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# Selecting Goodman Units for Reliable Mobile Home Climate Control

## Overview of HVAC needs specific to mobile homes

In today's rapidly changing climate, ensuring reliable climate control in mobile homes has become more crucial than ever. Technicians need specific training to work on HVAC systems in manufactured housing **mobile home hvac units** money. Mobile homes, often situated in varying environments and constructed with different materials compared to traditional houses, require a specific approach to heating and cooling. This is where selecting the right HVAC units becomes vital, and Goodman units stand out as an excellent choice for providing dependable comfort.

Mobile homes are unique living spaces that can present specific challenges when it comes to maintaining consistent indoor temperatures. Their lightweight construction makes them more susceptible to external temperature fluctuations, which can lead to discomfort during extreme weather conditions. Therefore, having a robust and reliable climate control system is essential not only for comfort but also for energy efficiency and cost savings.

Goodman HVAC units have earned a reputation for their reliability and efficiency, making them ideal for mobile home applications. One of the primary reasons Goodman units are preferred is their durability. Built with high-quality materials, these systems are designed to withstand the demands of diverse climates while delivering consistent performance year-round.

Another significant advantage of Goodman units is their energy efficiency. Mobile homeowners often face limited space and tighter budgets, so choosing an HVAC system that optimizes energy usage without sacrificing comfort is crucial. Goodman units feature advanced technology that helps reduce energy consumption while maintaining optimal indoor temperatures. This not only lowers utility bills but also contributes positively to environmental conservation efforts by minimizing carbon footprints.

The ease of installation and maintenance further enhances the appeal of Goodman units for mobile homes. Given the compact nature of these structures, finding systems that fit well within limited space constraints while providing easy access for maintenance is important.

Goodman's design philosophy ensures that their HVAC systems are user-friendly and adaptable to various installation requirements typical of mobile homes.

Additionally, Goodman offers a wide range of products tailored to meet diverse needs and preferences, allowing homeowners to choose systems that match their specific requirements-whether it's a focus on cooling efficiency or enhanced heating capabilities during colder months.

In conclusion, as we navigate through increasingly unpredictable weather patterns brought on by climate change, the importance of reliable climate control in mobile homes cannot be overstated. Selecting appropriate HVAC systems like those offered by Goodman ensures not only comfort but also long-term sustainability through efficient energy use and reduced operational costs. For mobile homeowners seeking peace of mind and consistent indoor climates regardless of external conditions, investing in a reliable unit from a reputable brand such as Goodman is undoubtedly a wise decision.

# Importance of efficient heating and cooling solutions —

- **Overview of HVAC needs specific to mobile homes**
- **Importance of efficient heating and cooling solutions**
- **Understanding Financing Options for Mobile Home HVAC**
- **Explanation of common financing packages available**
- **Key factors to consider when choosing a financing option**
- **Personal Loans for HVAC Systems**
- **Pros and cons of using personal loans for HVAC installation**

When it comes to ensuring a comfortable living environment in a mobile home, selecting the appropriate HVAC system is of paramount importance. Goodman units have long been recognized for their reliability, efficiency, and performance, making them a favored choice for many homeowners. In this overview, we will delve into the key considerations when selecting Goodman units specifically tailored for mobile home climate control.

Mobile homes present unique challenges when it comes to heating and cooling. Their smaller size compared to traditional homes means that temperature regulation needs to be both efficient and effective. Moreover, mobile homes often have different insulation standards, which can affect how well they retain heat or cool air. This is where Goodman units shine with their versatile range of products designed to meet varying demands.

One of the primary advantages of Goodman units is their energy efficiency. The company's commitment to high SEER (Seasonal Energy Efficiency Ratio) ratings ensures that homeowners can enjoy optimal climate control without incurring exorbitant energy bills. For mobile homes, where space and resources may be limited, this efficiency becomes even more critical. By opting for a unit with a higher SEER rating, homeowners can reduce energy consumption while maintaining consistent indoor comfort levels.

Durability and ease of maintenance are other compelling reasons to consider Goodman units for mobile homes. These systems are designed with robust materials and engineering excellence that withstand diverse weather conditions-an essential feature considering that mobile homes may be located in areas prone to extreme temperatures or severe weather events. Additionally, Goodman units are known for straightforward maintenance processes which help extend the lifespan of the unit and ensure dependable operation over time.

When selecting an HVAC system for a mobile home, sizing is also crucial. A system that's too large or too small can lead to inefficiencies such as uneven temperature distribution or unnecessary energy use. Fortunately, Goodman offers a variety of sizes and configurations allowing homeowners to select a unit that perfectly matches their specific needs.

Lastly, affordability remains one of Goodman's standout features without compromising quality or performance-a crucial factor for many families looking at cost-effective solutions during these challenging economic times.

In summary, choosing the right HVAC system is vital in maintaining comfort within a mobile home setting; thus making Goodman units an excellent option due mainly because they combine efficiency with durability while offering various models suited explicitly towards compact living spaces like those found in typical manufactured housing environments-all at competitive prices! Whether it's battling summer heatwaves or keeping warm during chilly winter nights-Goodman has suitable options ensuring families remain comfortable year-round regardless what Mother Nature throws their way!

