T D H
TEXAS DEPARTMENT OF HEALTH

Texas Voluntary Indoor Air Quality Guidelines for Government Buildings

Effective Date: December 22, 2002

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Publication #2-10
January 2003

An Explanation Of These Guidelines

Effective December 22, 2002, these *Voluntary Indoor Air Quality Guidelines for Government Buildings* replaced the *Voluntary Indoor Air Quality Guidelines for Public Schools* that were in effect from May 10, 1998 through December 21, 2002. House Bill 2008 (HB 2008), passed in the 77th Texas Legislature, 2001, amended the Texas Health and Safety Code, Subtitle C, Title 5, Chapter 385, to require the Texas Department of Health (TDH) to establish voluntary guidelines for indoor air quality in government buildings. Previous legislation passed in 1995 (House Bill 2850) had required TDH to establish voluntary guidelines for indoor air quality in public schools. HB 2008 basically broadened the scope of the original guidelines to cover all government buildings, including public school buildings. After the passage of these bills in both 1995 and 2001, TDH assembled voluntary task forces of stakeholders to assist in the development of the guidelines. The TDH Indoor Air Quality Branch would like to thank the members of these task forces for the time and effort devoted to this endeavor.

The current guidelines, while voluntary, went through a required Texas Department of Health rule-making process. The proposed rules were presented to and approved by the board, then were published in the August 9, 2002 *Texas Register* for a public comment period. Comments received were considered by TDH, and where appropriate, changes were made to the proposed language in the guidelines. The final rules were again presented to and approved by the board, and were then published in the December 13, 2002 Texas Register.

New sections 297.1 - 297.10 of the Health and Safety Code replace repealed sections 297.1 - 297.6.

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§297.1. General Provisions

(a) Purpose. Health and Safety Code, Chapter 385, "Indoor Air Quality in Government Buildings," requires the Board of Health (board) to establish voluntary guidelines for indoor air quality (IAQ) in government buildings, including guidelines for ventilation and indoor air pollution control systems. The department developed these guidelines to promote practices that prevent or reduce the contamination of indoor air, thereby contributing to a safe, healthy, productive and comfortable environment for building occupants. Benefits of good IAQ may include improved health of occupants, decrease in the spread of infectious disease, protection of susceptible populations, increased productivity of occupants, improved relationships/fewer complaints, reduction in potential building closures and relocation of occupants, less deterioration of buildings and equipment, reduced maintenance costs, and decreased liability and risk.

(b) Scope. These are voluntary guidelines for government buildings. Only buildings that are enclosed on all sides from floor to ceiling by walls or windows (exclusive of door ways) that extend from the floor to the ceiling are covered by these guidelines. Examples of governmental buildings include, but are not limited to, office buildings, public schools, public colleges, public universities, laboratories, dormitories, correctional facilities, courts, libraries, hospitals, warehouses, convention centers, sports facilities or any other building that is defined in this guideline as a government building. Open air parking garages and other facilities that are not enclosed are not covered by these guidelines. These guidelines are not intended to cover industrial-type activities in governmental buildings that are covered by occupational health and safety guidelines and standards unless these activities affect office, classroom, or other non-industrial occupied areas. Industrial-type activities would commonly be found in laboratories, maintenance shops, print shops, woodworking shops, or automotive maintenance and repair shops.

(1) The department does not have any enforcement authority requiring implementation of these guidelines. They do not create liability for a governmental entity for an injury caused by the failure to comply with the voluntary guidelines established by the board under Health and Safety Code, §385.002.

(2) Additional information on IAQ and a list of other resources for more information can be provided by the Indoor Air Quality Branch of the department. There are several resources available free of charge which offer guidance on the development of an IAQ Management Plan and which provide forms that can be used or modified to fit the needs of governmental buildings. These include the U.S. Environmental Protection Agency (EPA) publications, *Building Air Quality Action Plan* and *Building Air Quality: A Guide for Building Owners and Facility Managers*, *Indoor Air Quality Building Education Assessment Model (I-BEAM) Software* and *IAQ Tools for Schools* Action Kit. These resources are available on the Internet at www.epa.gov/iaq.

(3) The needs, costs and available funding for improving the IAQ vary greatly in different governmental entities. Governmental administrators should evaluate, and adopt or promote those guidelines that in their judgment are relevant, applicable and feasible to implement. It is important to realize that these guidelines are presented as a basic standard of practice that the department is encouraging governmental administrators to strive for.

(4) If portions of these guidelines conflict with any applicable building codes or other laws, then such laws take precedence over these guidelines. It is the responsibility of each governmental building administrator and other users of these guidelines to comply with applicable laws including but not limited to, those related to building, plumbing, electrical and mechanical systems, fire protection, safety, energy use and environmental protection.

(c) Severability. Should any section or subsection of this chapter be found to be void for any reason, such finding shall not affect all other sections.

§297.2. Definitions.

The following words and terms, when used in these sections, shall have the following meanings, unless the context clearly indicates otherwise.

(1) Acceptable indoor air quality - The quality of air in an occupied enclosed space that is within an established temperature and humidity comfort zone, and which does not contain air contaminants in sufficient concentration to produce a negative impact on the health and comfort of the occupants.

(2) Air contaminant - A gaseous, liquid, or solid substance or combination of substances in a form transported by or in air that has the potential to be detrimental to human health.

(3) ASHRAE – American Society of Heating, Refrigerating and Air-conditioning Engineers, Incorporated.

(4) Board - The Texas Board of Health.

(5) Building commissioning - The process of ensuring that all building systems are designed, installed, functionally tested, and operated in conformity with design intent. Commissioning includes planning, design, construction, start-up, testing, documentation, owner acceptance, and training throughout the life of the systems and building.

(6) Department - The Texas Department of Health.

(7) Government building - A building that is:

(A) owned, or leased for a term of at least three months, by a state governmental entity or by a political subdivision of this state, including a county, municipality, special purpose district, or school district; and

(B) regularly open to members of the public or used by the state or local governmental entity for a purpose that involves regular occupancy of the building by an employee or by a person in the custody or control of the governmental entity such as a public school student.

(8) HVAC system - The heating, ventilation, and air-conditioning system that

provides the processes of comfort heating, ventilating and/or air conditioning within, or associated with, a building.

(9) IAQ - Indoor Air Quality. The attributes of the respirable atmosphere (climate) inside a building including gaseous composition, humidity, temperature, and contaminants.

(10) IAQ coordinator - A designated person who provides leadership and coordination of IAQ activities. The responsibilities should include coordination of an IAQ team, preparation for emergency responses, dissemination of IAQ information, tracking of IAQ complaints and direction of responses, and communication of IAQ issues and status to interested parties.

(11) IAQ management plan - A written plan for preventing and resolving IAQ problems.

(12) Indoor air pollution - The presence, in an indoor environment, of one or more air contaminants in sufficient concentration and of sufficient duration to be capable of causing irritation and/or adverse effects to human health.

(13) MERV - Minimum Efficiency Reporting Value. A number that reflects the filter efficiency based on the testing procedure defined in ASHRAE Standard 52.2-1999.

(14) Microbials - Agents derived from, or that are, living organisms (e.g., viruses, bacteria, fungi, and mammal, bird and dust mite antigens) that can be inhaled and can cause adverse health effects including allergic reactions, respiratory disorders, hypersensitivity disorders, and infectious diseases. Also referred to as "microbiologicals" or "biological contaminants."

(15) Negative pressure - A condition that exists when the air pressure in an enclosed space is less than that in the surrounding areas. Under this condition, if an opening exists between these locations, air will flow from surrounding areas into the negatively pressurized space. A negatively pressurized building will have airflow from the outside into the building through available openings.

(16) Occupied zone - the region within an occupied space between the planes three and 72 inches above the floor and more than two feet from the walls or fixed air-conditioning equipment (ASHRAE Standard 62-2001).

