- **Estimating Labor Expenses for Repair Services**
  Estimating Labor Expenses for Repair Services Comparing Replacement Part Prices for Various Systems Reviewing Maintenance Plan Rates in Detail Exploring Payment Arrangements for Major Overhauls Analyzing Long Term Savings with Efficient Upgrades Investigating Seasonal Discounts from Service Providers Understanding Monthly Budgeting for HVAC Projects Balancing Initial Spending with Potential Savings Evaluating Total Costs for System Retrofits Preparing for Unexpected Repair Fees Weighing Return on Investment for Modern Equipment Identifying Hidden Expenses in Older Units
- **Understanding Local Building Code Requirements**
  Understanding Local Building Code Requirements Reviewing State Regulations for HVAC Installation Exploring County Permit Applications for Mobile Homes Navigating EPA 608 Certification Steps Recognizing UL Rated Components for Safety Determining Required Inspections for New Units Preparing Official Documents for System Upgrades Knowing When to Seek Professional Licensing Support Identifying Legal Mandates for Refrigerant Disposal Sorting Out Utility Guidelines for Meter Upgrades Meeting Deadlines for Permit Renewals Locating Reliable Compliance Resources for Homeowners
- **About Us**

The importance of proper licensing for HVAC professionals cannot be overstated. In a field that demands precision, safety, and technical expertise, obtaining the appropriate licenses is not merely a regulatory requirement but a testament to one's commitment to maintaining industry standards and ensuring public safety. However, navigating the complexities of professional licensing can often seem daunting. Proper airflow improves the overall comfort of mobile home interiors **mobile home hvac** knowledge. Knowing when to seek professional licensing support can make a significant difference in achieving compliance and success in the HVAC industry.

Licensing acts as a safeguard for both professionals and consumers by ensuring that individuals who install, repair, or maintain heating, ventilation, and air conditioning systems possess the necessary knowledge and skills. The strict regulations governing HVAC work are designed to protect against potential hazards such as gas leaks or electrical fires. Therefore, securing proper licensure is not only about adhering to legal requirements but also about demonstrating competence and reliability.

For many aspiring HVAC technicians or seasoned professionals looking to expand their qualifications, understanding the nuances of state-specific licensing requirements can be overwhelming. Each jurisdiction may have varying criteria regarding education hours, work experience, examinations, and continuing education units needed for license renewal. This complexity underscores the need for professional support when navigating the licensing process.

Seeking out expert guidance can streamline this journey significantly. Licensing consultants or specialized services offer invaluable assistance by clarifying regulatory obligations and providing insights into best practices for application preparation. These experts help applicants understand timelines, gather necessary documentation efficiently, prepare for certification tests effectively, and avoid common pitfalls that could delay licensure.

Moreover, engaging with professional organizations within the HVAC industry offers additional benefits beyond mere compliance assistance. Such associations often provide resources like workshops or seminars focused on up-to-date industry trends-knowledge that becomes crucial when preparing for exams or fulfilling continuing education requirements post-licensure.

In conclusion, while acquiring an HVAC license might initially appear as just another bureaucratic hurdle; its significance extends far beyond paperwork-it is an affirmation of quality assurance in every project undertaken by licensed professionals across diverse settings from residential homes to commercial complexes alike. Recognizing when it's time to seek professional support ensures not only seamless navigation through intricate processes but also empowers aspirants towards long-term career growth within this vital trade sector where skillful practice meets essential service delivery daily-a responsibility requiring utmost diligence underscored by robust licensure frameworks worldwide today more than ever before!

Factors Influencing Labor Costs in Mobile Home HVAC Repairs —

Mobile home HVAC systems present a unique set of challenges for technicians, and one of the most significant hurdles they face is knowing when to seek professional licensing support. While the fundamental principles of heating, ventilation, and air conditioning remain consistent across different types of dwellings, mobile homes often come with specific constraints and requirements that can complicate matters. As these professionals navigate their daily tasks, understanding when to call in reinforcements in the form of professional licensing support becomes crucial not only for compliance but also for ensuring safety and efficiency.

One primary challenge is the structural differences between traditional homes and mobile homes. Mobile homes have limited space and unique construction methods which can affect how HVAC systems are installed and maintained. Technicians may find themselves confronted with non-standard configurations or outdated equipment that does not meet current codes or standards. In such cases, relying solely on experience or intuition might lead to oversights that could result in inefficient system performance or even safety hazards like gas leaks or electrical issues.

The ever-evolving landscape of regulations also poses a significant challenge. HVAC technicians must stay updated on local codes, environmental laws, and energy efficiency mandates that govern mobile home installations. These regulations can change frequently, and failure to comply can result in hefty fines or penalties. Thus, recognizing when a project exceeds their knowledge base or involves complex legal stipulations is essential for technicians. Seeking professional licensing support ensures that all work adheres to current standards, helping avoid legal troubles and enhancing trust with clients.

Another factor compelling technicians to seek licensing support is the increased complexity of modern HVAC systems. With advancements in technology leading to more sophisticated equipment-such as smart thermostats, variable speed compressors, and advanced filtration systems-technicians need specialized training and certification to handle these innovations properly. Without proper credentials, attempting repairs or installations can lead to improper handling that diminishes system longevity or voids warranties.

Furthermore, obtaining professional licensing support boosts a technician's credibility and marketability. Clients are more likely to trust professionals who demonstrate their commitment to excellence by acquiring appropriate licenses and certifications. This not only builds a strong reputation but also opens doors to greater job opportunities and higher earning potential.

In conclusion, while technicians working on mobile home HVAC systems encounter various challenges stemming from structural differences, regulatory complexities, technological advancements, and client expectations-knowing when to seek professional licensing support remains pivotal. By doing so, they ensure compliance with regulations while maintaining high standards of safety and efficiency. Additionally, it enhances their career prospects by establishing credibility within the industry-a win-win situation for both technicians and their clients alike.

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Steps to Accurately Estimate Labor Expenses for HVAC Repair Services

In the complex world of professional careers, licensing often serves as a crucial gateway to practice and recognition. However, navigating the intricate pathways of obtaining and maintaining a license can be daunting for many. Recognizing when to seek professional licensing support is an essential skill that can save time, reduce stress, and increase your chances of success in securing necessary credentials.

Firstly, one significant indicator that you might need professional licensing support is unfamiliarity with the licensing process. Each profession has its unique set of requirements and regulations, which can vary widely depending on the jurisdiction. For instance, medical professionals may face different hurdles compared to architects or lawyers. If you find yourself overwhelmed by legal jargon or unsure about the steps involved in your specific licensing process, it's a clear sign that expert guidance could be beneficial.

Another critical indicator is encountering repeated setbacks or rejections in your application process. Often, these setbacks occur due to minor errors or omissions that could have been avoided with professional assistance. Licensing experts are well-versed in common pitfalls and can provide invaluable advice on how to present applications accurately and comprehensively.

Time constraints also play a significant role in determining whether professional help is needed. Many professionals juggle demanding jobs while trying to advance their careers through additional certifications or licenses. In such cases, outsourcing some of the workload to specialists can ensure that all deadlines are met without compromising current responsibilities.