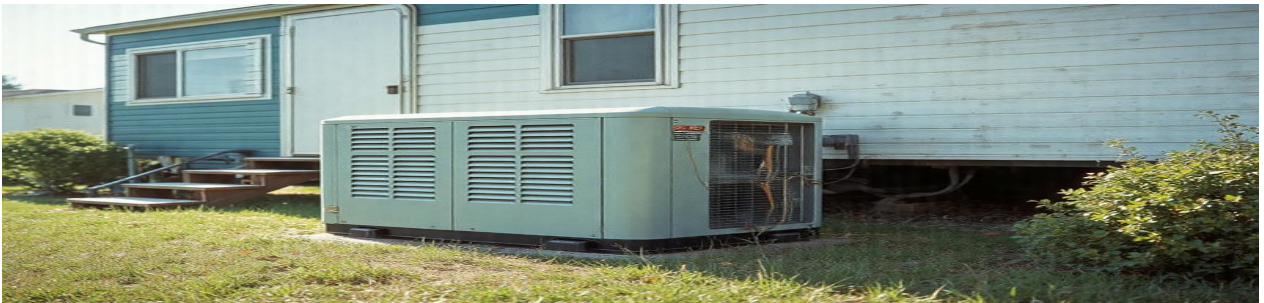
## Affordable Payment Plans for Upgrading Mobile Home AC Systems



Choosing the right payment plan for upgrading your mobile home AC system is a crucial decision that can significantly impact your financial stability and comfort at home.. With numerous options available, it's essential to consider several factors to ensure you select a plan that aligns with your needs and budget. Firstly, assess your financial situation.

Posted by on 2024-12-30

## Aligning Equipment Compatibility with Financing Options in Mobile Homes



In the dynamic world of mobile homes, aligning equipment compatibility with financing options is a crucial element that can significantly impact the success of any project.. The process involves ensuring that the equipment used in mobile home construction or renovation is not only technically suitable but also financially feasible.

Posted by on 2024-12-30

## Benefits of Payment Plans Tailored for Mobile Home HVAC Upgrades



When contemplating upgrades to your mobile home's HVAC system, choosing the right payment plan is as crucial as selecting the equipment itself.. As energy efficiency and comfort become increasingly important, many homeowners are considering tailored payment plans that make these enhancements more accessible.

Posted by on 2024-12-30

# Understanding Financing Options for Mobile Home HVAC

When selecting a climate control system for your mobile home, reliability and efficiency are paramount. Goodman units stand out as an exemplary choice, offering a blend of key features and benefits that make them ideal for this unique living space.

First and foremost, Goodman units are renowned for their robust durability. Built with high-quality materials and advanced engineering, these systems are designed to withstand the test of time, providing consistent performance even in challenging conditions. This reliability is crucial for mobile homes, which may face varying weather patterns as they travel or settle in different regions.

Energy efficiency is another standout feature of Goodman units. With increasing energy costs and growing environmental concerns, having an HVAC system that minimizes energy consumption is essential. Goodman units are equipped with high SEER (Seasonal Energy Efficiency Ratio) ratings, ensuring that they operate efficiently while keeping utility bills in check. This makes them not only a cost-effective choice but also an environmentally responsible one.

Moreover, Goodman units offer superior comfort through precise climate control capabilities. They are designed to maintain steady indoor temperatures by efficiently regulating airflow and humidity levels. For mobile home residents who often experience space constraints, the compact yet powerful design of Goodman systems ensures optimal comfort without occupying excessive room or detracting from the home's aesthetics.

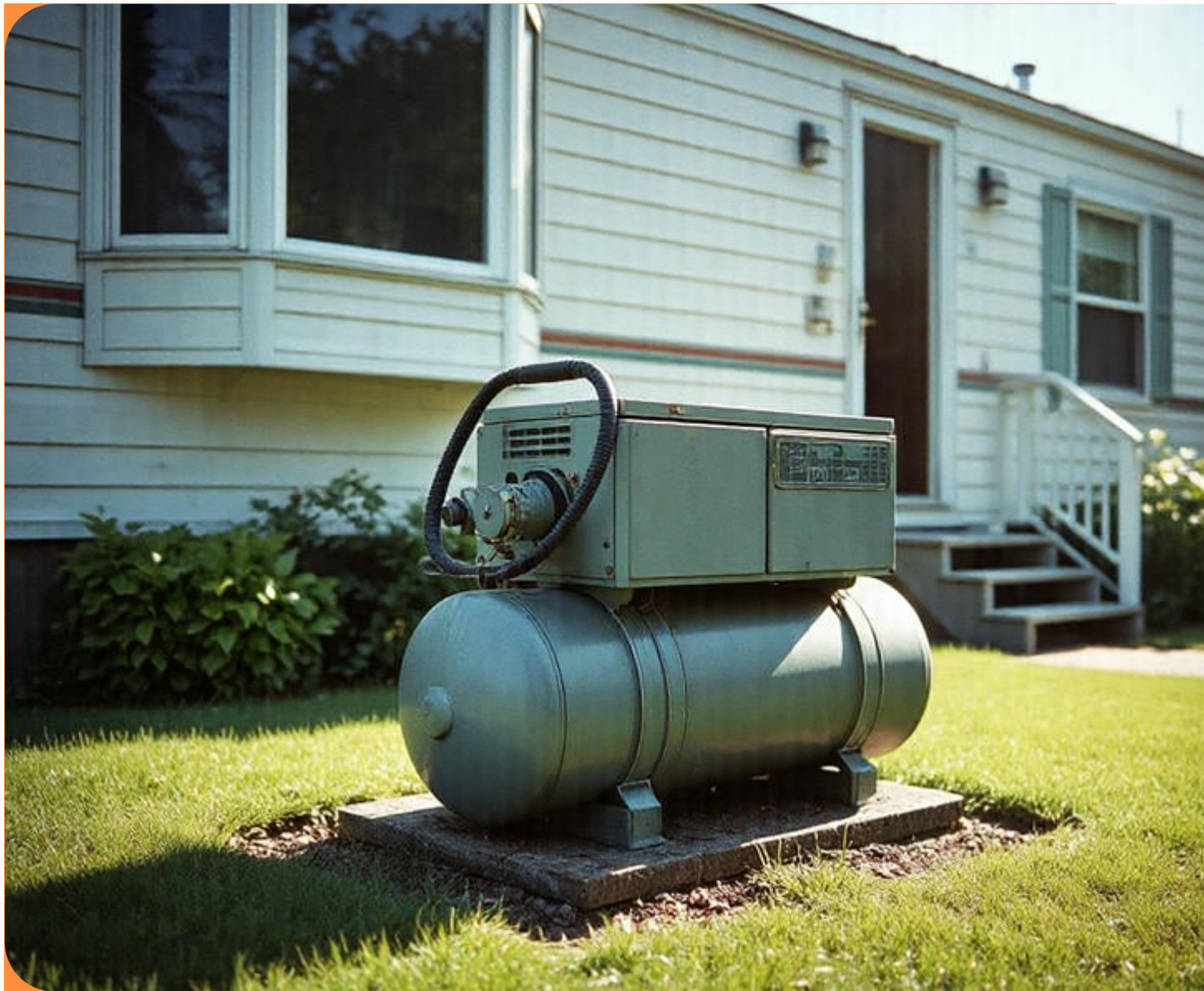
Ease of installation and maintenance further enhances the appeal of Goodman units. Their straightforward design allows for quicker installations with fewer complications-an important consideration when working within the limited spaces typical of mobile homes. Additionally, their user-friendly interfaces and accessible components simplify routine maintenance tasks, reducing downtime and extending the life span of the unit.