(17) Positive pressure - A condition that exists when the air pressure in an enclosed space is greater than that in the surrounding areas. Under this condition, if an opening exists between these locations, air will flow from the positively pressurized space into surrounding areas. A positively pressurized building will have air flow from the building to the outside through available openings.

(18) Preventive maintenance - Regular and systematic inspection, cleaning, and replacement of worn parts, materials and systems. Preventive maintenance helps to keep parts,

materials, and systems from failing by ensuring they are in good working order.

(19) Public school - A building owned by a public school district or leased by a public school district for three months or more that is used by the district for a purpose that involves regular occupancy of the building by students.

(20) Qualified – Personnel possessing the necessary education, experience and equipment (where required) to accomplish the activities being performed. Certifications may be required for some regulated functions, such as asbestos and lead-based paint abatement.

(21) Recognized best practices - Those procedures that are considered by knowledgeable practitioners to be necessary to produce the most favorable results.

§297.3. Recommendations for Implementing a Governmental Building IAQ Program.

(a) Initial program development. The development of a governmental IAQ program should include the following considerations.

(1) IAQ coordinator. An IAQ coordinator should be appointed and trained to manage the IAQ program.

(2) Occupant considerations. When implementing an IAQ program for a building, characteristics and activities of the population occupying and visiting the building should be considered, as these may indicate unique needs relating to indoor air quality.

(3) Facilities assessment. An IAQ and operational assessment of all facilities should be performed to identify and document building operations and problem areas based on current use and recognized codes and standards where available. Operational and maintenance needs that can be addressed immediately, and in the future, should also be identified and documented.

(4) Development of goals. Based on the results of the IAQ occupant needs and facility assessment, and resources available, each IAQ coordinator should develop goals, written plans and programs, which must be achieved for the implementation of an effective IAQ program.

(5) Governmental administrative support for stated goals. Administrative support from the highest level of the organization and a written commitment from the governmental entity and other key personnel to the goals are necessary for an effective IAQ program.

(6) Funding. Adequate budgets are necessary for IAQ and maintenance staff to meet the stated goals, plans and programs. The amounts of funding will vary based on the scope of each governmental program.

(7) Staff. An IAQ support team should be developed and trained as necessary to achieve the goals of the governmental entity. The team may include administrators, facility managers, health officials, custodians and maintenance personnel, an energy manager, design and construction staff, occupants, and others.

(b) IAQ management plan. A written IAQ management plan should be developed and maintained. The plan should include the following.

(1) Training. Education and training of the IAQ coordinator, support team, and building occupants on the recognition, prevention and resolution of IAQ problems.

(2) Communication. A procedure for communicating with building occupants regarding IAQ issues. Communication methods should be in writing utilizing any of the following methods: e-mail, posting in common areas visible to all employees, memo to each area of the facility. The notification should be posted at least five days prior to any activity (pesticide use, painting, dust-producing activities or other maintenance activities which may impact IAQ).

(3) Complaint response. A written procedure for documenting and responding to IAQ complaints and problems. The response procedure should include: instructions for obtaining information from complainants, assessing the urgency of the problem and appropriate action to follow, the communication plan for dissemination of information, investigating the complaint or seeking assistance to investigate the complaint as appropriate, deciding on the remedial actions to be implemented and by whom, assessing the effectiveness of the remedial action, and follow-up actions to check the long-term effectiveness of the remedial action or to monitor the recurrence of the original complaint, if no remedial action was performed. This procedure should define the forms that should be used to document and report all activities conducted in response to the complaint and their results.

(4) Record keeping. A written procedure that defines the minimum documentation to be collected, handling instructions and length of time for record retention in response to IAQ complaints, including any maintenance, repair or remodeling activities conducted in the building that could adversely impact the IAQ. Records retention rules specific for each agency should be followed.

(5) Maintenance and operation plan. A written building maintenance and operation plan containing: a written description of the building systems and functions, and occupancy, schematics and/or as-built drawings with equipment locations and performance criteria, outside air requirements, sequences of operation, daily building and system operation schedules, test and balance reports, maintenance schedules, building inspection checklists and maintenance equipment checklists. The plan should be updated and approved by the IAQ coordinator annually.

(6) Implementation schedule. A schedule to implement the IAQ plans and programs.

(7) Annual review. Annual IAQ inspection/review of facilities including a walk through by the IAQ coordinator or designee should be conducted.

(c) Administrative Review. A review of the IAQ program status and future needs should be presented annually to the appropriate governing body by the IAQ coordinator.

§297.4. Design/Construction/Renovation.

(a) Building design (new construction). The following factors should be considered during the planning and design stages.

(1) New buildings. Design and construction standards that facilitate the maintenance of acceptable IAQ should be established.

(2) Site selection. During the selection of building sites, consideration should be given to minimizing or designing to avoid potential contaminant sources. Some of these considerations include the following.

(A) Environmental assessment. A Phase I (visual inspection and condition measurements) environmental assessment of property to identify on-site contamination that could affect indoor air quality should be conducted.

(B) External contaminants. Potential external contaminant sources such as combustion sources (freeways or power plants), dust generators (agricultural or cement plants), and industrial plants that may emit pollutants into the air should be identified.

(C) Climate. Climate assessment data that include factors affecting building layout and other architectural design considerations such as temperature, relative humidity, dewpoint, rain quantity and prevailing direction, elevation and prevailing winds should be developed and evaluated.

(D) Radon. A radon assessment of the site should be conducted, if applicable.

(E) Drainage. Conduct a drainage survey to assure water can be diverted from the building site and away from the building.

(3) Documentation. Facility design should include the development of owner's project requirement (the listing of facility uses, requirements and intent for the building), and basis of design (the design professional's description of the building elements and systems to accomplish the owner's project requirements) documents to guide the design and construction team in the selection of the least polluting materials and the production of a healthy building environment for the occupants. Some of the documentation and methods include:

(A) The design team should be assembled from qualified and licensed professionals that are knowledgeable in air quality issues.

(B) A building use and occupancy plan, schedule, and requirements should be assembled.

(C) An indoor pollutant source control plan should be developed to guide the materials usage, equipment selection and activities in the building.

(D) Comply with appropriate codes and standards.

(E) Assess the budget and schedule impacts of all materials and systems.

(F) A testing and commissioning plan should be developed to quantify the facility performance results required.

(G) Building operational and training documentation plans should be provided including the requirements for equipment systems manuals.

(4) Site and Facility Planning. The building design should consider the following.

(A) Building structure factors. Factors that can affect IAQ, such as the shape and size, orientation, layout, proximity to pollution-generating activities, building materials, types of windows and doors, ventilation system design, location of air intakes and exhausts, and susceptibility to pest intrusion should be considered.

(B) Internal contaminant sources. Proper venting to the outside atmosphere of pollution source areas, such as laboratories and preparation rooms, housekeeping and material storage, restrooms, workshops, cooking areas, art and hobby rooms, computer rooms, copy rooms, and other emission-producing spaces should be provided.

(C) Loading Docks. Loading docks should be designed such that vehicle exhaust shall be prevented from entering enclosed work spaces (including air intakes and building openings) by installing barriers to airflow from loading dock areas (i.e. doors, curtains, etc.) and using pressurization. Outside air intakes should not be near or above truck or other vehicle access areas.

(D) Moisture prevention. Water intrusion, condensation, water vapor intrusion, and other moisture problems in the building should be avoided through the proper design and installation of the building components. The use of vapor barriers (membrane inserted in a wall assembly to reduce moisture flow) should be based on best practices design for the local area. Care should be taken not to have two vapor barriers in one wall such as an exterior barrier with vinyl wall covering on the inside. In hot and humid climates, vinyl wall covering should not be used on exterior walls to avoid condensation and mold growth behind the covering.