Furthermore, changes in regulations or updates in industry standards can signal the need for professional intervention. Licensing requirements are not static; they evolve over time due to new laws or technological advancements. Staying up-to-date with these changes can be challenging for someone outside the regulatory sphere. Professionals who specialize in licensing are often more adept at tracking these shifts and advising accordingly.

Lastly, language barriers or lack of confidence in self-navigation through bureaucratic processes may also prompt individuals to seek support. For non-native speakers especially, understanding complex legal documents can be particularly challenging. In such scenarios, having someone knowledgeable interpret and guide you through the process can make all the difference.

In conclusion, recognizing when to seek professional licensing support involves assessing your familiarity with procedures, evaluating previous application experiences, considering time constraints, monitoring regulatory changes, and acknowledging any personal limitations such as language barriers. By identifying these indicators early on and seeking appropriate assistance when needed, you position yourself for smoother navigation through the labyrinthine world of professional licensing-ultimately paving a more confident path toward achieving your career goals.

Tools and Software for Estimating Labor Costs in Mobile Home HVAC Repairs

In the increasingly complex landscape of professional licensing, navigating the path to obtaining or maintaining a license can be daunting. Whether you are an aspiring healthcare provider, engineer, educator, or any professional subject to regulatory requirements, understanding when to seek professional licensing assistance is crucial for ensuring both compliance and success in your career.

One of the most compelling benefits of seeking professional licensing assistance is the expertise and knowledge these services provide. Professional licensing consultants are well-versed in the intricacies of various regulatory environments. They possess a deep understanding of the specific requirements necessary for licensure in different fields and jurisdictions. This expertise can help you avoid common pitfalls and ensure that all aspects of your application meet stringent standards. By leveraging their knowledge, you save time and reduce stress, as they guide you through each step with precision and clarity.

Moreover, professional licensing assistance offers invaluable support during times when regulations change or evolve. Regulatory bodies frequently update their criteria, which can leave professionals scrambling to understand new requirements. Licensing experts stay abreast of these changes and can efficiently inform you about what adjustments need to be made on your part. This proactive approach minimizes disruptions in your practice or career progression by ensuring continuous compliance with current standards.

Another significant benefit lies in the personalized guidance that these professionals offer. Every applicant's situation is unique; therefore, standardized advice might not adequately address individual needs. Licensing consultants take into account your personal circumstances-such as educational background, work experience, and any past discrepancies-and tailor their support accordingly. This individualized attention helps to streamline the process and enhances your likelihood of a successful outcome.

Furthermore, engaging with professional licensing assistance can expedite the entire process significantly. Licensing applications often involve extensive paperwork and numerous steps that can become overwhelming without expert navigation. Consultants know how to efficiently manage timelines and prioritize tasks so that deadlines are met without compromising quality. Their involvement often leads to quicker approvals because applications are complete and accurate upon submission.

Finally, seeking professional licensing assistance provides peace of mind-a benefit that cannot be overstated in high-stakes professions where errors might lead to severe consequences such as legal issues or loss of livelihood. Knowing that experienced professionals are handling your licensure concerns allows you to focus on developing skills within your field rather than worrying about bureaucratic hurdles.

In conclusion, knowing when to seek professional licensing support is pivotal for any individual pursuing a regulated profession. The benefits-ranging from expert knowledge and regulatory insight to personalized guidance and expedited processes-underscore why investing in such services is wise. Ultimately, this support not only facilitates a smoother journey towards licensure but also empowers professionals with confidence as they advance their careers securely within their chosen fields.

Case Studies: Examples of Labor Cost Estimation in Various Repair Scenarios

Operating without proper licensing is akin to navigating a ship through treacherous waters without a map or compass. It's risky, fraught with potential pitfalls, and can lead to dire consequences that not only jeopardize the business's success but also its very existence. The importance of understanding when to seek professional licensing support cannot be overstated, as it serves as a safeguard against numerous threats that could arise from non-compliance.

One of the most immediate risks of operating without the necessary licensure is legal action. Regulatory bodies are established to ensure that businesses adhere to specific standards and practices designed to protect consumers and maintain fair competition within industries. Operating without proper licenses can result in hefty fines, legal penalties, and even the forced closure of a business. This kind of disruption can be catastrophic, especially for small businesses or startups that may not have the resources to recover from such setbacks.

Moreover, failing to secure proper licensing undermines consumer trust. In an era where reputation is everything, customers expect businesses to adhere to all regulatory requirements as an assurance of quality and safety. A business that operates outside these parameters may find its reputation tarnished quickly if word spreads about its lack of compliance. This loss of trust can be damaging beyond repair, affecting customer retention and diminishing brand loyalty.

Financial instability is another significant risk associated with improper licensing. Beyond potential fines and legal fees, businesses might face increased insurance costs or find themselves unable to obtain necessary coverage altogether if they are deemed high-risk due to non-compliance issues. Investors are also likely to shy away from enterprises that do not demonstrate adherence to industry regulations; thus, securing funding becomes an uphill battle.

Additionally, employees working for unlicensed operations are put in precarious positions. They may face job insecurity if their place of employment suddenly needs to cease operations due to regulatory crackdowns. Furthermore, there could be personal liability issues if they unknowingly contribute to unlawful business activities under the guise of legitimate operation.

Given these substantial risks, knowing when and how to seek professional licensing support becomes crucial for any business owner or entrepreneur. Professional advisors bring valuable expertise in navigating complex regulatory landscapes efficiently and effectively. They provide guidance on what licenses are necessary for specific industries and jurisdictions while offering insights into maintaining compliance as laws evolve over time.

In conclusion, operating without proper licensing is a gamble no prudent business should take lightly. The potential risks-legal repercussions, loss of customer trust, financial instability, employee vulnerability-are too severe not to consider seeking expert guidance when needed. By ensuring compliance through professional licensing support, businesses can focus on growth and innovation rather than worrying about avoidable setbacks stemming from regulatory negligence.

Tips for Managing and Reducing Labor Expenses Without Compromising Quality

Navigating the intricate world of professional licensing can often feel like traversing a labyrinth without a map. Whether you are an individual seeking to obtain a professional license or a business aiming to ensure compliance with myriad regulatory requirements, knowing when to seek licensing support services can be crucial. This decision-making process necessitates an understanding of your own limitations, the complexity of the licensure involved, and the potential consequences of missteps.

Firstly, recognizing when you might need professional licensing support often requires an honest assessment of your capabilities and resources. For individuals or small businesses without dedicated legal or regulatory expertise, the task of interpreting and complying with licensing requirements can be daunting. Regulatory language is often dense and complex, making it easy for non-experts to misunderstand requirements or overlook critical details. If you find yourself confused by terminology or uncertain about procedural steps, it might be time to seek expert assistance.

Moreover, the complexity of the specific license in question plays a significant role in determining the necessity for professional help. Some licenses are relatively straightforward; they require basic information and adherence to simple guidelines. Others, however, involve multiple layers of regulations across different jurisdictions-each with its own set of rules and standards. Industries such as healthcare, engineering, finance, and real estate often have intricate licensing mechanisms that mandate specialized knowledge and experience to navigate effectively. In these cases, enlisting professional support not only saves time but also reduces errors that could lead to costly delays or penalties.