In terms of customer support and warranty offerings, Goodman excels by providing comprehensive service packages that offer peace of mind to homeowners. Their extensive network of service professionals ensures prompt assistance whenever needed, further solidifying their reputation as a reliable choice for mobile home climate control.

In conclusion, selecting a Goodman unit for your mobile home is an investment in quality and reliability. With features emphasizing durability, energy efficiency, comfort optimization, ease of maintenance, and strong customer support structures in place-Goodman units prove themselves as a top contender in ensuring effective climate control tailored to meet the needs of mobile homeowners everywhere.







## Explanation of common financing packages available

When considering the selection of Goodman units for mobile homes, several key factors come into play to ensure that these homes are provided with reliable climate control. Mobile homes, given their unique structural and environmental characteristics, require specialized attention when it comes to heating and cooling solutions. Goodman, a reputable name in the HVAC

industry, offers a range of units specifically designed to meet these needs effectively.

First and foremost, it's crucial to assess the size and layout of your mobile home. Mobile homes typically have different spatial configurations compared to traditional houses, often being narrower and more compact. Therefore, selecting an appropriately sized Goodman unit is essential for efficient climate control. An undersized unit may struggle to maintain desired temperatures during extreme weather conditions, while an oversized unit might cycle on and off too frequently, leading to increased wear and tear.

Energy efficiency is another critical factor to consider. Mobile homes often have limited insulation compared to conventional homes, which can result in higher energy consumption if not properly managed. Goodman units are known for their energy-efficient models that comply with current regulations aimed at reducing energy usage while maintaining optimal performance. Choosing a unit with a high Seasonal Energy Efficiency Ratio (SEER) rating can lead to significant savings on utility bills over time.

The installation process is also an important consideration. Mobile homes may present challenges due to their construction materials and limited space for ductwork or external components like condensers. It's advisable to consult with HVAC professionals who have experience working with mobile homes to ensure proper installation of the Goodman unit. This not only guarantees efficient operation but also prolongs the lifespan of the system by preventing potential issues arising from improper setup.

Additionally, consider the specific climate conditions where your mobile home is located. Different geographic locations will have varying temperature ranges and humidity levels throughout the year. Selecting a Goodman unit that can handle these specific demands ensures consistent indoor comfort regardless of external weather conditions.

Maintenance and serviceability should also be factored into your decision-making process. Regular maintenance is vital for any HVAC system's longevity and efficiency, particularly in mobile homes where space constraints can make servicing more challenging. Goodman units are designed for ease of maintenance with accessible components that simplify routine checks and repairs.

In conclusion, selecting the right Goodman unit for your mobile home involves careful consideration of various factors including size compatibility, energy efficiency ratings, installation requirements, climatic conditions specific to your location, and ease of

maintenance. By taking these elements into account, you can ensure that your mobile home remains comfortable year-round while optimizing energy use and extending the life of your HVAC system. Investing time in making an informed choice will pay dividends in terms of both comfort levels within your home and cost savings on utilities over time.

# Key factors to consider when choosing a financing option

When it comes to ensuring reliable climate control in mobile homes, selecting the right HVAC units is crucial. Goodman units have consistently proven to be a dependable choice for this purpose, known for their efficiency and durability. However, achieving optimal performance from these units requires careful attention during installation and diligent maintenance afterward.

The first step towards reliable climate control begins with proper installation. Ensuring that the unit is correctly sized for your mobile home is paramount. An undersized unit will struggle to maintain the desired temperature, leading to increased energy consumption and wear over time. Conversely, an oversized unit may cycle on and off too frequently, reducing its efficiency and lifespan. Consulting with a professional HVAC technician who can assess your home's specific heating and cooling needs is essential.