(E) Space allocation.

(i) Adequate space for maintenance access and proper operation of building equipment, such as HVAC system equipment and boilers, should be provided.

(ii) Separate designated rooms used for materials and chemical storage only and that are kept under negative pressure and vented to the outside atmosphere should be provided.

(F) Building materials, interior finishes, and furnishings.

(i) The lowest chemical-emitting building materials, interior finishes, and furnishings that are practical should be used. Contaminant-emitting and retention potential of furnishings, floor and wall coverings and casework, and other interior finishes

should be evaluated. Emissions data from manufacturers should be evaluated before specifying or approving construction products and building furnishings.

(ii) Materials that prevent (or at least inhibit) microbial growth without occupant exposure to potentially harmful chemicals should be used.

(iii) The use of porous or fleecy materials is discouraged where unmanaged excessive moisture or improper maintenance could occur.

(iv) Projected life cycles of materials and equipment should be considered to provide the most sustainable construction.

(v) Recycling of construction waste and materials from remodeled facilities should be provided where possible.

(vi) Maintenance requirements should be considered. Materials that can be easily cleaned with the least toxic cleaning supplies should be utilized when possible.

(vii) Building materials and products susceptible to water damage should be properly stored and protected to prevent damage before or during construction phase.

(5) HVAC system design. HVAC systems should be designed to include the following.

(A) Air intakes. Sufficient acceptable outside air to maintain a healthy environment in all occupied areas should be provided. (Reference ASHRAE Standard 62-2001). Preconditioning of outside air supplies, particularly dehumidification, is recommended where possible.

(B) Air distribution. Proper air distribution should be provided to all occupied areas.

(C) Filters. Medium to high efficiency (MERV 9 – 11) filtering systems should be used. Air handlers should be designed and selected to accommodate the pressure drops required for adequate filtration. Low capacity systems may use lower efficient filters (MERV 6 – 8) if it cannot be retrofitted for the more efficient filters. Filters should be installed to minimize air bypass around the filters and maintained per the manufacturer's recommendations.

(D) Access doors/ports. Convenient access doors/ports to facilitate inspection, maintenance and cleaning of air handling units and ducts should be provided.

(E) Coils. Coils with adequate heating and/or cooling capacity and with features to facilitate maintenance should be used.

(F) Drain pans. Insulated drain pans with proper slope and drainage to prevent standing water should be installed on all new cooling (wet) coils.

(G) Drain lines and traps. Drain lines need to be adequately sloped to

provide proper drainage. Drain traps should be properly installed when drain lines from condensate pans connect to sewer systems.

(H) Ducts. Ducts with internal surfaces that are easily cleaned, not damaged by typical cleaning methods, do not harbor dust and microbials, and that will not emit materials or gases that can harm the occupants should be provided on all new HVAC systems.

(I) Return air. Ducting of return air is recommended.

(J) Positive building pressure. The rooms of the buildings should be maintained at a net positive pressure (minimum of 1 Pascal) with respect to the wall cavities and plenums, and the wall cavities should be maintained at a net positive pressure (minimum of 1 Pascal) with respect to the outside atmospheric pressure. Some areas in buildings that have isolation or process requirements, such as print shops, darkrooms, and restrooms, may require defined pressure relationships to adjacent areas.

(K) Exhaust systems. Adequate exhaust systems for restrooms, storage rooms, copy rooms, animal areas, chemistry labs, computer rooms, industrial arts rooms, kilns, home economics rooms, locker rooms/showers, swimming pools and other areas with contaminant sources should be provided. These areas should be under negative pressure with respect to adjacent areas, such as classrooms, offices and hallways.

(i) Exhausts should be vented directly to the outside.

(ii) Exhaust vents should be located to avoid contaminants being drawn back into the building and no closer than 25 feet from an air intake.

(L) Comfort. Adequate temperature and humidity control with proper air velocity should be provided to maintain comfort, process requirements, and minimize microbials and contaminants in all occupied areas.

(M) Humidity. The maximum relative humidity should be maintained below 60% throughout the year to prevent mold growth. Ideal relative humidity levels are generally between 30% and 60%, however between levels 30% and 50% will decrease the chance of mold growth. In climates where outdoor humidity levels are often less than 30% and building occupants do not complain of health effects or discomfort from the lower humidity, then lower humidity inside buildings is acceptable.

(N) Air diffusers. Air diffusers should be used to manage air flow volumes, mixing, and patterns for occupant comfort. Normal occupied spaces should have an average air velocity between 20 and 50 feet per minute in the occupied zone.

(O) Controls. Proper controls and energy management systems should be installed to maintain recommended interior conditions. Thermostats in each occupied room and conference room are preferred. Humidistats should be used in rooms where humidity control is important.

(b) Maintaining acceptable IAQ during renovation. Building occupants should be

protected from airborne contaminants that may be disturbed, generated, or released during mitigation and/or renovation, including irritating or toxic substances such as asbestos, lead, pesticides, heavy metals, mold, cement dust, paint vapors, and roof tarring vapors.

(1) Asbestos Survey. Prior to any renovation or dismantling, assure that the asbestos surveys for the building in question are up-to-date. If such survey information is not available, engage a licensed asbestos consultant or other licensed professional to conduct an asbestos survey and plan for the building as per the Texas Asbestos Health Protection Act, Article 4477-3a, V.T.C.S. and Rules, §§295.31-295.73 of this title (relating to Texas Asbestos Health Protection Act), and the National Emission Standards for Hazardous Air Pollutants, 40 CFR 61 Subpart M, National Emission Standards for Asbestos.

(2) Lead-based paint concerns. Lead-based paint, used in many buildings built prior to 1978, may create an exposure risk for young children occupying or visiting the building, if the paint is deteriorating or is disturbed. Prior to any renovation or remodeling project in such a facility that is occupied or frequented by young children, a lead inspection by a state-certified person to determine the presence of lead-based paint is recommended, if the presence of such has not already been determined. If lead-based paint will be disturbed during a renovation or remodeling project, lead-safe work practices should be used to avoid unnecessary lead exposure to workers and building occupants. In a "child-occupied facility" as defined in §295.202 of this title (relating to Definitions), any "lead based paint activity", i.e. lead inspection, risk assessment or abatement, must be conducted in accordance with the Texas Environmental Lead Reduction rules, §§295.201-295.220 of this title.

(3) The IAQ Coordinator should review designs and construction activities for all proposed remodeling and renovation activities prior to their initiation.

(4) Minimize volatile organic compounds (VOCs) by purchase and use of low-emitting products, such as paints, varnishes, building materials, furnishings, etc., and processes (wet-sanding drywall). Minimize emissions from new furnishings by airing out the product before installation. Water-based solvents, when available, are preferred.

(5) Hazardous chemicals and substances. Hazardous chemicals as defined in the Health and Safety Code, *§*502.003 and hazardous substances as defined in the Health and Safety Code, *§*361.003, should be managed and disposed of in accordance with all applicable state and federal laws.

(6) Scheduling. Occupant exposure to contaminants should be minimized by scheduling renovations that may produce contaminants or uncomfortable conditions when the building is unoccupied.

(7) Isolation. Ventilation and barrier control strategies to isolate construction areas from the occupied areas should be used. Increase ventilation in occupied areas if necessary to control odors from construction area. The area of renovation should be kept under a negative pressure relative to occupied areas during renovation periods.

(8) Remediation of toxic contaminants. Procedures appropriate for toxic contaminants (lead, microbial, asbestos, hazardous chemical, etc.) should be utilized if such contaminants are expected or discovered during renovation and in some cases must be utilized

under state and federal law.

(9) Filters. Filters should be changed more frequently during contaminant-generating activities, and also replaced after work is completed. The highest possible MERV rated filters should be used during renovation and for a few days after to minimize exposure to renovation related particulates and dust.