Another factor prompting the engagement of licensing support services is understanding the stakes involved in obtaining or maintaining a license. Licenses are not merely bureaucratic hurdles; they are essential credentials that enable professionals and businesses to operate legally within their fields. Failure to secure appropriate licensing can result in severe repercussions such as fines, legal action, or even cessation of business operations. Therefore, if acquiring a particular license is critical for your career progression or business continuity, investing in expert advice is prudent risk management.

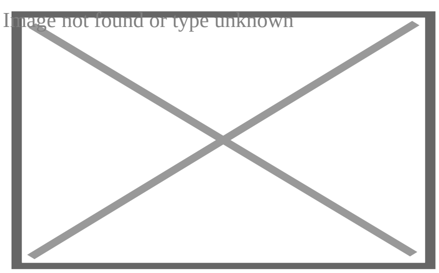
Choosing the right licensing support service involves careful consideration as well. It's essential to select consultants who possess relevant experience within your industry and demonstrate up-to-date knowledge about current regulations. Recommendations from peers in your field can be invaluable; they provide insights into which firms have proven track records for reliability and success.

Additionally, assessing customer service quality is crucial-responsive communication indicates that a firm values its clients' needs and respects their timelines. Finally, transparency regarding fees ensures that there will be no unpleasant surprises later on.

In conclusion, knowing when to seek professional licensing support hinges on evaluating both internal competencies and external complexities associated with specific licenses. The stakes involved demand careful consideration; thus selecting proficient partners becomes imperative for ensuring compliance while minimizing risks associated with licensure processes. By acknowledging these factors early on-before problems arise-you pave the way for smoother transitions through otherwise challenging regulatory landscapes.

About Thermal comfort

This article is about comfort zones in building construction. For other uses, see Comfort zone (disambiguation).



A thermal image of human

Thermal comfort is the condition of mind that expresses subjective satisfaction with the thermal environment.[1] The human body can be viewed as a heat engine where food is the input energy. The human body will release excess heat into the environment, so the body can continue to operate. The heat transfer is proportional to temperature difference. In cold environments, the body loses more heat to the environment and in hot environments the body does not release enough heat. Both the hot and cold scenarios lead to discomfort.[2] Maintaining this standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC (heating, ventilation, and air conditioning) design engineers.

Thermal neutrality is maintained when the heat generated by human metabolism is allowed to dissipate, thus maintaining thermal equilibrium with the surroundings. The main factors that influence thermal neutrality are those that determine heat gain and loss, namely metabolic rate, clothing insulation, air temperature, mean radiant temperature, air speed and relative humidity. Psychological parameters, such as individual expectations, and physiological parameters also affect thermal neutrality.[3] Neutral temperature is the temperature that can lead to thermal neutrality and it may vary greatly between individuals and depending on factors such as activity level, clothing, and humidity. People are highly sensitive to even small differences in environmental temperature. At 24 °C, a difference of 0.38 °C can be detected between the temperature of two rooms.[4]

The Predicted Mean Vote (PMV) model stands among the most recognized thermal comfort models. It was developed using principles of heat balance and experimental data collected in a controlled climate chamber under steady state conditions.[5] The adaptive model, on the other hand, was developed based on hundreds of field studies with the idea that occupants dynamically interact with their environment. Occupants control their thermal environment by means of clothing, operable windows, fans, personal heaters, and sun shades.[3][6] The PMV model can be applied to air-conditioned buildings, while the adaptive model can be applied only to buildings where no mechanical systems have been installed.[1] There is no consensus about which comfort model should be applied for buildings that are partially air-conditioned spatially or temporally.

Thermal comfort calculations in accordance with the ANSI/ASHRAE Standard 55,[1] the ISO 7730 Standard[7] and the EN 16798-1 Standard[8] can be freely performed with either the CBE Thermal Comfort Tool for ASHRAE 55,[9] with the Python package pythermalcomfort[10] or with the R package comf.

Significance

[edit]

Satisfaction with the thermal environment is important because thermal conditions are potentially life-threatening for humans if the core body temperature reaches conditions of hyperthermia, above 37.5–38.3 °C (99.5–100.9 °F),[11][12] or hypothermia, below 35.0 °C (95.0 °F).[13] Buildings modify the conditions of the external environment and reduce the effort that the human body needs to do in order to stay stable at a normal human body temperature, important for the correct functioning of human physiological processes.

The Roman writer Vitruvius actually linked this purpose to the birth of architecture.[14] David Linden also suggests that the reason why we associate tropical beaches with paradise is because in those environments is where human bodies need to do less metabolic effort to maintain their core temperature.[15] Temperature not only supports human life; coolness and warmth have also become in different cultures a symbol of protection, community and even the sacred.[16]

In building science studies, thermal comfort has been related to productivity and health. Office workers who are satisfied with their thermal environment are more productive.[17][18] The combination of high temperature and high relative humidity reduces thermal comfort and indoor air quality.[19]

Although a single static temperature can be comfortable, people are attracted by thermal changes, such as campfires and cool pools. Thermal pleasure is caused by varying thermal sensations from a state of unpleasantness to a state of pleasantness, and the scientific term for it is positive thermal alliesthesia.[20] From a state of thermal neutrality or comfort any change will be perceived as unpleasant.[21] This challenges the assumption that mechanically controlled buildings should deliver uniform temperatures and comfort, if it is at the cost of excluding thermal pleasure.[22]

Influencing factors

[edit]

Since there are large variations from person to person in terms of physiological and psychological satisfaction, it is hard to find an optimal temperature for everyone in a given space. Laboratory and field data have been collected to define conditions that will be found comfortable for a specified percentage of occupants.[1]

There are numerous factors that directly affect thermal comfort that can be grouped in two categories:

1. **Personal factors** – characteristics of the occupants such as metabolic rate and clothing level
2. **Environmental factors** – which are conditions of the thermal environment, specifically air temperature, mean radiant temperature, air speed and humidity

Even if all these factors may vary with time, standards usually refer to a steady state to study thermal comfort, just allowing limited temperature variations.

Personal factors

[edit]

Metabolic rate

[edit]
Main article: Metabolic rate

People have different metabolic rates that can fluctuate due to activity level and environmental conditions.[23][24][25] ASHRAE 55-2017 defines metabolic rate as the

rate of transformation of chemical energy into heat and mechanical work by metabolic activities of an individual, per unit of skin surface area.[1]
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Metabolic rate is expressed in units of met, equal to 58.2 W/m² (18.4 Btu/h·ft²). One met is equal to the energy produced per unit surface area of an average person seated at rest.