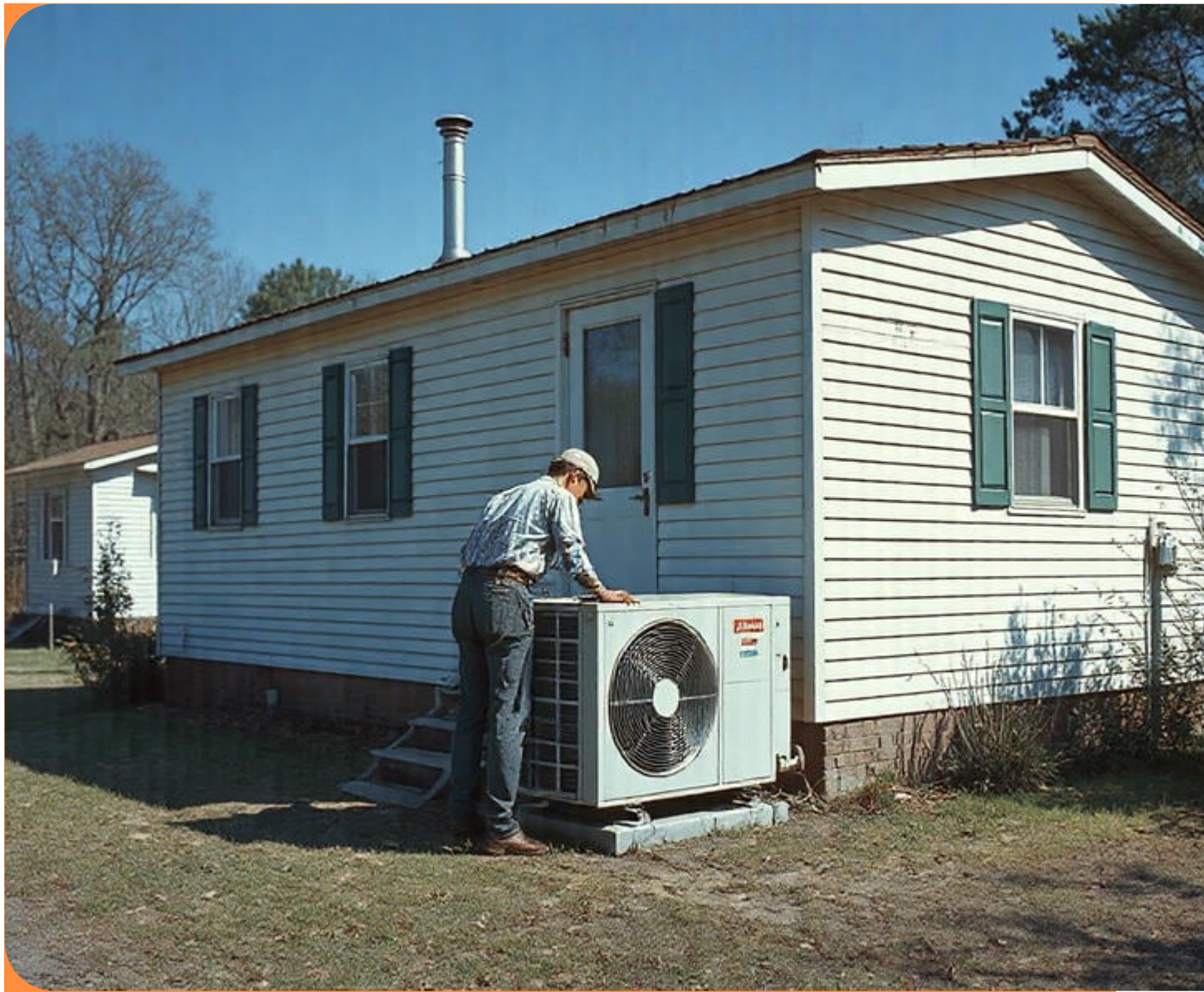
Once the right size is determined, the installation process must focus on strategic placement. Goodman units need adequate clearance around them for proper airflow; blocking this space can hinder performance and lead to overheating or mechanical failure. Additionally, ensuring that ductwork is properly sealed can prevent air leaks which compromise the system's efficiency.

After successful installation, regular maintenance becomes key in sustaining optimal performance of Goodman units. One of the simplest yet most effective tips is routinely replacing air filters. Clogged filters restrict airflow, forcing the system to work harder than necessary and potentially leading to costly repairs down the line.

Furthermore, scheduling annual inspections with an HVAC professional can help identify potential issues before they become major problems. Technicians can check refrigerant levels, clean coils, inspect electrical connections, and ensure that all components function as intended.

Homeowners should also pay attention to any unusual noises or changes in system performance such as irregular cycling or uneven heating/cooling within different areas of the home. These could be early indicators of underlying issues needing prompt attention.

In summary, while selecting a Goodman unit sets a strong foundation for reliable climate control in mobile homes, maximizing its performance hinges on meticulous installation and proactive maintenance practices. By following these guidelines-choosing the right size unit, ensuring proper placement during installation, routinely replacing filters, conducting regular professional inspections-the longevity and efficiency of Goodman systems can be greatly enhanced, providing comfort year-round without unexpected disruptions or expenses.



# Personal Loans for HVAC Systems

When it comes to selecting climate control systems for mobile homes, Goodman units frequently emerge as a popular choice. This preference is not without reason; Goodman units are renowned for their energy efficiency and cost-effectiveness. These two factors are crucial when considering the unique needs of mobile homes, which often require a delicate balance between performance and affordability.