(10) HVAC equipment. Ensure that HVAC equipment is protected from damage and entry of contaminants.

(11) Water-damage. Porous building supplies that become water-damaged should be discarded to avoid the potential for mold contamination.

(12) Re-occupancy. All renovated areas should be thoroughly cleaned utilizing high-efficiency particulate air (HEPA) filtered vacuuming and adequately ventilated prior to re-occupancy.

(c) HVAC system testing. For new construction and major remodeling, the HVAC systems in those areas should be tested and balanced by an independent certified contractor at the completion of construction or remodeling.

(d) Commissioning of building. Building commissioning of new and/or renovated buildings should be provided by a trained and knowledgeable commissioning authority according to recognized national standards to assure proper operation of all building systems.

(e) Design documentation. Design documentation including the owner's project requirements (design intent), and basis of design should be retained for the life of the facility. As-built documents should be prepared during construction and retained at the facility.

(f) Monitoring activities. Construction and renovation activities should be monitored by the owner's representative, facility IAQ coordinator, and commissioning authority.

(g) Ventilation protocols. Ventilation protocols should be developed to include proper area exhaust rates and pressurization requirements to be used during repairing and remodeling. During initial occupancy of a new area and during re-occupancy following repairs or renovations, the fresh air rate and the total air supply rate may need to be increased until any out gassing of the new material has decreased to a level that will not cause adverse heath effects to the occupants.

§297.5. Building Operation and Maintenance Guidelines.

(a) Written preventive maintenance program. A written preventive maintenance program should be established for each public building to provide a healthy environment. The program should include procedures for the following.

(1) HVAC Systems

(A) Filters. A system filter change-out program should be developed and implemented. A filter upgrade program should be implemented if the filters do not meet the

latest recommended efficiency of MERV 9 or higher. Some low capacity air handlers may only have sufficient capacity to utilize MERV 6 filters.

(B) Coils and condensate drain systems. A cleaning program of the coil and condensate drain systems of the HVAC systems should be developed and implemented.

(C) Cleanliness. The air supply and return systems and mechanical rooms should be kept clean and properly maintained.

(2) Sewer traps. A sewer trap maintenance program should be developed and implemented to prevent sewer gas back drafts into buildings.

(3) Emergency response plan. An emergency response plan for water leaks and other contaminant problems should be developed and utilized.

(4) Records. A written maintenance record program should be developed and implemented.

(5) Maintenance requirements. Adherence to product manufacturers' maintenance requirements should be required as a minimum.

(6) Recommissioning. Scheduled recommissioning of the facilities should be conducted to facilitate efficient and healthy building operations.

(b) Training. Personnel should be educated and trained in the prevention, recognition, and resolution of IAQ concerns.

(c) Scheduling maintenance. Schedule and conduct maintenance activities that could produce high emissions (painting, roofing repair, pesticide applications) to minimize occupant exposure to indoor air contaminants. Develop and utilize effective ventilation protocols based on system capabilities, occupancy, and contaminant characteristics for each facility and operation. Increase ventilation in occupied areas as necessary to control odors.

(d) Housekeeping.

(1) Custodial program. A written custodial program should be developed with specified cleaning procedures, schedules, quality levels, and chemicals allowed for each facility.

(2) Storage. Storage and janitorial rooms should be kept clean and properly maintained. Air handling rooms should not be used for storage.

(3) Supplies. Maintenance and operational supplies should be kept in order and properly labeled in a clean, dry room to prevent contamination of the air and infestation of insects and rodents. Material safety data sheets (MSDS) for all products should be readily accessible.

(4) Cleaning procedures. Cleaning procedures and equipment should be selected to be effective and to minimize airborne dust.

(5) Walk-off Mats. Use walk-off mats (barrier mats) to trap dirt at all entry ways into the building, including pedestrian entrances, loading docks, receiving areas, freight entrances, and garages.

(e) Tobacco products. The use of any smoking tobacco products or smokeless tobacco products by employees or visitors should be prohibited in government buildings, within twenty feet of any entrance, and within twenty feet of the building's fresh air intakes. The use of such tobacco products should be permitted only in outside areas that have been designated for "Tobacco Product Use."

(f) HVAC systems.

(1) Outside air. The HVAC systems should be operated to provide acceptable outside air with quantities in conformance with the most current and accepted standard, such as ASHRAE Standard 62, up to the equipment capabilities. Proper operation and flow rates should be verified annually. The outside intake should be covered with a grill to prevent insects or birds from entering the intake ducts; the grills need to be routinely inspected and cleaned to prevent clogging by dirt and debris. In humid areas, the outside air should be humidity-controlled if the outside air is vented directly into occupied spaces, is continuously left running, or the HVAC unit cannot handle the humidity load on very hot and humid days.

(2) Positive pressure. The HVAC systems should be operated to provide a positive building pressure to significantly reduce the entry of outside contaminants, and provide more effective temperature and humidity control.

(3) Moisture control. The HVAC systems should be operated to prevent excessive moisture that could cause microbial growth or high humidity.

(4) Ducts.

(A) Inspection. Periodic (annually is recommended) visual inspection of ducts for mold, dirt and deterioration should be performed.

(B) Cleaning. Routine cleaning of ducts in well-maintained systems (i.e. systems that are sealed properly, have high efficiency filters that are correctly installed, and are being maintained per the manufacturers' instructions) is rarely required. Cleaning of ducts internally lined with fibrous or soft material that can be damaged by mechanical cleaning devices is discouraged. Replacement of these types of contaminated lined ducts is preferred. If need is indicated, the ducts should be cleaned using methods that will not expose occupants to potentially harmful substances. Where applicable, the National Air Duct Cleaning Association standards are recommended. The use of "blown in" chemicals to clean, seal or sanitize ductwork is discouraged.

(C) Replacement. When a duct is repaired or replaced, those with internal surfaces that are easily cleaned, not damaged by typical cleaning methods, do not harbor dust and microbials, and that will not emit materials or gases that can harm the occupants should be used.

(5) Drain pans. Condensate drain systems should be free of microbial growth and other debris. The condensate pan should drain completely so there is no standing water. The use of unregistered chemicals in the drain pans or on the coils to reduce mold growth that could cause air quality problems for the occupants is discouraged.

(6) Exhaust air. Exhaust air systems should be operating properly and vented to the outside. Proper operation and flow rates should be verified annually.

(7) Preconditioning. The HVAC systems should be operated for sufficient time prior to building occupancy to remove contaminants and to condition the air.

(8) Access. If existing access to the HVAC systems does not allow proper inspection and maintenance, access ports, preferably hinged with good seals and latch(es), should be installed.

(9) Responsibility. Assignment of responsibilities for maintenance and operations of all areas and systems is essential to an indoor air quality program.

(10) Documentation. Documentation provided by design, construction and renovation projects must be maintained and updated.

(11) Standards. Maintenance standards should be developed and maintained for all systems and operations.

(g) Microbial management. The control of the conditions that allow or encourage microbial growth should be a primary objective of building operations and maintenance.

(1) Water intrusion. Damaged building systems or components that cause water condensation or water leaks in the building should be promptly repaired. Inspect the building for evidence of water damage and visible mold growth and promptly correct the problem. Areas that go unattended can soon become major problem areas.

(2) Water damage. Porous materials that cannot be dried within 24-48 hours usually cannot be saved without great expense. Remove and dispose of water- damaged porous materials, such as sheetrock, fiberglass or cellulose insulation, carpets, mattresses, pillows, upholstered furniture, papers, and books. If water damage is from floodwaters that may contain sewage or from sewage backup, the water-damaged porous materials should be replaced and special cleaning is required for all hard surfaces. If large areas are water-damaged, desiccants and/or dehumidifiers may be necessary to remove excess humidity and prevent mold growth.