ASHRAE 55 provides a table of metabolic rates for a variety of activities. Some common values are 0.7 met for sleeping, 1.0 met for a seated and quiet position, 1.2–1.4 met for light activities standing, 2.0 met or more for activities that involve movement, walking, lifting heavy loads or operating machinery. For intermittent activity, the standard states that it is permissible to use a time-weighted average metabolic rate if individuals are performing activities that vary over a period of one hour or less. For longer periods, different metabolic rates must be considered.[1]

According to ASHRAE Handbook of Fundamentals, estimating metabolic rates is complex, and for levels above 2 or 3 met – especially if there are various ways of performing such activities – the accuracy is low. Therefore, the standard is not applicable for activities with an average level higher than 2 met. Met values can also be determined more accurately than the tabulated ones, using an empirical equation that takes into account the rate of respiratory oxygen consumption and carbon dioxide production. Another physiological yet less accurate method is related to the heart rate, since there is a relationship between the latter and oxygen consumption.[26]

The Compendium of Physical Activities is used by physicians to record physical activities. It has a different definition of met that is the ratio of the metabolic rate of the activity in question to a resting metabolic rate.[27] As the formulation of the concept is different from the one that ASHRAE uses, these met values cannot be used directly in PMV calculations, but it opens up a new way of quantifying physical activities.

Food and drink habits may have an influence on metabolic rates, which indirectly influences thermal preferences. These effects may change depending on food and drink intake.[28]

Body shape is another factor that affects metabolic rate and hence thermal comfort. Heat dissipation depends on body surface area. The surface area of an average person is 1.8 m^2 (19 ft^2).[1] A tall and skinny person has a larger surface-to-volume ratio, can dissipate heat more easily, and can tolerate higher temperatures more than a person with a rounded body shape.[28]

Clothing insulation

[edit]
Main article: Clothing insulation

The amount of thermal insulation worn by a person has a substantial impact on thermal comfort, because it influences the heat loss and consequently the thermal balance. Layers of insulating clothing prevent heat loss and can either help keep a person warm or lead to overheating. Generally, the thicker the garment is, the greater insulating ability it has. Depending on the type of material the clothing is made out of, air movement and relative humidity can decrease the insulating ability of the material.[29][30]

1 clo is equal to 0.155 m^2·K/W (0.88 °F·ft^2·h/Btu). This corresponds to trousers, a long sleeved shirt, and a jacket. Clothing insulation values for other common ensembles or single garments can be found in ASHRAE 55.[1]

Skin wetness

[edit]

Skin wetness is defined as "the proportion of the total skin surface area of the body covered with sweat".[31] The wetness of skin in different areas also affects perceived thermal comfort. Humidity can increase wetness in different areas of the body, leading to a perception of discomfort. This is usually localized in different parts of the body, and local thermal comfort limits for skin wetness differ by locations of the body.[32] The extremities are much more sensitive to thermal discomfort from wetness than the trunk of the body. Although local thermal discomfort can be caused by wetness, the thermal comfort of the whole body will not be affected by the wetness of certain parts.

Environmental factors

[edit]

Air temperature

[edit]
Main article: Dry-bulb temperature

The air temperature is the average temperature of the air surrounding the occupant, with respect to location and time. According to ASHRAE 55 standard, the spatial average takes into account the ankle, waist and head levels, which vary for seated or standing occupants. The temporal average is based on three-minutes intervals with at least 18 equally spaced points in time. Air temperature is measured with a dry-bulb thermometer and for this reason it is also known as dry-bulb temperature.

Mean radiant temperature

[edit]
Main article: Mean radiant temperature

The radiant temperature is related to the amount of radiant heat transferred from a surface, and it depends on the material's ability to absorb or emit heat, or its emissivity. The mean radiant temperature depends on the temperatures and emissivities of the surrounding surfaces as well as the view factor, or the amount of the surface that is “seen” by the object. So the mean radiant temperature experienced by a person in a room with the sunlight streaming in varies based on how much of their body is in the sun.

Air speed

[edit]

Air speed is defined as the rate of air movement at a point, without regard to direction. According to ANSI/ASHRAE Standard 55, it is the average speed of the air surrounding a representative occupant, with respect to location and time. The spatial average is for three heights as defined for average air temperature. For an occupant moving in a space the sensors shall follow the movements of the occupant. The air speed is averaged over an interval not less than one and not greater than three minutes. Variations that occur over a period greater than three minutes shall be treated as multiple different air speeds.[33]

Relative humidity

[edit]
Main article: Relative humidity

Relative humidity (RH) is the ratio of the amount of water vapor in the air to the amount of water vapor that the air could hold at the specific temperature and pressure. While the human body has thermoreceptors in the skin that enable perception of temperature, relative humidity is detected indirectly. Sweating is an effective heat loss mechanism that relies on evaporation from the skin. However at high RH, the air has close to the maximum water vapor that it can hold, so evaporation, and therefore heat loss, is decreased. On the other hand, very dry environments (RH < 20–30%) are also uncomfortable because of their effect on the mucous membranes. The recommended level of indoor humidity is in the range of 30–60% in air conditioned buildings,[34][35] but new standards such as the adaptive model allow lower and higher humidity, depending on the other factors involved in thermal comfort.

Recently, the effects of low relative humidity and high air velocity were tested on humans after bathing. Researchers found that low relative humidity engendered thermal discomfort as well as the sensation of dryness and itching. It is recommended to keep relative humidity levels higher in a bathroom than other rooms in the house for optimal conditions.[36]

Various types of apparent temperature have been developed to combine air temperature and air humidity. For higher temperatures, there are quantitative scales, such as the heat index. For lower temperatures, a related interplay was identified only qualitatively:

- High humidity and low temperatures cause the air to feel chilly.[37]
- Cold air with high relative humidity "feels" colder than dry air of the same temperature because high humidity in cold weather increases the conduction of heat from the body.[38]

There has been controversy over why damp cold air feels colder than dry cold air. Some believe it is because when the humidity is high, our skin and clothing become moist and are better conductors of heat, so there is more cooling by conduction.[39]

The influence of humidity can be exacerbated with the combined use of fans (forced convection cooling).[40]

Natural ventilation

[edit]
Main article: Natural ventilation

Many buildings use an HVAC unit to control their thermal environment. Other buildings are naturally ventilated (or would have cross ventilation) and do not rely on mechanical systems to provide thermal comfort. Depending on the climate, this can drastically reduce energy consumption. It is sometimes seen as a risk, though, since indoor temperatures can be too extreme if the building is poorly designed. Properly designed, naturally ventilated buildings keep indoor conditions within the range where opening windows and using fans in the summer, and wearing extra clothing in the winter, can keep people thermally comfortable.[41]

Models and indices

[edit]

There are several different models or indices that can be used to assess thermal comfort conditions indoors as described below.