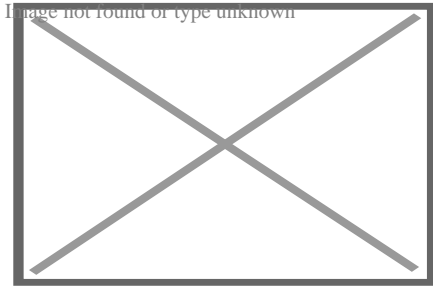
Energy efficiency is paramount in any heating or cooling system, but it holds particular significance in mobile homes. Mobile homes typically have less insulation compared to traditional houses, making them more susceptible to external temperature changes. Goodman units address this challenge by employing advanced technology that optimizes energy use while maintaining a comfortable indoor environment. They feature high Seasonal Energy Efficiency Ratios (SEER) for air conditioners and Heat Seasonal Performance Factors (HSPF) for heat pumps, ensuring that homeowners receive maximum climate control with minimal energy consumption.

The cost-effectiveness of Goodman units further enhances their appeal for mobile home owners. Purchasing and installing HVAC systems can represent a significant investment, particularly when budgets are tight. Goodman units stand out due to their competitive pricing and reliable performance over time. Their durability ensures that maintenance costs remain low, while the initial purchase price is often more affordable than comparable brands without sacrificing quality.

Moreover, many Goodman models come with comprehensive warranties that provide additional peace of mind for homeowners worried about potential repair costs down the line. This financial security allows mobile home residents to enjoy consistent climate control without fear of unexpected expenses disrupting their monthly budget.

In summation, the decision to select a Goodman unit for climate control in a mobile home setting is often driven by its superior energy efficiency and remarkable cost-effectiveness. By reducing energy consumption and minimizing long-term expenses, these units offer an ideal solution for achieving reliable comfort without breaking the bank. As such, they continue to be an intelligent choice for those seeking dependable HVAC solutions tailored to the distinct needs of mobile home living.

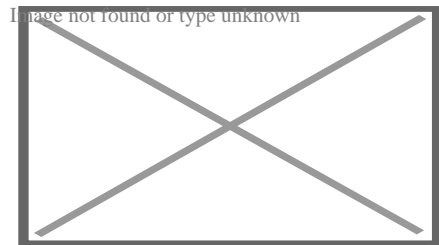
## **About Indoor air quality**



An air filter being cleaned

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Part of a series on



Air pollution from a factory



- Acid rain
- Air quality index
- Atmospheric dispersion modeling
- Chlorofluorocarbon
- Combustion
- Exhaust gas
- Haze
- Global dimming
- Global distillation
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- Firewater
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- Groundwater
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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,<sup>[1]</sup> 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.<sup>[2]</sup> In scenarios where outdoor pollution would deteriorate indoor air quality, other treatment devices such as filtration may also be necessary.<sup>[3]</sup>

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).<sup>[4]</sup>

Indoor air pollution is a major health hazard in developing countries and is commonly referred to as "household air pollution" in that context.<sup>[5]</sup> 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.<sup>[6]</sup> The Global Burden of Disease study estimated the number of deaths in 2017 at 1.6 million.<sup>[7]</sup>

## Definition

[edit]

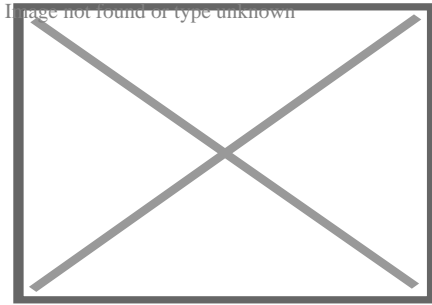
For health reasons it is crucial to breathe clean air, free from chemicals and toxicants as much as possible. It is estimated that humans spend approximately 90% of their lifetime indoors<sup>[8]</sup> and that indoor air pollution in some places can be much worse than that of the ambient air.<sup>[9]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

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.<sup>[citation needed]</sup> 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.<sup>[11][12]</sup>

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.<sup>[13]</sup>

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.<sup>[14][15][16][17][18][19]</sup>

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

## 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.<sup>[21]</sup> Around 3 billion people cook over open fires or on rudimentary cook stoves. Cooking fuels are coal, wood, animal dung, and crop residues.<sup>[22]</sup> IAQ is a particular concern in low and middle-income countries where such practices are common.<sup>[23]</sup>

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.<sup>[24]</sup><sup>[25]</sup>

## 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.[<sup>26</sup>] 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.[<sup>27</sup>] Appliance malfunction may be due to faulty installation or lack of maintenance and proper use.[<sup>26</sup>] In low- and middle-income countries the most common sources of CO in homes are burning biomass fuels and cigarette smoke.[<sup>27</sup>]

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.[<sup>28</sup>][<sup>26</sup>]

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

## **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%). [<sup>30</sup>]

Secondhand smoke contains more than 7000 chemicals, of which hundreds are harmful to health.[<sup>30</sup>] 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.[<sup>31</sup>] Inhaling secondhand smoke on multiple occasions can cause asthma, pneumonia, lung cancer, and sudden infant death syndrome, among other conditions.[<sup>32</sup>]

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.<sup>[33]</sup>

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

## Particulates

[edit]

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).<sup>[36]</sup> 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.<sup>[37]</sup> Preparing a Thanksgiving dinner can produce very high concentrations of particulate matter, exceeding 300  $\mu\text{g}/\text{m}^3$ .<sup>[38]</sup>

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.<sup>[39]</sup>

## 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.<sup>[40]</sup> 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.<sup>[41][42]</sup> VOCs presenting health hazards include benzene, formaldehyde, tetrachloroethylene and trichloroethylene.<sup>[43]</sup>

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.<sup>[44]</sup> 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.<sup>[45][46]</sup> Cooking can release long-chain aldehydes and alkanes when oil is heated and terpenes can be released when spices are prepared and/or cooked.<sup>[45]</sup> Leaks of natural gas from cooking appliances have been linked to elevated levels of VOCs including benzene in homes in the USA.<sup>[47]</sup> 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.<sup>[46]</sup>

