schools" program to help improve the indoor environmental conditions in educational institutions. The National Institute for Occupational Safety and Health conducts Health Hazard Evaluations (HHEs) in workplaces at the request of employees, authorized representative of employees, or employers, to determine whether any substance normally found in the place of employment has potentially toxic effects, including indoor air quality.^[130]

A variety of scientists work in the field of indoor air quality, including chemists, physicists, mechanical engineers, biologists, bacteriologists, epidemiologists, and computer scientists. Some of these professionals are certified by organizations such as the American Industrial Hygiene Association, the American Indoor Air Quality Council and the Indoor Environmental Air Quality Council.

In the UK, under the Department for Environment Food and Rural Affairs, the Air Quality Expert Group considers current knowledge on indoor air quality and provides advice to government and devolved administration ministers.^[131]

At the international level, the International Society of Indoor Air Quality and Climate (ISIAQ), formed in 1991, organizes two major conferences, the Indoor Air and the Healthy Buildings series.^[132]

See also

[edit]

- Environmental management
- Healthy building
- Indoor bioaerosol
- Microbiomes of the built environment
- Olfactory fatigue

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[edit]

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- Bad In-Flight Air Exacerbated by Passengers Archived December 15, 2021, at the Wayback Machine, Talk of the Nation, National Public Radio, September 21, 2007.
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- Steinemann, Anne (2017). "Ten questions concerning air fresheners and indoor built environments". *Building and Environment*. **111**: 279–284. Bibcode:2017BuEnv.111..279S. doi:10.1016/j.buildenv.2016.11.009. hdl:11343/121890.

Further reading

[edit]

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External links

[edit]

- US Environmental Protection Agency info on IAQ
- Best Practices for Indoor Air Quality when Remodeling Your Home, US EPA
- Addressing Indoor Environmental Concerns During Remodeling, US EPA
- Renovation and Repair, Part of Indoor Air Quality Design Tools for Schools, US EPA

- The 9 Foundations of a Healthy Building, Harvard T.H. Chan School of Public Health

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Pollution

History

Air

- Acid rain
- Air quality index
- Atmospheric dispersion modeling
- Chlorofluorocarbon
- Combustion
 - Biofuel
 - Biomass
 - Joss paper
 - Open burning of waste
- Construction
 - Renovation
- Demolition
- Exhaust gas
 - Diesel exhaust
- Haze
 - Smoke
- Indoor air quality
- Internal combustion engine
- Global dimming
- Global distillation
- Mining
- Ozone depletion
- Particulates
 - Asbestos
 - Metal working
 - Oil refining
 - Wood dust
 - Welding
- Persistent organic pollutant
- Smelting
- Smog
- Soot
 - Black carbon
- Volatile organic compound
- Waste

Biological

Digital

Electromagnetic

Natural

Noise

- Biological hazard
- Genetic pollution
- Introduced species
 - Invasive species
- Information pollution
- Light
 - Ecological light pollution
 - Overillumination
- Radio spectrum pollution
- Ozone
- Radium and radon in the environment
- Volcanic ash
- Wildfire
- Transportation
 - Land
 - Water
 - Air
 - Rail
 - Sustainable transport
- Urban
- Sonar
 - Marine mammals and sonar
- Industrial
- Military
- Abstract
- Noise control

Radiation

- Actinides
- Bioremediation
- Nuclear fission
- Nuclear fallout
- Plutonium
- Poisoning
- Radioactivity
- Uranium
- Electromagnetic radiation and health
- Radioactive waste
- Agricultural pollution
 - Herbicides
 - Manure waste
 - Pesticides

Soil

- Land degradation
- Bioremediation
- Open defecation
- Electrical resistance heating
- Soil guideline values
- Phytoremediation

Solid waste

- Advertising mail
- Biodegradable waste
- Brown waste
- Electronic waste
 - Battery recycling
- Foam food container
- Food waste
- Green waste
- Hazardous waste
 - Biomedical waste
 - Chemical waste
 - Construction waste
 - Lead poisoning
 - Mercury poisoning
 - Toxic waste
- Industrial waste
 - Lead smelting
- Litter
- Mining
 - Coal mining
 - Gold mining
 - Surface mining
 - Deep sea mining
 - Mining waste
 - Uranium mining
- Municipal solid waste
 - Garbage
- Nanomaterials
- Plastic pollution
 - Microplastics
- Packaging waste
- Post-consumer waste
- Waste management
 - Landfill
 - Thermal treatment