PMV/PPD method

[edit]

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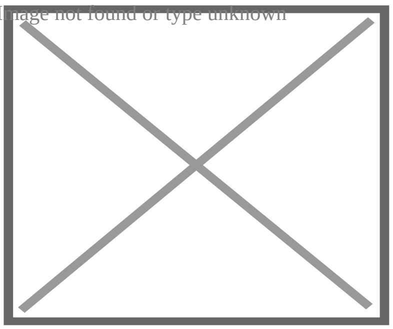

Psychrometric Chart

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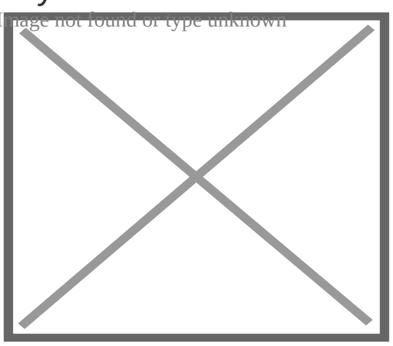

Temperature-relative humidity chart
Two alternative representations of thermal comfort for the PMV/PPD method

The PMV/PPD model was developed by P.O. Fanger using heat-balance equations and empirical studies about skin temperature to define comfort. Standard thermal comfort surveys ask subjects about their thermal sensation on a seven-point scale from cold (?3) to hot (+3). Fanger's equations are used to calculate the predicted mean vote (PMV) of a group of subjects for a particular combination of air temperature, mean radiant temperature, relative humidity, air speed, metabolic rate, and clothing insulation.[5] PMV equal to zero is representing thermal neutrality, and the comfort zone is defined by the combinations of the six parameters for which the

PMV is within the recommended limits (?0.5 < PMV < +0.5).[1] Although predicting the thermal sensation of a population is an important step in determining what conditions are comfortable, it is more useful to consider whether or not people will be satisfied. Fanger developed another equation to relate the PMV to the Predicted Percentage of Dissatisfied (PPD). This relation was based on studies that surveyed subjects in a chamber where the indoor conditions could be precisely controlled.[5]

The PMV/PPD model is applied globally but does not directly take into account the adaptation mechanisms and outdoor thermal conditions.[3][42][43]

ASHRAE Standard 55-2017 uses the PMV model to set the requirements for indoor thermal conditions. It requires that at least 80% of the occupants be satisfied.[1]

The CBE Thermal Comfort Tool for ASHRAE 55[9] allows users to input the six comfort parameters to determine whether a certain combination complies with ASHRAE 55. The results are displayed on a psychrometric or a temperature-relative humidity chart and indicate the ranges of temperature and relative humidity that will be comfortable with the given the values input for the remaining four parameters.[44]

The PMV/PPD model has a low prediction accuracy.[45] Using the world largest thermal comfort field survey database,[46] the accuracy of PMV in predicting occupant's thermal sensation was only 34%, meaning that the thermal sensation is correctly predicted one out of three times. The PPD was overestimating subject's thermal unacceptability outside the thermal neutrality ranges (-1?PMV?1). The PMV/PPD accuracy varies strongly between ventilation strategies, building types and climates.[45]

Elevated air speed method

[edit]

ASHRAE 55 2013 accounts for air speeds above 0.2 metres per second (0.66 ft/s) separately than the baseline model. Because air movement can provide direct cooling to people, particularly if they are not wearing much clothing, higher temperatures can be more comfortable than the PMV model predicts. Air speeds up to 0.8 m/s (2.6 ft/s) are allowed without local control, and 1.2 m/s is possible with local control. This elevated air movement increases the maximum temperature for an office space in the summer to 30 °C from 27.5 °C (86.0–81.5 °F).[1]

Virtual Energy for Thermal Comfort

[edit]

"Virtual Energy for Thermal Comfort" is the amount of energy that will be required to make a non-air-conditioned building relatively as comfortable as one with air-conditioning. This is based on the assumption that the home will eventually install air-conditioning or heating.[47] Passive design improves thermal comfort in a building, thus reducing demand for heating or cooling. In many developing countries, however, most occupants do not currently heat or cool, due to economic constraints, as well as climate conditions which border lines comfort conditions such as cold winter nights in Johannesburg (South Africa) or warm summer days in San Jose, Costa Rica. At the same time, as incomes rise, there is a strong tendency to introduce cooling and heating systems. If we recognize and reward passive design features that improve thermal comfort today, we diminish the risk of having to install HVAC systems in the future, or we at least ensure that such systems will be smaller and less frequently used. Or in case the heating or cooling system is not installed due to high cost, at least people should not suffer from discomfort indoors. To provide an example, in San Jose, Costa Rica, if a house were being designed with high level of glazing and small opening sizes, the internal temperature would easily rise above 30 °C (86 °F) and natural ventilation would not be enough to remove the internal heat gains and solar gains. This is why Virtual Energy for Comfort is important.

World Bank's assessment tool the EDGE software (Excellence in Design for Greater Efficiencies) illustrates the potential issues with discomfort in buildings and has created the concept of Virtual Energy for Comfort which provides for a way to present potential thermal discomfort. This approach is used to award for design solutions which improves thermal comfort even in a fully free running building. Despite the inclusion of requirements for overheating in CIBSE, overcooling has not been assessed. However, overcooling can be an issue, mainly in the developing world, for example in cities such as Lima (Peru), Bogota, and Delhi, where cooler indoor temperatures can occur frequently. This may be a new area for research and design guidance for reduction of discomfort.

Cooling Effect

[edit]

ASHRAE 55-2017 defines the Cooling Effect (CE) at elevated air speed (above 0.2 metres per second (0.66 ft/s)) as the value that, when subtracted from both the air temperature and the mean radiant temperature, yields the same SET value under still air (0.1 m/s) as in the first SET calculation under elevated air speed.[1]

$$\displaystyle SET(t_a,t_r,v,met,clo,RH)=SET(t_a-CE,t_r-CE,v=0.1,met,clo,RH)$$

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The CE can be used to determine the PMV adjusted for an environment with elevated air speed using the adjusted temperature, the adjusted radiant temperature and still air (0.2 metres per second (0.66 ft/s)). Where the adjusted temperatures are equal to the original air and mean radiant temperatures minus the CE.

Local thermal discomfort

[edit]

Avoiding local thermal discomfort, whether caused by a vertical air temperature difference between the feet and the head, by an asymmetric radiant field, by local convective cooling (draft), or by contact with a hot or cold floor, is essential to providing acceptable thermal comfort. People are generally more sensitive to local discomfort when their thermal sensation is cooler than neutral, while they are less sensitive to it when their body is warmer than neutral.[33]

Radiant temperature asymmetry

[edit]

Large differences in the thermal radiation of the surfaces surrounding a person may cause local discomfort or reduce acceptance of the thermal conditions. ASHRAE Standard 55 sets limits on the allowable temperature differences between various surfaces. Because people are more sensitive to some asymmetries than others, for example that of a warm ceiling versus that of hot and cold vertical surfaces, the limits depend on which surfaces are involved. The ceiling is not allowed to be more than +5 °C (9.0 °F) warmer, whereas a wall may be up to +23 °C (41 °F) warmer than the other surfaces.[1]

Draft

[edit]

While air movement can be pleasant and provide comfort in some circumstances, it is sometimes unwanted and causes discomfort. This unwanted air movement is called "draft" and is most prevalent when the thermal sensation of the whole body is cool. People are most likely to feel a draft on uncovered body parts such as their head, neck, shoulders, ankles, feet, and legs, but the sensation also depends on the air speed, air temperature, activity, and clothing.[1]

Floor surface temperature

[edit]