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

Testing emissions from building materials used indoors has become increasingly common for floor coverings, paints, and many other important indoor building materials and finishes.<sup>[49]</sup> 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.<sup>[42]</sup> In both cases, these delayed emissions can result in chronic and low-level exposures to VOCs.<sup>[50]</sup>

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,<sup>[51]</sup> M1,<sup>[52]</sup> Blue Angel<sup>[53]</sup> and Indoor Air Comfort<sup>[54]</sup> in Europe, as well as California Standard CDPH Section 01350<sup>[55]</sup> 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<sup>[56][57]</sup> 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.<sup>[56]</sup>

## 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.<sup>[58]</sup>

## 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.<sup>[59][60][61][62]</sup> 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).<sup>[63]</sup> Airborne microplastic dust can be produced during renovation, building, bridge and road reconstruction projects<sup>[64]</sup> and the use of power tools.<sup>[65]</sup>

## Ozone

[edit]

See also: Ground-level ozone

Indoors ozone ( $O_3$ ) 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.<sup>[66]</sup> 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.<sup>[67]</sup>

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<sup>[46]</sup> as well as fine and ultrafine particles.<sup>[68]</sup> Ventilation with outdoor air containing elevated ozone concentrations may complicate remediation attempts.<sup>[69]</sup>

The WHO standard for ozone concentration is  $60 \mu\text{g}/\text{m}^3$  for long-term exposure and  $100 \mu\text{g}/\text{m}^3$  as the maximum average over an 8-hour period.<sup>[29]</sup> The EPA standard for ozone concentration is 0.07 ppm average over an 8-hour period.<sup>[70]</sup>

## 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.<sup>[71]</sup>

While mold growth is associated with high moisture levels,<sup>[72]</sup> 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.<sup>[73]</sup> 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.<sup>[74]</sup> 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%).<sup>[74][75]</sup>

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.<sup>[76]</sup> 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.<sup>[77]</sup>

Mold predominantly affects the airways and lungs. Known effects of mold on health include asthma development and exacerbation,<sup>[78]</sup> with children and elderly at greater risk of more severe health impacts.<sup>[79]</sup> Infants in homes with mold have a much greater risk of developing asthma and allergic rhinitis.<sup>[80][71]</sup> More than half of adult workers in moldy or humid buildings suffer from nasal or sinus symptoms due to mold exposure.<sup>[71]</sup> 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

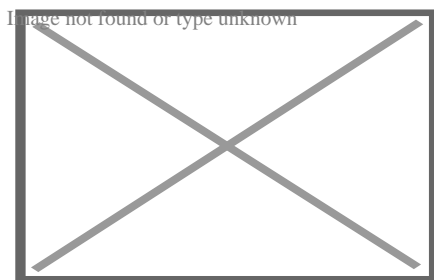
outdoor fountains at public attractions. The presence of *Legionella* in commercial building water supplies is highly under-reported, as healthy people require heavy exposure to acquire infection.

*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]



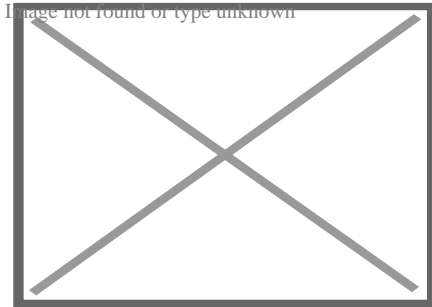
Airborne bacteria

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.<sup>[81]</sup>

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*.<sup>[citation needed]</sup>

## 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.<sup>[82][83]</sup> 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.<sup>[84]</sup>

## Carbon dioxide

[edit]

Humans are the main indoor source of carbon dioxide (CO<sub>2</sub>) in most buildings. Indoor CO<sub>2</sub> levels are an indicator of the adequacy of outdoor air ventilation relative to indoor occupant density and metabolic activity.

Indoor CO<sub>2</sub> levels above 500 ppm can lead to higher blood pressure and heart rate, and increased peripheral blood circulation.<sup>[85]</sup> With CO<sub>2</sub> 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.<sup>[86][87]</sup> However, evidence on the health effects of CO<sub>2</sub> at lower concentrations is conflicting and it is difficult to link CO<sub>2</sub> 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.<sup>[88]</sup>

Indoor carbon dioxide concentrations can be used to evaluate the quality of a room or a building's ventilation.<sup>[89]</sup> To eliminate most complaints caused by CO<sub>2</sub>, the total indoor CO<sub>2</sub> level should be reduced to a difference of no greater than 700 ppm above outdoor levels.<sup>[90]</sup> 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.<sup>[91]</sup> The UK standards for schools say that carbon dioxide levels of 800 ppm or lower indicate that the room is well-ventilated.<sup>[92]</sup> Regulations and standards from around the world show that CO<sub>2</sub> levels below 1000 ppm represent good IAQ, between 1000 and 1500 ppm represent moderate IAQ and greater than 1500 ppm represent poor IAQ.<sup>[88]</sup>

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.<sup>[93]</sup>

## 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.<sup>[94]</sup>

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.<sup>[95]</sup> 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.<sup>[96]</sup> They are usually cost effective and can greatly reduce or even eliminate the contamination and the associated health risks.<sup>[citation needed]</sup>