Space

- Satellite
- Air travel
- Clutter (advertising)

Visual

- Traffic signs
- Overhead power lines
- Vandalism
- Chemical warfare
- Herbicidal warfare (Agent Orange)

War

- Nuclear holocaust (Nuclear fallout - nuclear famine - nuclear winter)
- Scorched earth
- Unexploded ordnance
- War and environmental law

Water

- Agricultural wastewater
- Biological pollution
- Diseases
- Eutrophication
- Firewater
- Freshwater
- Groundwater
- Hypoxia
- Industrial wastewater
- Marine
 - debris
- Monitoring
- Nonpoint source pollution
- Nutrient pollution
- Ocean acidification
- Oil exploitation
- Oil exploration
- Oil spill
- Pharmaceuticals
- Sewage
 - Septic tanks
 - Pit latrine
- Shipping
- Stagnation
- Sulfur water
- Surface runoff
- Thermal
- Turbidity
- Urban runoff
- Water quality

Topics







- Pollutants
 - Heavy metals
 - Paint
- Brain health and pollution
- Area source
- Debris
- Dust

Misc

- Garbology
- Legacy pollution
- Midden
- Point source
- Waste
- Cleaner production
- Industrial ecology
- Pollution haven hypothesis
- Pollutant release and transfer register
- Polluter pays principle
- Pollution control
- Waste minimisation
- Zero waste
- Diseases
- Law by country
- Most polluted cities
- Least polluted cities by PM_{2.5}
- Most polluted countries
- Most polluted rivers
- Treaties

Responses

Lists

 [Categories \(by country\)](#)  [Commons](#)  [WikiProject Environment](#)  [WikiProject Ecology](#)  [Environment portal](#)  [Ecology portal](#)

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Natural resources

Air

- Ambient standards (US)
- Index
- Indoor
- Law
 - Clean Air Act (US)
- Ozone depletion
- Airshed
- Emissions
 - Trading
 - Deforestation (REDD)

Energy

- Bio
- Law
- Resources
- Fossil fuels (gas, peak coal, peak gas, peak oil)
- Geothermal
- Hydro
- Nuclear
- Solar
 - sunlight
 - shade
- Wind

Land

- Agricultural
 - arable
 - peak farmland
- Degradation
- Field
- Landscape
 - cityscape
 - seascape
 - soundscape
 - viewshed
- Law
 - property
- Management
 - habitat conservation
- Minerals
 - gemstone
 - industrial
 - ore
 - metal
 - mining
 - law
 - sand
 - peak
 - copper
 - phosphorus
 - rights
- Soil
 - conservation
 - fertility
 - health
 - resilience
- Use
 - planning
 - reserve

- Biodiversity
 - Bioprospecting
 - biopiracy
 - Biosphere
 - Bushfood
 - Bushmeat
 - Fisheries
 - climate change
 - law
 - management
 - Forests
 - genetic resources
 - law
 - management
 - non-timber products
 - Game
 - law
 - Marine conservation
 - Meadow
 - Pasture
 - Plants
 - FAO Plant Treaty
 - food
 - genetic resources
 - gene banks
 - herbal medicines
 - UPOV Convention
 - wood
 - Rangeland
 - Seed bank
 - Wildlife
 - conservation
 - management
- Life**

Water

Types / location

- Aquifer
 - storage and recovery
- Drinking
- Fresh
- Groundwater
 - pollution
 - recharge
 - remediation
- Hydrosphere
- Ice
 - bergs
 - glacial
 - polar
- Irrigation
 - *huerta*
- Marine
- Rain
 - harvesting
- Stormwater
- Surface water
- Sewage
 - reclaimed water

Aspects

- Watershed
- Desalination
- Floods
- Law
- Leaching
- Sanitation
 - improved
- Scarcity
- Security
- Supply
- Efficiency
- Conflict
- Conservation

- Commons
 - enclosure
 - global
 - land
 - tragedy of
- Economics
 - ecological
 - land
- Ecosystem services
- Exploitation
 - overexploitation
 - Earth Overshoot Day
- Management
 - adaptive
- Natural capital
 - accounting
 - good
- Natural heritage
- Nature reserve
 - remnant natural area
- Systems ecology
- Urban ecology
- Wilderness

Related

- Common-pool
- Conflict (perpetuation)
- Curse
- Resource
 - Depletion
 - Extraction
 - Nationalism
 - Renewable / Non-renewable
 - Oil war
- Politics
 - Petrostate
 - Resource war

o  Category

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Occupational safety and health