Floors that are too warm or too cool may cause discomfort, depending on footwear. ASHRAE 55 recommends that floor temperatures stay in the range of 19–29 °C (66–84 °F) in spaces where occupants will be wearing lightweight shoes.[1]

Standard effective temperature

[edit]

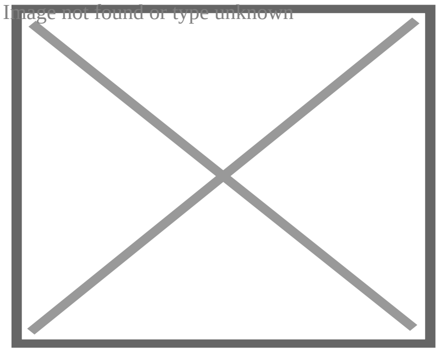
Standard effective temperature (SET) is a model of human response to the thermal environment. Developed by A.P. Gagge and accepted by ASHRAE in 1986,[48] it is also referred to as the Pierce Two-Node model.[49] Its calculation is similar to PMV because it is a comprehensive comfort index based on heat-balance equations that incorporates the personal factors of clothing and metabolic rate. Its fundamental difference is it takes a two-node method to represent human physiology in measuring skin temperature and skin wettedness.[48]

The SET index is defined as the equivalent dry bulb temperature of an isothermal environment at 50% relative humidity in which a subject, while wearing clothing standardized for activity concerned, would have the same heat stress (skin temperature) and thermoregulatory strain (skin wettedness) as in the actual test environment.[48]

Research has tested the model against experimental data and found it tends to overestimate skin temperature and underestimate skin wettedness.[49][50] Fountain and Huizenga (1997) developed a thermal sensation prediction tool that computes SET.[51] The SET index can also be calculated using either the CBE Thermal Comfort Tool for ASHRAE 55,[9] the Python package pythermalcomfort,[10] or the R package comf.

Adaptive comfort model

[edit]



Adaptive chart according to ASHRAE Standard 55-2010

The adaptive model is based on the idea that outdoor climate might be used as a proxy of indoor comfort because of a statistically significant correlation between them. The adaptive hypothesis predicts that contextual factors, such as having access to environmental controls, and past thermal history can influence building occupants' thermal expectations and preferences.[3] Numerous researchers have conducted field studies worldwide in which they survey building occupants about their thermal comfort while taking simultaneous environmental measurements. Analyzing a database of results from 160 of these buildings revealed that occupants of naturally ventilated buildings accept and even prefer a wider range of temperatures than their counterparts in sealed, air-conditioned buildings because their preferred temperature depends on outdoor conditions.[3] These results were incorporated in the ASHRAE 55-2004 standard as the adaptive comfort model. The adaptive chart relates indoor comfort temperature to prevailing outdoor temperature and defines zones of 80% and 90% satisfaction.[1]

The ASHRAE-55 2010 Standard introduced the prevailing mean outdoor temperature as the input variable for the adaptive model. It is based on the arithmetic average of the mean daily outdoor temperatures over no fewer than 7 and no more than 30 sequential days prior to the day in question.[1] It can also be calculated by weighting the temperatures with different coefficients, assigning increasing importance to the most recent temperatures. In case this weighting is used, there is no need to respect the upper limit for the subsequent days. In order to apply the adaptive model, there should be no mechanical cooling system for the space, occupants should be engaged in sedentary activities with metabolic rates of 1–1.3 met, and a prevailing mean temperature of 10–33.5 °C (50.0–92.3 °F).[1]

This model applies especially to occupant-controlled, natural-conditioned spaces, where the outdoor climate can actually affect the indoor conditions and so the comfort zone. In fact, studies by de Dear and Brager showed that occupants in naturally ventilated buildings were tolerant of a wider range of temperatures.[3] This is due to both behavioral and physiological adjustments, since there are different types of adaptive processes.[52] ASHRAE Standard 55-2010 states that differences in recent thermal experiences, changes in clothing, availability of control options, and shifts in occupant expectations can change people's thermal responses.[1]

Adaptive models of thermal comfort are implemented in other standards, such as European EN 15251 and ISO 7730 standard. While the exact derivation methods and results are slightly different from the ASHRAE 55 adaptive standard, they are substantially the same. A larger difference is in applicability. The ASHRAE adaptive standard only applies to buildings without mechanical cooling installed, while EN15251 can be applied to mixed-mode buildings, provided the system is not running.[53]

There are basically three categories of thermal adaptation, namely: behavioral, physiological, and psychological.

Psychological adaptation

[edit]

An individual's comfort level in a given environment may change and adapt over time due to psychological factors. Subjective perception of thermal comfort may be influenced by the memory of previous experiences. Habituation takes place when repeated exposure moderates future expectations, and responses to sensory input. This is an important factor in explaining the difference between field observations and PMV predictions (based on the static model) in naturally ventilated buildings. In these buildings, the relationship with the outdoor temperatures has been twice as strong as predicted.[3]

Psychological adaptation is subtly different in the static and adaptive models. Laboratory tests of the static model can identify and quantify non-heat transfer (psychological) factors that affect reported comfort. The adaptive model is limited to reporting differences (called psychological) between modeled and reported comfort.[*citation n*

Thermal comfort as a "condition of mind" is *defined* in psychological terms. Among the factors that affect the condition of mind (in the laboratory) are a sense of control over the temperature, knowledge of the temperature and the appearance of the (test) environment. A thermal test chamber that appeared residential "felt" warmer than one which looked like the inside of a refrigerator.[54]

Physiological adaptation

[edit]
Further information: Thermoregulation

The body has several thermal adjustment mechanisms to survive in drastic temperature environments. In a cold environment the body utilizes vasoconstriction; which reduces blood flow to the skin, skin temperature and heat dissipation. In a warm environment, vasodilation will increase blood flow to the skin, heat transport, and skin temperature and heat dissipation.[55] If there is an imbalance despite the vasomotor adjustments listed above, in a warm environment sweat production will start and provide evaporative cooling. If this is insufficient, hyperthermia will set in, body temperature may reach 40 °C (104 °F), and heat stroke may occur. In a cold environment, shivering will start, involuntarily forcing the muscles to work and increasing the heat production by up to a factor of 10. If equilibrium is not restored, hypothermia can set in, which can be fatal.[55] Long-term adjustments to extreme temperatures, of a few days to six months, may result in cardiovascular and endocrine adjustments. A hot climate may create increased blood volume, improving the effectiveness of vasodilation, enhanced performance of the sweat mechanism, and the readjustment of thermal preferences. In cold or underheated conditions, vasoconstriction can become permanent, resulting in decreased blood volume and increased body metabolic rate.[55]

Behavioral adaptation

[edit]

In naturally ventilated buildings, occupants take numerous actions to keep themselves comfortable when the indoor conditions drift towards discomfort. Operating windows and fans, adjusting blinds/shades, changing clothing, and consuming food and drinks are some of the common adaptive strategies. Among these, adjusting windows is the most common.[56] Those occupants who take these sorts of actions tend to feel cooler at warmer temperatures than those who do not.[57]

The behavioral actions significantly influence energy simulation inputs, and researchers are developing behavior models to improve the accuracy of simulation results. For example, there are many window-opening models that have been developed to date, but there is no consensus over the factors that trigger window opening.[56]

People might adapt to seasonal heat by becoming more nocturnal, doing physical activity and even conducting business at night.