Radon is measured in picocuries per liter of air (pCi/L) or becquerel per cubic meter (Bq m<sup>-3</sup>). Both are measurements of radioactivity. The World Health Organization (WHO) sets the ideal indoor radon levels at 100 Bq/m<sup>-3</sup>.<sup>[97]</sup> 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.<sup>[98]</sup> In the United Kingdom the ideal is presence of radon indoors is 100 Bq/m<sup>-3</sup>. Action needs to be taken in homes with 200 Bq/m<sup>-3</sup> or more.<sup>[99]</sup>

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

## 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.<sup>[103]</sup> 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.<sup>[104][105]</sup> Numerous predictions for how indoor air pollutants will change have been made,<sup>[106][107][108][109]</sup> 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.<sup>[110]</sup>

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.<sup>[111][112]</sup>

## 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,<sup>[29]</sup> as well as the WHO IAQ guidelines for selected compounds,<sup>[113]</sup> whereas the UK Health Security Agency published IAQ guidelines for selected VOCs.<sup>[114]</sup> 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.<sup>[115]</sup> 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.<sup>[116]</sup><sup>[117]</sup>

## 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).<sup>[118]</sup> 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.<sup>[119]</sup>

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.<sup>[120]</sup>

### 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.<sup>[121]</sup>

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.<sup>[122]</sup>

## Source control

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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.<sup>[citation needed]</sup>

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.<sup>[citation needed]</sup>

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<sup>[123]</sup> (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.<sup>[citation needed]</sup>

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.<sup>[122]</sup> Air filters are used to reduce the amount of dust that reaches the wet coils.<sup>[citation needed]</sup> Dust can serve as food to grow molds on the wet coils and ducts and can reduce the efficiency of the coils.<sup>[citation needed]</sup>

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.<sup>[124]</sup>

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.<sup>[citation needed]</sup> 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.<sup>[citation needed]</sup>

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.<sup>[citation needed]</sup> Some facilities are being designed using desiccant wheels with gas-fired heaters to dry out the wheel enough to get the required dew

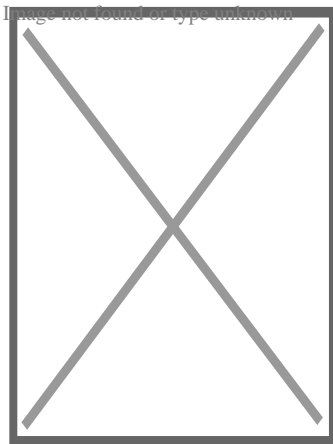
points.<sup>[citation needed]</sup> On those systems, after the moisture is removed from the make-up air, a cooling coil is used to lower the temperature to the desired level.<sup>[citation needed]</sup>

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 CO<sub>2</sub> 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

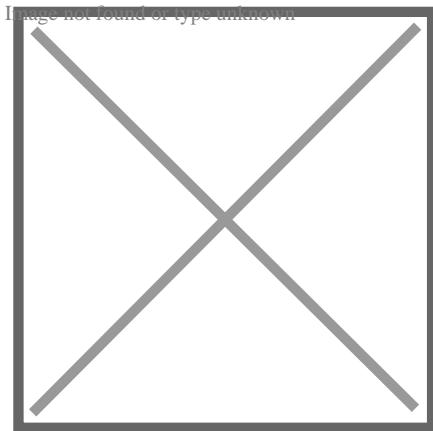
suffered from poor replication<sup>[125]</sup> and are not applicable to typical buildings, where outdoor-to-indoor air exchange already removes VOCs at a rate that could only be matched by the placement of 10–1000 plants/m<sup>2</sup> of a building's floor space.<sup>[126]</sup>

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

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.<sup>[129]</sup>

## 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.<sup>[130]</sup>

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.<sup>[131]</sup>

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.<sup>[132]</sup>

## 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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## 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 hazard
- Genetic pollution
- Introduced species
  - Invasive species
- Information pollution
- Light
  - Ecological light pollution
  - Overillumination
- Radio spectrum pollution

## Biological

## Digital

## Electromagnetic

## Natural

- Ozone
- Radium and radon in the environment
- Volcanic ash
- Wildfire
- Transportation
  - Land
  - Water
  - Air
  - Rail
  - Sustainable transport

## Noise

- Urban
- Sonar
  - Marine mammals and sonar
- Industrial
- Military
- Abstract
- Noise control
- Actinides
- Bioremediation
- Nuclear fission
- Nuclear fallout

## Radiation

- 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

## Visual

- Satellite
- Air travel
- Clutter (advertising)
- Traffic signs
- Overhead power lines
- Vandalism





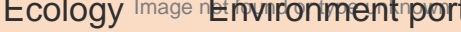

## War

- Chemical warfare
- Herbicidal warfare (Agent Orange)
- Nuclear holocaust (Nuclear fallout - nuclear famine - nuclear winter)
- Scorched earth
- Unexploded ordnance
- War and environmental law
- Agricultural wastewater
- Biological pollution
- Diseases
- Eutrophication
- Firewater
- Freshwater
- Groundwater
- Hypoxia
- Industrial wastewater
- Marine

## Water

- 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
- Pollutants
  - Heavy metals
  - Paint
- Brain health and pollution