(3) Cleaning/replacement. Promptly clean or replace materials contaminated with mold or other microbials. Contaminated porous materials should be replaced. Take precautions to prevent exposures to workers/occupants when cleaning and/or disinfecting with chemicals. When removing contaminated materials, handle the material carefully and gently to avoid dispersion of contaminant, and bag the material prior to removal from contamination site to prevent further contamination of adjacent areas.

(4) Construction, operation and maintenance. To prevent microbial growth:

exhaust the air directly to the outside in high moisture areas; prevent condensation on cold surfaces (i.e. windows, piping, exterior walls, roof or floors) by adding insulation, raising the temperature and increasing circulation; prevent water intrusion from rain and ground water by proper maintenance of the landscape, roof, and exterior structure materials; maintain relative humidity below 60%, preferably below 50%, at all times if possible; do not install carpet in areas where there is a potential moisture problem; and check the installation and operation of moisture barriers, weep holes, HVAC systems, roof, windows, and vents.

(5) Water systems. Ensure that the following water systems are built, operated and maintained to prevent the growth of *Legionella* and other microorganisms that can become airborne: potable water systems, emergency water systems, heated spas, whirlpool baths, drip pans, architectural fountains, waterfall systems, cooling towers, fluid coolers, evaporative condensers, direct evaporative air coolers, misters, air washers and humidifiers. Treatment for these systems includes the use of chemicals, ionization and/or heat, depending on the system. Additional guidance can be found in ASHRAE Guideline 12-2000 "Minimizing the Risk of Legionellosis Associated with Building Water Systems."

(6) Pest, bird and animal control.

(A) Prevent entry. Pests, birds, bats, rodents and other wild animals should not be allowed to roost in or enter occupied buildings, including attics, plenums or in or near fresh air intakes, as they may carry disease and/or produce conditions conducive to the growth of disease-causing microbials. Professional assistance may be necessary for the removal of potentially dangerous live animals or if the area is heavily infested.

(B) Contamination. Areas contaminated with animal urine, feces, nesting materials, etc. should be decontaminated, i.e., physical removal of waste and disinfecting of the area. Protection for building occupants and workers should be required during the process, using the procedures of United States Department of Health and Human Services (DHHS): "*Histoplasmosis: Protecting Workers at Risk,*" DHHS (NIOSH) Publication Number 97-146, September 1997.

(7) Remediation. Microbial contamination on surfaces or in water reservoirs is unacceptable and should be removed by qualified personnel according to current recognized guidelines and standards to avoid dissemination and worker/occupant exposure. Appropriate steps should be taken to prevent future growth in these locations, without causing occupant exposure to potentially harmful chemicals.

(8) Sewage backups. Building occupants should be removed from any area flooded by sewage. The cleanup should ensure rapid decontamination (to include water extraction, cleaning and disinfecting) and drying of all wet surfaces. Contaminated porous materials should be replaced.

(h) Animals. If building activities require or allow certain animals in the building, ensure that they are in a controlled area with proper ventilation, are contained in enclosures that can easily be cleaned and that all animal waste is removed daily.

(i) Plants. Plants should be maintained in a healthy and clean condition. Plants that have

been over-watered, over-fertilized, or have insect infestations contribute to poor air quality. The benefits of well-maintained plants in improving indoor air quality are insignificant in large areas or buildings.

(j) Loading dock operation. Vehicle exhaust should be prevented from entering enclosed work spaces (including air intakes and building openings) by installing barriers to airflow from loading dock areas (i.e. doors, curtains, etc.) and using pressurization.

(k) Remediation of contaminants. Use recognized best practices for the removal of toxic contaminants of concern (lead, microbial, asbestos, chemical, etc.) when performing maintenance, repairs or remediation. Always follow any applicable state and federal laws.

(l) Cleaning products.

(1) Toxicity. The least toxic cleaning products needed to accomplish the task should be used. Sanitizers are not recommended for general cleaning.

(2) Directions. Follow manufacturer's directions for cleaning products. The use of excessive amounts of cleaning materials can cause unacceptable IAQ.

(3) Training. Assure that all personnel using cleaning products and hazardous chemicals have been trained in the proper usage and handling of such products as required by the Texas Hazard Communication Act, the Health and Safety Code, §502.010.

(4) Labeling. The employer shall follow the labeling requirements of the Health and Safety Code, §502.007.

(5) Ventilation. Adequate ventilation during and immediately after use of cleaning products should be used to minimize exposure to potentially harmful or irritating substances in the products.

(6) Scheduling. Schedule the use of cleaning products when building is unoccupied to minimize exposure to students, staff and other occupants.

(m) Pesticide use.

(1) Management. Pest management, for both building and lawn care, should emphasize non-chemical management strategies whenever practical, and least toxic chemical controls when pesticides are needed.

(2) Products. Pest control products used in and around a building should be documented and a Material Safety Data Sheet (MSDS) made available for building occupant review if requested. Either a written procedure or contract language will ensure that people who use pest control products read and follow all label directions for proper use, mixing, storage, and disposal.

(3) Statutes. Pest management for schools must be in accordance with the Structural Pest Control Act, Texas Revised Civil Statutes, Article 135b-6, §4J and 22 Texas

Administrative Code, §595.11 (relating to schools). These protocols are recommended for all other government buildings.

(4) Contracting. When contracting for pest control services, the use of businesses that conform to the standards set forth in 22 Texas Administrative Code §595.14 relating to Reduced Impact Pest Control Service, is recommended.

(5) Removal. Dead pests should be promptly removed from the premises.

(n) Emergencies. An emergency response plan, including staff training, should be developed for chemical spills, release of hazardous air contaminants, and similar events. Such response measures may be required by state or federal law in some circumstances.

(1) Ventilation. The required outside ventilation air rate should not be interrupted during building operation unless a known contaminant presents an immediate concern of entering the building's outside air intake. Consider the use of high efficiency and carbon-filtered outdoor air to improve general IAQ and reduce potential impact of intentionally released contaminants. Outdoor air intakes should be able to be closed manually in case of an intentional release of contaminants outside.

(2) Airborne Chemical, Biological, or Radiological Attacks. Guidance is available from the United States Department of Health and Human Services (DHHS): *"Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks,"* DHHS (NIOSH) Publication No. 2002-139.

(o) Records.

(1) Material safety data sheets. A public employer shall maintain a legible copy of the current Material Safety Data Sheet for each hazardous chemical used or brought into the workplace including those in cleaning supplies, pesticides and art supplies in accordance with the Health and Safety Code, §502.006.

(2) Workplace chemical list. The employer shall prepare a workplace chemical list if required by the Health and Safety Code, §502.005.

(3) Facility chemical list. The employer shall prepare a facility chemical list (also known as a Tier Two report) if required by the Health and Safety Code §506.006.

(4) Maintenance records. Maintenance should be documented by a signed and dated report or check-off list.

§297.6. Recommended Building Occupant Responsibilities.

(a) Cleanliness. Offices, classrooms, workrooms, mechanical rooms and supply areas should be kept clean and orderly to prevent contamination of indoor air and conditions conducive to insect or rodent infestations.

(b) Product usage. Products such as pesticides, air fresheners (including plug-ins), scented products (including candles), spray products, and other materials that may be a health concern, should not be used.

(c) Work activities. Use the least toxic instructional or work materials (markers, glue, art supplies, etc.) that will serve the intended purpose. When activities/projects generate air pollutants, steps should be taken to minimize impact, such as using local exhaust fans or opening windows.

(d) Diffusers and grills. Supply air diffusers and return air grills should be kept free and clear of any obstructions.

(e) Mechanical Rooms. Mechanical rooms and/or closets housing HVAC systems should not be used for storage.