Specificity and sensitivity

[edit]

Individual differences

[edit]
Further information: Cold sensitivity

The thermal sensitivity of an individual is quantified by the descriptor *FS*, which takes on higher values for individuals with lower tolerance to non-ideal thermal conditions.[58] This group includes pregnant women, the disabled, as well as individuals whose age is below fourteen or above sixty, which is considered the adult range. Existing literature provides consistent evidence that sensitivity to hot and cold surfaces usually declines with age. There is also some evidence of a gradual reduction in the effectiveness of the body in thermo-regulation after the age of sixty.[58] This is mainly due to a more sluggish response of the counteraction mechanisms in lower parts of the body that are used to maintain the core temperature of the body at ideal values.[58] Seniors prefer warmer temperatures than young adults (76 vs 72 degrees F or 24.4 vs 22.2 Celsius).[54]

Situational factors include the health, psychological, sociological, and vocational activities of the persons.

Biological sex differences

[edit]

While thermal comfort preferences between sexes seem to be small, there are some average differences. Studies have found males on average report discomfort due to rises in temperature much earlier than females. Males on average also estimate higher levels of their sensation of discomfort than females. One recent study tested males and females in the same cotton clothing, performing mental jobs while using a dial vote to report their thermal comfort to the changing temperature.[59] Many times, females preferred higher temperatures than males. But while females tend to be more sensitive to temperatures, males tend to be more sensitive to relative-humidity levels.[60][61]

An extensive field study was carried out in naturally ventilated residential buildings in Kota Kinabalu, Sabah, Malaysia. This investigation explored the sexes thermal sensitivity to the indoor environment in non-air-conditioned residential buildings. Multiple hierarchical regression for categorical moderator was selected for data analysis; the result showed that as a group females were slightly more sensitive than males to the indoor air temperatures, whereas, under thermal neutrality, it was found that males and females have similar thermal sensation.[62]

Regional differences

[edit]

In different areas of the world, thermal comfort needs may vary based on climate. In China[*where?*] the climate has hot humid summers and cold winters, causing a need for efficient thermal comfort. Energy conservation in relation to thermal comfort has become a large issue in China in the last several decades due to rapid economic and population growth.[63] Researchers are now looking into ways to heat and cool buildings in China for lower costs and also with less harm to the environment.

In tropical areas of Brazil, urbanization is creating urban heat islands (UHI). These are urban areas that have risen over the thermal comfort limits due to a large influx of people and only drop within the comfortable range during the rainy season.[64] Urban heat islands can occur over any urban city or built-up area with the correct conditions.[65][66]

In the hot, humid region of Saudi Arabia, the issue of thermal comfort has been important in mosques, because they are very large open buildings that are used only intermittently (very busy for the noon prayer on Fridays) it is hard to ventilate them properly. The large size requires a large amount of ventilation, which requires a lot of energy since the buildings are used only for short periods of time. Temperature regulation in mosques is a challenge due to the intermittent demand, leading to many mosques being either too hot or too cold. The stack effect also comes into play due to their large size and creates a large layer of hot air above the people in the mosque. New designs have placed the ventilation systems lower in the buildings to provide more temperature control at ground level.[67] New monitoring steps are also being taken to improve efficiency.[68]

Thermal stress

[edit]

Not to be confused with thermal stress on objects, which describes the change materials experience when subject to extreme temperatures.

The concept of thermal comfort is closely related to thermal stress. This attempts to predict the impact of solar radiation, air movement, and humidity for military personnel undergoing training exercises or athletes during competitive events. Several thermal stress indices have been proposed, such as the Predicted Heat Strain (PHS) or the humidex.[69] Generally, humans do not perform well under thermal stress. People's performances under thermal stress is about 11% lower than their performance at normal thermal wet conditions. Also, human performance in relation to thermal stress varies greatly by the type of task which the individual is completing. Some of the physiological effects of thermal heat stress include increased blood flow to the skin, sweating, and increased ventilation.[70][71]

Predicted Heat Strain (PHS)

[edit]

The PHS model, developed by the International Organization for Standardization (ISO) committee, allows the analytical evaluation of the thermal stress experienced by a working subject in a hot environment.[72] It describes a method for predicting the sweat rate and the internal core temperature that the human body will develop in response to the working conditions. The PHS is calculated as a function of several physical parameters, consequently it makes it possible to determine which parameter or group of parameters should be modified, and to what extent, in order to reduce the risk of physiological strains. The PHS model does not predict the physiological response of an individual subject, but only considers standard subjects in good health and fit for the work they perform. The PHS can be determined using either the Python package pythermalcomfort[10] or the R package comf.

American Conference on Governmental Industrial Hygienists (ACGIH) Action Limits and Threshold Limit Values

[edit]

ACGIH has established Action Limits and Threshold Limit Values for heat stress based upon the estimated metabolic rate of a worker and the environmental conditions the worker is subjected to.

This methodology has been adopted by the Occupational Safety and Health Administration (OSHA) as an effective method of assesing heat stress within workplaces.[73]

Research

[edit]

The factors affecting thermal comfort were explored experimentally in the 1970s. Many of these studies led to the development and refinement of ASHRAE Standard 55 and were performed at Kansas State University by Ole Fanger and others. Perceived comfort was found to be a complex interaction of these variables. It was found that the majority of individuals would be satisfied by an ideal set of values. As the range of values deviated progressively from the ideal, fewer and fewer people were satisfied. This observation could be expressed statistically as the percent of individuals who expressed satisfaction by *comfort conditions* and the *predicted mean vote* (PMV). This approach was challenged by the adaptive comfort model, developed from the ASHRAE 884 project, which revealed that occupants were comfortable in a broader range of temperatures.[3]

This research is applied to create Building Energy Simulation (BES) programs for residential buildings. Residential buildings in particular can vary much more in thermal comfort than public and commercial buildings. This is due to their smaller size, the variations in clothing worn, and different uses of each room. The main rooms of concern are bathrooms and bedrooms. Bathrooms need to be at a temperature comfortable for a human with or without clothing. Bedrooms are of importance because they need to accommodate different levels of clothing and also different metabolic rates of people asleep or awake.[74] Discomfort hours is a common metric used to evaluate the thermal performance of a space.

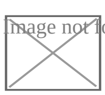
Thermal comfort research in clothing is currently being done by the military. New air-ventilated garments are being researched to improve evaporative cooling in military settings. Some models are being created and tested based on the amount of cooling they provide.[75]

In the last twenty years, researchers have also developed advanced thermal comfort models that divide the human body into many segments, and predict local thermal discomfort by considering heat balance.[76][77][78] This has opened up a new arena of thermal comfort modeling that aims at heating/cooling selected body parts.