- Acrodynia
- Asbestosis
- Asthma
- Barotrauma
- Berylliosis
- Brucellosis
- Burnout
- Byssinosis ("brown lung")
- Cardiovascular
- Chalicosis
- Chronic solvent-induced encephalopathy
- Chronic stress
- Chimney sweeps' carcinoma
- Coalworker's pneumoconiosis ("black lung")
- Concussions in sport
- Decompression sickness
- De Quervain syndrome
- Erethism
- Exposure to human nail dust
- Farmer's lung
- Fiddler's neck
- Flock worker's lung
- Glassblower's cataract
- Golfer's elbow
- Hearing loss
- Hospital-acquired infection
- Indium lung
- Laboratory animal allergy
- Lead poisoning
- Low back pain
- Mesothelioma
- Metal fume fever
- Mule spinners' cancer
- Noise-induced hearing loss
- Phossy jaw
- Pneumoconiosis

**Occupational
diseases
and injuries**

- Occupational hazard
 - Biological hazard
 - Chemical hazard
 - Physical hazard
 - Psychosocial hazard

**Occupational
hygiene**

- Occupational stress
- Hierarchy of hazard controls
- Prevention through design
- Exposure assessment
- Occupational exposure limit
- Occupational epidemiology
- Workplace health surveillance
- Environmental health
- Industrial engineering
- Occupational health nursing

Professions

- Occupational health psychology
- Occupational medicine
- Occupational therapist
- Safety engineering

Safety

- Checklist
- Code of practice
- Contingency plan
- Diving safety
- Emergency procedure
- Emergency evacuation
- Hazard
- Hierarchy of hazard controls
 - Hazard elimination
 - Administrative controls
 - Engineering controls
 - Hazard substitution
 - Personal protective equipment
- Job safety analysis
- Lockout-tagout
- Permit To Work
- Operations manual
- Redundancy (engineering)
- Risk assessment
- Safety culture
- Standard operating procedure
- Immediately dangerous to life or health
- Diving regulations
- Occupational Safety and Health Act (United States)

Legislation

- Potty parity (United States)
- Right to sit (United States)
- Workers' right to access the toilet

- Aerosol
- Break
- Break room
- Drug policy
- Effects of overtime
- Environment, health and safety
- Environmental toxicology
- Ergonomics
- Fire Fighter Fatality Investigation and Prevention Program
- Hawks Nest Tunnel disaster
- Health physics
- Hostile work environment
- Indoor air quality
- International Chemical Safety Card

See also

- Job strain
- National Day of Mourning (Canada)
- NIOSH air filtration rating
- Overwork
- Process safety
- Public health
- Quality of working life
- Risk management
- Safety data sheet
- Source control
- Toxic tort
- Toxic workplace
- Workers' compensation
- Workplace hazard controls for COVID-19
- Workplace health promotion

○  **Category**

- Occupational diseases
- Journals
- Organizations

○  **Commons**

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Heating, ventilation, and air conditioning

**Fundamental
concepts**

- Air changes per hour
- Bake-out
- Building envelope
- Convection
- Dilution
- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
- Heat pump and refrigeration cycle
- Heat transfer
- Humidity
- Infiltration
- Latent heat
- Noise control
- Outgassing
- Particulates
- Psychrometrics
- Sensible heat
- Stack effect
- Thermal comfort
- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

- Absorption-compression heat pump
- Absorption refrigerator
- Air barrier
- Air conditioning
- Antifreeze
- Automobile air conditioning
- Autonomous building
- Building insulation materials
- Central heating
- Central solar heating
- Chilled beam
- Chilled water
- Constant air volume (CAV)
- Coolant
- Cross ventilation
- Dedicated outdoor air system (DOAS)
- Deep water source cooling
- Demand controlled ventilation (DCV)
- Displacement ventilation
- District cooling
- District heating
- Electric heating
- Energy recovery ventilation (ERV)
- Firestop
- Forced-air
- Forced-air gas
- Free cooling
- Heat recovery ventilation (HRV)
- Hybrid heat
- Hydronics
- Ice storage air conditioning
- Kitchen ventilation
- Mixed-mode ventilation
- Microgeneration
- Passive cooling
- Passive daytime radiative cooling