## Topics

|  |   |   |
|--|---|---|
| <b>Misc</b>  | <ul style="list-style-type: none"> <li>○ Area source</li> <li>○ Debris</li> <li>○ Dust</li> <li>○ Garbology</li> <li>○ Legacy pollution</li> <li>○ Midden</li> <li>○ Point source</li> <li>○ Waste</li> </ul> |   |
|  | <b>Responses</b>  | <ul style="list-style-type: none"> <li>○ Cleaner production</li> <li>○ Industrial ecology</li> <li>○ Pollution haven hypothesis</li> <li>○ Pollutant release and transfer register</li> <li>○ Polluter pays principle</li> <li>○ Pollution control</li> <li>○ Waste minimisation</li> <li>○ Zero waste</li> </ul> |
|  | <b>Lists</b>  | <ul style="list-style-type: none"> <li>○ Diseases</li> <li>○ Law by country</li> <li>○ Most polluted cities</li> <li>○ Least polluted cities by PM<sub>2.5</sub></li> <li>○ Most polluted countries</li> <li>○ Most polluted rivers</li> <li>○ Treaties</li> </ul>  |
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Natural resources

|            |                     |  |
|------------|---------------------|--|
| <b>Air</b> | Pollution / quality | <ul style="list-style-type: none"> <li>○ Ambient standards (US)</li> <li>○ Index</li> <li>○ Indoor</li> <li>○ Law <ul style="list-style-type: none"> <li>○ Clean Air Act (US)</li> </ul> </li> <li>○ Ozone depletion</li> <li>○ Airshed</li> </ul> |
|            | Emissions           | <ul style="list-style-type: none"> <li>○ Trading</li> <li>○ Deforestation (REDD)</li> </ul>  |



## **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

## **Life**

- 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

## 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
- Watershed
- Desalination
- Floods
- Law
- Leaching
- Sanitation
  - improved
- Scarcity
- Security
- Supply
- Efficiency
- Conflict
- Conservation
- Peak water
- Pollution
- Privatization
- Quality
- Right
- Resources
  - improved
  - policy

### Aspects

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

**Related**

-  **Category** image not found or type unknown

- v
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Occupational safety and health

**Occupational  
diseases  
and injuries**

- 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
- Radium jaw
- Repetitive strain injury
- Silicosis
- Silo-filler's disease
- Sports injury
- Surfer's ear
- Tennis elbow
- Tinnitus
- Writer's cramp

- 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
- International**
  - European Agency for Safety and Health at Work
  - International Labour Organization
  - World Health Organization
  - Canadian Centre for Occupational Health and Safety (Canada)
  - Istituto nazionale per l'assicurazione contro gli infortuni sul lavoro (Italy)
- Agencies and organizations**
  - National**
    - National Institute for Safety and Health at Work (Spain)
    - Health and Safety Executive (UK)
    - Occupational Safety and Health Administration
    - National Institute for Occupational Safety and Health (US)
- Standards**
  - Bangladesh Accord
  - OHSAS 18001
  - ISO 45001
  - Occupational Safety and Health Convention, 1981
  - Worker Protection Standard (US)
  - Working Environment Convention, 1977

## **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
- 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

**See also**

-  **Category** image not found or type unknown

- Occupational diseases
- Journals
- Organizations

-  **Commons** image not found or type unknown

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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

## **Technology**

- 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
- Passive house
- Passive ventilation
- Radiant heating and cooling
- Radiant cooling
- Radiant heating
- Radon mitigation
- Refrigeration
- Renewable heat
- Room air distribution
- Solar air heat
- Solar combisystem
- Solar cooling
- Solar heating

- 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
- Fire damper
- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
- Gas compressor
- Gas heater
- Gasoline heater
- Grease duct
- Grille

**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
- 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

**Professions,  
trades,  
and services**

**Industry organizations**

- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC

**Health and safety**

- Indoor air quality (IAQ)
- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)
- ASHRAE Handbook
- Building science
- Fireproofing

**See also**

- 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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**Photo**

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## Photo

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## Things To Do in Tulsa County

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### Photo

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### Gathering Place

4.8 (12116)

### Photo

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### Golden Driller Statue

4.6 (1935)

### Photo

## **Bob Dylan Center**

**4.9 (245)**

### **Photo**

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## **The Blue Dome**

**4.5 (60)**

### **Photo**

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## **Tulsa Air and Space Museum & Planetarium**

**4.3 (419)**

### **Photo**



**The Tulsa Arts District**

**4.7 (22)**

## **Driving Directions in Tulsa County**

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**Driving Directions From Tulsa VA Behavioral Medicine Clinic to Durham Supply Inc**

**Driving Directions From Catoosa to Durham Supply Inc**

**Driving Directions From Country Inn & Suites by Radisson, Tulsa, OK to Durham Supply Inc**

**Driving Directions From Reception Jehovah's Witnesses to Durham Supply Inc**

**Driving Directions From East Central High School to Durham Supply Inc**

**Furnace store**

**Heating contractor**

**HVAC contractor**

**Driving Directions From The Cave House to Durham Supply Inc**

**Driving Directions From Gathering Place to Durham Supply Inc**

**Driving Directions From Golden Driller Statue to Durham Supply Inc**

**Driving Directions From Bob Dylan Center to Durham Supply Inc**

**Driving Directions From Philbrook Museum of Art to Durham Supply Inc**

**Driving Directions From Philbrook Museum of Art to Durham Supply Inc**

**Mobile home supply store**

**Air conditioning repair service**

**Air conditioning store**

**Air conditioning system supplier**

**Reviews for Durham Supply Inc**

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### **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.

Selecting Goodman Units for Reliable Mobile Home Climate Control [View GBP](#)

Check our other pages :

- [Evaluating Carrier Options for Mobile Home Air Conditioning](#)
- [Exploring Major Brands for Mobile Home Furnace Installations](#)
- [Verifying Rheem Specifications in Mobile Home HVAC Retrofits](#)
- [Maintaining Uniform Performance with Mixed Brand Components](#)

Royal Supply Inc

Phone : +16362969959

City : Oklahoma City

State : OK

Zip : 73149

Address : Unknown Address

### Google Business Profile

Company Website : <https://royal-durhamsupply.com/locations/oklahoma-city-oklahoma/>

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