Another area of study is the hue-heat hypothesis that states that an environment with warm colors (red, orange yellow hues) will feel warmer in terms of temperature and comfort, while an environment with cold colors (blue, green hues) will feel cooler.[79][80][81] The hue-heat hypothesis has both been investigated scientifically[82] and ingrained in popular culture in the terms warm and cold colors [83]

Medical environments

[edit]



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Whenever the studies referenced tried to discuss the thermal conditions for different groups of occupants in one room, the studies ended up simply presenting comparisons of thermal comfort satisfaction based on the subjective studies. No study tried to reconcile the different thermal comfort requirements of different types of occupants who compulsorily must stay in one room. Therefore, it looks to be necessary to investigate the different thermal conditions required by different groups of occupants in hospitals to reconcile their different requirements in this concept. To reconcile the differences in the required thermal comfort conditions it is recommended to test the possibility of using different ranges of local radiant temperature in one room via a suitable mechanical system.

Although different researches are undertaken on thermal comfort for patients in hospitals, it is also necessary to study the effects of thermal comfort conditions on the quality and the quantity of healing for patients in hospitals. There are also original researches that show the link between thermal comfort for staff and their levels of productivity, but no studies have been produced individually in hospitals in this field. Therefore, research for coverage and methods individually for this subject is recommended. Also research in terms of cooling and heating delivery systems for patients with low levels of immune-system protection (such as HIV patients, burned patients, etc.) are recommended. There are important areas, which still need to be focused on including thermal comfort for staff and its relation with their productivity, using different heating systems to prevent hypothermia in the patient and to improve the thermal comfort for hospital staff simultaneously.

Finally, the interaction between people, systems and architectural design in hospitals is a field in which require further work needed to improve the knowledge of how to design buildings and systems to reconcile many conflicting factors for the people occupying these buildings.[84]

Personal comfort systems

[edit]

Personal comfort systems (PCS) refer to devices or systems which heat or cool a building occupant personally.[85] This concept is best appreciated in contrast to central HVAC systems which have uniform temperature settings for extensive areas. Personal comfort systems include fans and air diffusers of various kinds (e.g. desk fans, nozzles and slot diffusers, overhead fans, high-volume low-speed fans etc.) and personalized sources of radiant or conductive heat (footwarmers, legwarmers, hot water bottles etc.). PCS has the potential to satisfy individual comfort requirements much better than current HVAC systems, as interpersonal differences in thermal sensation due to age, sex, body mass, metabolic rate, clothing and thermal adaptation can amount to an equivalent temperature variation of 2–5 °C (3,6–9 °F), which is impossible for a central, uniform HVAC system to cater to.[85] Besides, research has shown that the perceived ability to control one's thermal environment tends to widen one's range of tolerable temperatures.[3] Traditionally, PCS devices have been used in isolation from one another. However, it has been proposed by Andersen et al. (2016) that a network of PCS devices which generate well-connected microzones of thermal comfort, and report real-time occupant information and respond to programmatic actuation requests (e.g. a party, a conference, a concert etc.) can combine with occupant-aware building applications to enable new methods of comfort maximization.[86]

See also

[edit]

- ASHRAE
- ANSI/ASHRAE Standard 55
- Air conditioning
- Building insulation
- Cold and heat adaptations in humans
- Heat stress
- Mean radiant temperature
- Mahoney tables
- Povl Ole Fanger
- Psychrometrics
- Ralph G. Nevins
- Room air distribution
- Room temperature
- Ventilative cooling

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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

- 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

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

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)
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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Things To Do in Jefferson County

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Visit Jefferson County Tennessee

5 (3)

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Jefferson County Convention & Visitors Bureau

4.4 (30)

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Visit Jefferson County PA

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Jefferson Historical Museum

4.8 (239)

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Jefferson County Museum

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Jefferson County Area Tourism Council

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Driving Directions in Jefferson County

Driving Directions From Five Below to Royal Supply Inc

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Reviews for Royal Supply Inc

Royal Supply Inc

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Terry Self

(1)

Horrible workmanship, horrible customer service, don't show up when they say they are. Ghosted. Was supposed to come back on Monday, no call no show. Called Tuesday and Wednesday, left messages both days. Nothing. Kinked my line, crooked to the pad and house, didn't put disconnect back on, left the trash.....

Royal Supply Inc

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Toney Dunaway

(5)

This is another amazing place where we will do much more business. They are not tyrannical about the totally useless face diapers, they have a great selection of stock, they have very knowledgeable staff, very friendly staff. We got the plumbing items we really needed and will be getting more plumbing items. They also have central units, thermostats, caulking, sealants, doors, seems everything you need for a mobile home. We've found a local treasure and will be bringing much more business. Their store is clean and tidy as well!

Royal Supply Inc

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Gidget McCarthy

(5)

Very knowledgeable, friendly, helpful and don't make you feel like you're inconveniencing them. They seem willing to take all the time you need. As if you're the only thing they have to do that day. The store is clean, organized and not cluttered, symmetrical at that. Cuz I'm even and symmetricals biggest fan. It was a pleasure doing business with them and their prices are definitely reasonable. So, I'll be doing business with them in the future no doubt.

Royal Supply Inc

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bill slayton

(1)

Went to get a deadbolt what they had was one I was told I'd have take it apart to lengthen and I said I wasn't buying something new and have to work on it. Thing of it is I didn't know if it was so that it could be lengthened said I didn't wanna buy something new I had to work on just to fit my door. He got all mad and slung the whole box with part across the room. A real business man. I guess the owner approves of his employees doing as such.

Royal Supply Inc

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Ae Webb

(5)

Royal installed a new furnace and air conditioner just before we got our used mobile home. Recently, the furnace stopped lighting. Jared (sp?) made THREE trips to get it back to good. He was so gracious and kind. Fortunately for us it was still under warranty. BTW, those three trips were from Fenton, Missouri to Belleville, Illinois! Thanks again, Jared!

Knowing When to Seek Professional Licensing Support**View GBP**

Check our other pages :

- **Locating Reliable Compliance Resources for Homeowners**
- **Estimating Labor Expenses for Repair Services**
- **Navigating EPA 608 Certification Steps**

Frequently Asked Questions

What are the specific licensing requirements for installing or repairing HVAC systems in mobile homes?

Licensing requirements vary by state and locality. Typically, you need a specialized HVAC contractors license, which may require passing an exam, proof of experience, and insurance. Check with your local licensing board for exact details.

How can I determine if my current qualifications meet the licensing criteria for mobile home HVAC work?

Review your states licensing guidelines to check if your education and experience align with their requirements. Consider contacting the local licensing authority or a professional organization like NATE (North American Technician Excellence) for advice on next steps.

When should I seek help from a professional service to obtain an HVAC license for mobile homes?

You should seek professional assistance if youre unfamiliar with the application process, need help preparing for exams, or want guidance on meeting specific regulatory standards efficiently.

Can hiring a consultant expedite the process of obtaining an HVAC license?

Yes, hiring a consultant can streamline the process by providing expert guidance on documentation, exam preparation, and compliance with regulations, potentially saving time and avoiding common pitfalls.

Royal Supply Inc

Phone : +16362969959

City : Fenton

State : MO

Zip : 63026

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