(f) Spills. Spills should be cleaned up promptly and properly. Materials to cleanup the spills of hazardous chemicals must be disposed of in accordance with all applicable state and federal laws.

(g) Pets. Animals should be maintained in such a manner to prevent IAQ problems.

(h) Sensitive individuals. Carefully consider and, to the extent feasible, accommodate the needs of sensitive individuals by the following.

(1) Consulting. Individuals with allergies or chemical intolerances should consult, as necessary, with health officials, and their physicians.

(2) Locating. Locate sensitive individuals away from potential sources of symptom-triggering substances and activities.

(3) Discouraging. Discourage the use of scented personal care products or other scented products that may cause adverse reaction in sensitive individuals.

(i) Food. Food should be stored in airtight containers and refrigerated if necessary. Applicable food policies should be followed.

(j) Garbage. Waste containers should be stored properly, emptied regularly, and located away from air intakes or other sensitive areas.

(k) Tobacco policy. Employees and visitors entering a government building will abide by the building's written "Tobacco Policy."

(l) Portable air cleaning devices. Portable air cleaning filtration devices may be of limited help in cleaning a small area. They must be properly maintained to be beneficial.

(m) Ozone-generating devices. Ozone-generating devices should not be used in occupied spaces. Ozone is a lung irritant.

(n) Reporting. Promptly report IAQ problems/complaints to the IAQ coordinator or designee.

(o) Medical care. Any building occupant experiencing chronic or serious health

problems is encouraged to seek appropriate medical care, and work with medical professional(s) to manage the illness.

§297.7. Assessing and Resolving IAQ Problems.

(a) Written plan. A written plan should be developed as part of the building indoor air quality plan to include specific steps for investigating and resolving IAQ problems. Each facility or governmental entity should decide when and if investigations will be handled by in-house staff or if outside assistance is needed.

(b) Complaint response. All IAQ complaints should be acknowledged and investigated as quickly as possible. A written record should be kept of the complaint, investigation findings and resolution.

(c) Information gathering. The person(s) complaining or reporting an IAQ situation should be interviewed by a trained IAQ coordinator or qualified individual to gather as much information as possible. This information should include the nature of the complaint, the timing, complainant's symptoms, health effects, observed conditions at time of symptoms, such as odors, weather, occupant activities, and specific location(s) of problem(s). If several people and locations are involved, an occupant questionnaire can be used to help determine if the problem covers a specific location or is throughout most of an area or building, and if there are one or more problems. Results of the questionnaire may also be used to compare with building drawings to locate causes of the problem(s) and sources.

(d) On-site inspection. The complaint area should be inspected to locate any problem conditions or materials. Measuring temperature and humidity is recommended. Any visible microbial, chemical or material contamination sources, including the presence of odors, should be noted. During the inspection, the information gathered from the interviews should be compared with possible health effects of various contaminants and their sources, such as listed in Table 1, in §297.8(b), to aid in determining possible sources and contaminants to look for in the problem and related areas.

(e) HVAC system. The operation and condition of the HVAC system should be verified to ensure that adequate acceptable outside air provisions are being met. Check for drafts or stagnant areas. Check whether the layout of air supplies, returns, and exhausts promotes efficient air distribution to all occupants and isolates or dilutes contaminants. Check for short circuiting, airflow patterns and air velocity in occupied zone. Possible exterior contamination sources, such as vehicle exhausts, maintenance and construction operations and levels of natural exterior allergens should be noted.

(f) Resolution. Resolution of problem conditions determined as a result of occupant interviews and on-site inspections are often the only actions needed to resolve the complaint.

(g) Testing. Performing tests for contaminants of concern and factors affecting IAQ, unless conducted at the time of exposure, are unlikely to locate or measure a transient condition, and are not recommended for most investigations. If specific conditions are suspected and a need for verification testing is required, based on the visual inspection, health symptoms, clinical data and contents, and practices of the facility, then appropriate test methods should be performed by qualified personnel. Laboratory analysis of samples, where required, should be performed by a laboratory recognized or, preferably, certified in performing the analyses

requested. Equipment utilized in the evaluation procedures should be calibrated according to manufacturers' recommendations and the sampling methods utilized. Outdoor samples may be needed for comparison with indoor samples for some conditions, such as temperature and relative humidity, and some contaminants, such as carbon dioxide and air-borne mold.

(h) Evaluating data and exposures.

(1) Before any sample collection, a standard of comparison and/or recognized acceptable standards should be selected. (i.e., carbon dioxide 700 ppm above outside level).

(2) Compare samples collected to standards established by the same testing methods.

(3) Compare indoor and outdoor sample results if appropriate.

(4) Compare sample results to the symptoms and complaints using standard toxicological procedures.

(i) Remediation. If suspected or other contaminants are identified, perform any necessary remediation using established and appropriate control methods for the situation.

(j) Communication. Any perception by building occupants that management is withholding information about an indoor air problem can be very damaging. Steps should be taken to ensure that up-to-date information is provided to building occupants and other concerned parties regarding any on-going IAQ investigations, survey results, planned repairs or remediation projects.

(k) Hiring professional assistance.

(1) Professional companies or contractors hired to solve, prevent, or control IAQ problems should provide evidence of meeting minimum criteria, to include at least:

(A) Education. The contractor should provide evidence of having obtained formal education appropriate to the scope of their professional expertise.

(B) Training. The contractor should provide a record of all training in IAQ issues for all workers, as appropriate.

(C) Licensure. Contractors performing services that require licensure, such as physicians, engineers, architects, lawyers, asbestos or lead abatement contractors, and similar categories, should provide proof of licensure.

(D) Experience history. The contractor should provide verifiable references for at least five projects of similar size and scope.

(E) Compliance history. The contractor should provide a list of all compliance actions initiated by the U.S. EPA, U.S. Occupational Safety and Health Administration, the Department, the Texas Commission on Environmental Quality (formerly the

Texas Natural Resources Conservation Commission) or similar local agencies that are applicable to the job.

(F) Proof of insurance. The contractor should provide proof of insurance that includes general liability and/or errors and omissions coverage, as appropriate, to cover the job.

(G) Equipment. The contractor should have knowledge and skill to use the proper testing and inspection equipment needed to perform the job.

(2) Avoid conflicts of interest. Ensure that contractors are not in a position of (or the appearance of) creating work for themselves, nor inspecting or approving their own work.

§297.8. Guidelines for Comfort and Minimum Risk Levels.

(a) IAQ comfort. Comfort is an important part of indoor air quality. The major comfort issue is thermal comfort that involves temperature, relative humidity, and air velocity. Other comfort issues not covered here but that could affect the indoor environment are lighting, noise, and vibration. Maintaining the proper temperature range is not sufficient to achieve thermal comfort; it is also necessary to properly control the combination of temperature, relative humidity and air velocity.

(1) Temperature. The room temperature for a typical occupied office or classroom environment should be kept between 72 to 76 degrees Fahrenheit in the summer and 70 to 75 degrees in Fahrenheit in the winter and controlled within a temperature range of ± 2 degrees in Fahrenheit for a given day. Temperature at body and head height and near the floor needs to be considered. Occupant preferences, activity and attire will influence the comfort. Additional guidance documents for other situations are available, including ASHRAE Standard 55-1992 and 55a-1995.

(2) Relative Humidity. The relative humidity for a typical occupied office or classroom environment should be generally between 30 to 50%. The relative humidity should never exceed 60% due to potential mold growth. In geographical regions where the outdoor relative humidity is typically below 30%, no humidification is recommended if the occupants do not complain of discomfort due to the dryness.