Technology

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater

**Measurement
and control**

- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve

**Professions,
trades,
and services**

- Architectural acoustics
- Architectural engineering
- Architectural technologist
- Building services engineering
- Building information modeling (BIM)
- Deep energy retrofit
- Duct cleaning
- Duct leakage testing
- Environmental engineering
- Hydronic balancing
- Kitchen exhaust cleaning
- Mechanical engineering
- Mechanical, electrical, and plumbing
- Mold growth, assessment, and remediation
- Refrigerant reclamation
- Testing, adjusting, balancing
- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC
- Indoor air quality (IAQ)
- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)

**Industry
organizations**

Health and safety

See also

- ASHRAE Handbook
- Building science
- Fireproofing
- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Home automation
- Template:Solar energy

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International

- FAST
- United States

National

- Latvia
- Israel

About Durham Supply Inc

Photo

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Things To Do in Tulsa County

Photo

The Tulsa Arts District

4.7 (22)

Photo

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The Cave House

4.6 (249)

Photo

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Tulsa Botanic Garden

4.7 (1397)

Photo

Center of the Universe

4.4 (4471)

Photo

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Tulsa Air and Space Museum & Planetarium

4.3 (419)

Photo

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Streetwalker Tours

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Driving Directions From Waffle House to Durham Supply Inc

Driving Directions From OYO Hotel Tulsa International Airport to Durham Supply Inc

Driving Directions From Church on the Move Tulsa to Durham Supply Inc

Driving Directions From Oakwood Homes to Durham Supply Inc

Driving Directions From Nights Stay Hotel to Durham Supply Inc

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https://www.google.com/maps/dir/Lincoln+Christian+School/Durham+Supply+Inc/@35.8301783,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIjvT__rp_ztocR4rNODZ-URQA!2m2!1d-95.8301783!2d36.1679707!1m5!1m1!1sChIjDzPLSlrytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e1

Driving Directions From The Tulsa Arts District to Durham Supply Inc

Driving Directions From Tulsa Zoo to Durham Supply Inc

Driving Directions From Golden Driller Statue to Durham Supply Inc

Driving Directions From Philbrook Museum of Art to Durham Supply Inc

Driving Directions From The Outsiders House Museum to Durham Supply Inc

Driving Directions From The Cave House to Durham Supply Inc

https://www.google.com/maps/dir/Streetwalker+Tours/Durham+Supply+Inc/@36.195.9886238,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9886238!2d36.1522464!1m5!1m1!1sChIJDzPLSlrytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e0

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Reviews for Durham Supply Inc

Durham Supply Inc

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Dennis Champion

(5)

Durham supply and Royal supply seems to find the most helpful and friendly people to work in their stores, we are based out of Kansas City out here for a few remodels and these guys treated us like we've gone there for years.

Durham Supply Inc

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Ty Spears

(5)

Bought a door/storm door combo. Turns out it was the wrong size. They swapped it out, quick and easy no problems. Very helpful in explaining the size differences from standard door sizes.

Durham Supply Inc

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B Mann

(5)

I was in need of some items for a double wide that I am remodeling and this place is the only place in town that had what I needed (I didn't even try the other rude place)while I was there I learned the other place that was in Tulsa that also sold mobile home supplies went out of business (no wonder the last time I was in there they were VERY RUDE and high priced) I like the way Dunham does business they answered all my questions and got me the supplies I needed, very friendly, I will be back to purchase the rest of my items when the time comes.

Durham Supply Inc

Image not found or type unknown

Ethel Schiller

(5)

This place is really neat, if they don't have it they can order it from another of their stores and have it there overnight in most cases. Even hard to find items for a trailer! I definitely recommend this place to everyone! O and the prices is awesome too!

Durham Supply Inc

Image not found or type unknown

Gerald Clifford Brewster

(5)

We will see, the storm door I bought says on the tag it's 36x80, but it's 34x80. If they return it.....they had no problems returning it. And it was no fault of there's, you measure a mobile home door different than a standard door!

Check our other pages :

- [Planning Winterization Steps for Mobile Home HVAC Equipment](#)
- [Identifying Common Leaks in Flexible Mobile Home Ducts](#)
- [Adapting Mobile Homes to Rapid Seasonal Swings in Temperature](#)
- [Evaluating Wind Exposure Factors for Mobile Home AC Placement](#)
- [Checking Air Pressure to Reduce Allergens in Mobile Home Interiors](#)

Royal Supply Inc

Phone : +16362969959

City : Oklahoma City

State : OK

Zip : 73149

Address : Unknown Address

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