(3) Air Velocity. Some air movement is recommended to avoid a feeling of stagnant air, typically 25 to 55 feet per min (fpm). Higher air speeds may be acceptable if the affected occupants have control of local air speeds. Air supplied to the occupied zone (standing and sitting positions) should be supplied at a moderate velocity within the recommended temperature and relative humidity ranges. Air supplied from a diffuser at elevated speeds can create drafts in the occupied zone, causing complaints of too hot or too cold, dry eyes, sore throats and nasal irritation. Directing diffusers directly onto occupants' work zones or directly overhead may cause occupants discomfort, resulting in them "modifying" the supply system (e.g., placing cardboard over diffusers). The system should be properly tested and balanced. The appropriate supply and exhaust diffusers based on the occupant locations should be installed. These diffusers should supply air at an acceptable temperature and humidity. Additional guidance documents are available, including ASHRAE Standard 55-1992 and 55a-1995.

(b) Minimum risk levels. Table 1 in paragraph (4) of this subsection provides Minimum Risk Levels (MRLs) for common contaminants found in indoor air. The MRLs in Table 1 are not IAQ standards. There are no required federal or Texas standards for indoor air contaminants. The MRLs are based on the data contained in the Texas Commission on Environmental Quality's (formerly the Texas Natural Resources Conservation Commission) Effects Screening Levels List (July 19, 2000), the Agency for Toxic Substances and Disease Registry's (ATSDR) Minimal Risk Levels for Hazardous Substances (December 2001), and the Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) inhalation RfC values and the National Primary and Secondary Air Quality Standards (40 CFR 50). These information sources can be used as a reference for other contaminants not listed in Table 1.

(1) These levels are based on inhalation for an eight hour exposure for the general public. If a particular contaminant is expected to last significantly longer, the MRL should be lowered to compensate for the longer duration. The references in subsection (b) of this section may have this information. For one year, a reasonable approximation is to multiply the 8-hour MRL by 0.14.

(2) Most of the MRLs are at a no-observed-adverse-effect-level. They are set below levels that, based on current information, might cause adverse health effects in the people most sensitive to such substance-induced effects. If the indoor levels of contaminants in air exceed the MRL, it does not necessarily indicate a problem, but should trigger a concern for a more in-depth evaluation of the potential health effects or to reduce the concentration below the MRL. Most of the MRLs are based on non-cancer health effects only.

(3) The MRLs are expressed in units of parts per million (ppm) for most gases and volatiles, or milligrams per cubic meter (mg/m^3) for particles and some volatile organic compounds (VOCs).

(4) Table 1. Common Indoor Air Conditions/Contaminants in Government Buildings.

§297.9. Lease Agreements.

Whenever a government entity leases from or to another public or private entity, a clause should be included in the lease agreement to require the property owner/property management to comply with all applicable sections of the current Texas Department of Health Voluntary Guidelines for Indoor Air Quality in Government Buildings.

§297.10. Special Considerations.

(a) Hospital facilities. Refer to Texas Department of Health, Hospital Licensing, Physical Plant and Construction Requirements, New Construction Requirements, (25 Texas Administrative Code §133.162) (the Texas Hospital Licensing Law, Health and Safety Code Chapter 241), regarding ventilation requirements, general mechanical requirements, performance and acceptance of hospital facilities, and HVAC requirements, (25 Texas Administrative Code §133.169).

(b) Correctional facilities. When correctional facilities consider these guidelines, they must also consider compliance with all of the regulations that may affect their mission to protect the general population by securely housing the criminal offenders of the State. Security issues or the original structure of earlier facilities may prevent certain ventilation practices from being incorporated into existing facility designs. The building owner/operator should prioritize projects based on the criteria above and complete those projects based on hazard concerns and financial ability.

(c) Child-frequented facilities. Greater diligence should be taken to ensure indoor air quality in facilities occupied or frequented by children, such as schools and childcare facilities. Children are considered at higher risk for health problems from poor indoor air quality than are adults.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines [1]	Comments
Temperature	Weather, occupants, equipment, and HVAC systems.	Normally a comfort and productivity issue; high temperature may cause heat stress.	72 to 76 degrees Fahrenheit in the summer and 70 to 75 degrees Fahrenheit in the winter. Control within range of ± 2 degrees Fahrenheit for a given day.	Comfort related to temperature, relative humidity (RH), air velocity, and occupant preferences, activity and attire.
Relative Humidity (RH)	Moisture produced from weather, occupants, and other water sources.	Normally a comfort and productivity issue; high RH may cause "sticky feeling", and moisture damage to building contents; low RH may cause dry/itchy eyes, mucous membranes and skin.	30-60 % 30-50 % preferred for better mold prevention. For low RH regions: <30% acceptable if no occupant discomfort	Comfort related to temperature, RH, air velocity, activity and attire. Below 50% prevents most mold growth.
Air Velocity	HVAC systems, individual and equipment fans, significant area pressure changes.	Being too hot or too cold within the recommended temperature and relative humidity ranges, dry eyes, sore throats and nasal irritation.	25 to 55 feet per min (fpm).	Comfort related to temperature, RH, air velocity, activity and attire
Allergens (allergy is a hypersensitivity to a substance that does not normally cause a reaction)	Allergies may be caused by protein or an antigen. Animal dander, cockroach droppings, dust mite fecal matter, insects and insect parts, dust, latex.	Sneezing, runny or congested nose, coughing, wheezing, postnasal drip, sore throat, watering eyes, itching eyes, nose and throat, and allergic shiners (dark circles under the eyes).	Allergens: Cat: 8 µg/g Dust Mite: 2 µg/g Cockroach: 5 µg/g	According to National Institute of Health as many as 50 million Americans are affected by allergic diseases.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines [1]	Comments
Asbestos (fibrous material)	Building materials such as ceiling textures, wall compounds, resilient floor covering, pipe insulation.	Lung cancer, asbestosis, dyspnea, interstitial fibrosis, restricted pulmonary function and eye irritation.	0.01 fibers per cubic centimeter (f/cc)	Asbestos containing materials should not be used or installed in building.
Carbon Dioxide (CO_2) (Odorless gas)	Occupants' respiration; unvented or poorly vented indoor combustion sources; vehicle exhaust via traffic and parking garages; and outside air.	Indicator of amount of outside air in area. High levels may result in complaints of odors, "stuffy air", sleepiness, fatigue, and headaches.	700 ppm above outdoor level - should trigger concern over adequate fresh air.	Acceptable levels should prevent complaints of odors (body odors) and stuffy air.
Carbon Monoxide (CO) (Odorless gas)	Outside air, unvented or poorly vented indoor combustion sources, such as gas heaters and appliances; and vehicle exhaust in parking garages.	Headaches, dizziness, and nausea. At moderate concentrations, angina, impaired vision and reduced brain function. High levels can be fatal.	9 ppm for 8 hrs. 35 ppm for 1 hr If the inside CO level exceeds the outside CO level, look for a possible inside source.	If high levels of CO suspected, remove occupants. Blood analysis can verify exposure if done within an hour.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines [1]	Comments
Environmental Tobacco Smoke	Tobacco combustion.	Group A carcinogen by EPA, respiratory effects, multiple effects on children.	No level is considered acceptable, particularly for children and non-smokers.	Surgeon General recommends smoking only be allowed inside buildings if smoking area has separate ventilation system.
Formaldehyde (HCHO) (pungent odor)	Pressed-wood products (e.g. furniture and furnishings), embalming fluid, textiles and foam insulation.	Irritant of eyes, and respiratory tract, sensitizer, and possible carcinogen.	0.04 ppm Odor Threshold: 0.05-1.0 ppm	Tobacco smoke and other combustion sources are secondary sources.
Fungi (mold, mildew, yeasts) (biological)	Outdoor air-not normally a major source in building with good air filtration systems. Wet/damp building materials and furnishings, particularly after 24 hours. Air handling systems. Poorly maintained indoor plants. Spoiling food.	Allergies (most common) - Sneezing, runny or congested nose, coughing, wheezing, and postnasal drip, sore throat, watering eyes, and itching eyes, nose and throat. Difficulty breathing. Nose, throat, skin and eye irritation, rashes, headaches, and less common symptoms (i.e., aches, fever, fatigue, and central nervous system problems).	Visible mold on surfaces or mold odors is unacceptable. Dry or discard water-damaged materials within 24 hours. Maintain relative humidity <60%(preferably <50%) year round.	Rely on visual inspection, odors, history of moisture problems and occupant complaints and health symptoms. Remove mold growth and eliminate source of moisture.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines [(1)]	Comments
Hydrogen Sulfide (H_2S) (rotten egg odor)	Sewer gas Dry drain traps or broken sewer lines.	Irritant to eyes and respiratory tract, headache, dizziness, and nausea.	0.07 ppm Odor 0.001 ppm	Water must be kept in p-traps of drains that are connected to sewer lines.
Lead (Pb) (dust or fumes containing lead)	Paint, dust, welding and soldering activities and outdoor air.	Brain damage, particularly in children under 6 years old, weakness, and anemia.	0.0015 mg/m^3	Flaking lead-based paint a concern. Certain lead-based paint abatement activities are regulated.
Legionella (bacteria)	Natural and man-made stagnant water sources. Warm conditions and certain pH conditions will accelerate growth.	Legionnaires' disease: form of pneumonia. Mild cough and low fever to rapidly progressive pneumonia and coma. Early symptoms include malaise, muscle pain, and headache; later symptoms include high fever, dry cough and shortness of breath.	Prevent sources of stagnant water, particularly warm sources that rapidly produce bacteria; or if not preventable, periodically chemically or thermally disinfect.	For hot water sources: holding temperature: 140 ^oF; delivery temperature: 122 ^oF, or monthly thermally disinfect.
Mercury (Hg) (Silver-white, heavy liquid metal)	Thermometers, barometers, batteries, fluorescent light bulbs, blood pressure devices and electrical switches.	Irritation to eyes, skin, cough, chest pain, trouble breathing depending on exposure.	0.0002 mg/m^3	

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines (1)	Comments
Nitrogen Dioxide (NO_2) (acrid odor)	Leaking vented combustion appliances, unvented combustion appliances, outdoor air, diesel engines near loading docks. Welding, tobacco smoke.	Irritation to eyes, nose, throat. May induce cough. At higher concentrations depending on exposure time may result in chronic bronchitis, chest pain and pulmonary edema.	0.05 ppm	
Ozone (O_3) (pungent odor)	Electrostatic appliances, office machines, ozone generators, outdoor air.	Irritation to eyes and mucous membranes. Pulmonary edema and exposure times may lead to respiratory disease.	0.05 ppm	Can damage plants, some materials, particularly rubber-containing materials and certain plastics.
Particulate Matter (dust) (non-toxic particles; toxic particles covered elsewhere)	Construction and renovation activities, movement of materials, paper dust from printers, dust-producing activities and numerous outside sources.	Sneezing, coughing and itchy eyes. Some particles more hazardous than others, and can cause irritation to eyes and lungs. Respirable particles of greater hazard concern.	PM_{10} - 150 ug/m^3 (24 Hour)* $PM_{2.5}$ - 65 µg/m^3 (24 Hour) and 15 µg/m^3 (Annual Mean)*	* See 40 CFR 50.7 for definitions and additional information.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines (1)	Comments
Pesticides (includes insecticides, fungicides, rodenticides, termiticide, herbicides, and fumigants.	Direct indoor application of pesticides by occupant or commercial applicator. Outside, particularly near agriculture and fogging for mosquitoes or other pests.	Irritation of eyes and mucous membranes, headache, dizziness, weakness, tingling sensation, nausea, blurred vision, vomiting, tremors, abdominal cramps, chest tightness, and liver damage. Some are possible carcinogen(s). Avoid skin contact with pesticides. Organochlorine and organophophorus pesticides are generally more toxic than other type pesticides.	2,4-D 0.01 mg/m^3 2,4,5-T 0.10 mg/m^3 DDT 0.001 mg/m^3 Aldrin 0.0025 mg/m^3 Benomyl 0.05 mg/m^3 Chlordane 0.005 mg/m^3 Chlorpyrifos (Dursban) 0.002 mg/m^3 Dichlorvos 0.009 mg/m^3 Diazinon 0.001 mg/m^3 Heptachlor 0.0005 mg/m^3 Malathion 0.05 mg/m^3 Paraquat 0.001 mg/m^3 Parathion 0.0005 mg/m^3 Pyrethrum 0.05 mg/m^3 Roundup 0.05 mg/m^3 Sevin 0.050 mg/m^3 Warfarin 0.001 mg/m^3	Avoid use of chemical pesticide treatments if possible. Chlordane, heptachlor, aldrin, and dieldrin should not be used. Chlorpyrifos (Dursban) and Diazinon should not be used indoors. Recommend use of businesses that conform to 22 Texas Administrative Code, §595.14 Reduced Impact Pest Control Services.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines [(1)]	Comments
Radon (Rn) (naturally occurring, odorless, radioactive gas).	Soil, rocks, and water from the natural breakdown (radioactive decay) of uranium. Radon also breaks down into radioactive decay products.	Radon and its decay products emit ionizing radiation which if inhaled can damage the lung tissue and may cause lung cancer over time.	4 picocuries per liter of air (pCi/L)	Buildings can inexpensively be tested for radon.
Sulfur Dioxide (SO_2) (pungent odor).	Unvented space heaters (kerosene), other combustion sources, outdoor air.	Eye irritation, skin irritation, respiratory irritation.	0.01 ppm	
Volatile Organic Compounds (VOCs) (many are odorless, some have odor).	New building materials and furnishings, consumer products, maintenance materials, outdoor air, cleaners, personal care products, tobacco smoke, paints, pesticides, solvents, combustion processes.	May cause variable responses such as irritation of eyes, nose and upper respiratory tract, headaches, lightheadedness, and nausea. A few VOCs have been directly linked to cancer in humans and others are suspected of causing cancer.	Acetone 26 ppm Alkanes C_4-C_{16} (if not listed) 2.5 mg/m^3 Alkanes >C_{16} 0.07 mg/m^3 Aromatic distillates, light 0.17 ppm Aromatic distillates, heavy 0.43 ppm Benzene 0.05 ppm 2-butoxyethanol 6 ppm decane 1.22 ppm Ethylbenzene 1.0 ppm* Gasoline (<0.9% benzene) 0.83 ppm.	For total VOCs: 0.3-3 mg/m^3 - complaints possible; >3 mg/m^3 - complaints likely. Product emission rate should not result in an indoor concentration level greater than 0.5 mg/m^3 of total VOCs.

TABLE 1. Common Indoor Air Conditions/Contaminants in Government Buildings

Condition Or Contaminant	Major Sources	Comfort/Health Effects	MRL Guidelines (1)	Comments
Volatile Organic Compounds (VOCs), Continued			n-hexane 0.6 ppm isobutane 3.4 ppm isopropyl alcohol 2.2 ppm Methylene chloride 0.6 ppm Naphtha, coal tar 0.62 ppm Naphthalene 0.002 ppm** Styrene 0.06 ppm** Tetrachloroethylene 0.2 ppm 1,1,1-trichloroethane 1.4 ppm Trichloroethlyene 0.175 ppm Toluene 1 ppm Xylenes (o,m,p) 1 ppm	* level for 14 to 364 days exposure ** level for 365 days and longer exposure.

(1) MRL = Minimum Risk Level
Concentration units not defined in table:
mg/m^3 = milligrams of contaminant per cubic meter of air
ppm = parts of contaminant per million parts of air (on a volume per volume basis)
µg/g = micrograms of contaminant per gram of material