

Increased Ventilation

SS	WE	EA	MR	EQ	ID
Credit 2					

Intent

Provide additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well-being and productivity.

1 point

Requirements

FOR MECHANICALLY VENTILATED SPACES

- Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2004 as determined by EQ Prerequisite 1.

FOR NATURALLY VENTILATED SPACES

- Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Carbon Trust Good Practice Guide 237 [1998]. Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 1.18 of the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10: 2005, Natural ventilation in non-domestic buildings.

AND

- Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations set forth in the CIBSE Applications Manual 10: 2005, Natural ventilation in non-domestic buildings.

OR

- Use a macroscopic, multi-zone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2004 Chapter 6, for at least 90% of occupied spaces.

Potential Technologies & Strategies

For mechanically ventilated spaces: use heat recovery, where appropriate, to minimize the additional energy consumption associated with higher ventilation rates.

For naturally ventilated spaces: follow the eight design steps described in the Carbon Trust Good Practice Guide 237: 1) Develop design requirements, 2) Plan airflow paths, 3) Identify building uses and features that might require special attention, 4) Determine ventilation requirements, 5) Estimate external driving pressures, 6) Select types of ventilation devices, 7) Size ventilation devices, 8) Analyze the design. Use public domain software such as NIST's CONTAM, Multizone Modeling Software, along with LoopDA, Natural Ventilation Sizing Tool, to analytically predict room-by-room airflows.

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Summary of Referenced Standards

ASHRAE Standard 62.1-2004: Ventilation For Acceptable Indoor Air Quality

American Society of Heating, Refrigerating and Air-Conditioning Engineers

www.ashrae.org

(800) 527-4723

“The purpose of this standard is to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects. This standard is intended for regulatory application to new buildings, additions to existing buildings, and those changes to existing buildings that are identified in the body of the standard. This standard applies to all indoor or enclosed spaces that people may occupy, except where other applicable standards and requirements dictate larger amounts of ventilation than this standard. Release of moisture in residential kitchens and bathrooms, locker rooms, and swimming pools is included in the scope of this standard. Additional requirements for laboratory, industrial, and other spaces may be dictated by workplace and other standards, as well as by the processes occurring within the space. This standard considers chemical, physical, and biological contaminants that can affect air quality. Thermal comfort requirements are not included in this standard.” (ASHRAE 62.1-2004)

Note that although ASHARE Standard 62.1-2004 will be the relevant standard for the vast majority of LEED for New Construction projects, certain low-rise residential projects pursuing LEED for New Construction certification may use ASHRAE Standard 62.2-2004 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings to comply with this credit.

The Carbon Trust Good Practice Guide 237—Natural ventilation in non-domestic buildings—a guide for designers; developers and owners (1998)

www.thecarbontrust.org.uk/energy/pages/publication_view.asp?PubID=4603

“Carefully designed, naturally ventilated buildings can be cheaper to construct, maintain and operate than more heavily serviced equivalents. Occupants generally prefer windows that can be opened, and natural light, both of which are features of well designed, naturally ventilated buildings. The Guide summarizes the benefits of natural ventilation and considers the commercial implications, illustrating the issues by means of case studies.” (The Carbon Trust)

CIBSE Applications Manual 10: 2005, Natural ventilation in non-domestic buildings

www.cibse.org

“This publication is a major revision of the Applications Manual (AM) first published in 1997. At that time, there was a significant expansion of interest in the application of engineered natural ventilation to the design of non-domestic buildings. The original AM10 sought to capture the state of knowledge as it existed in the mid-90s and present it in a form suited to the needs of every member of the design team. Some 10 years on from the time when the initial manual was conceived, the state of knowledge has increased, and experience in the design and operation of naturally ventilated buildings has grown. This revision of AM10 is therefore a timely opportunity to update and enhance the guidance offered to designers and users of naturally ventilated buildings.” (CIBSE)

Approach and Implementation

A green building should provide its occupants with superior indoor air quality

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to support their health, comfort and well-being. A key component for maintaining superior indoor air quality is providing adequate ventilation rates. Under-ventilated buildings may be stuffy, odorous, uncomfortable and/or unhealthy for occupants.

Building ventilation systems, including both active HVAC systems and natural ventilation systems, are designed and installed to introduce fresh outside air into the building while exhausting an equal amount of building air. HVAC systems typically serve other functions as well, including providing thermal comfort for occupants. Building conditioning systems that provide enhanced ventilation air, as efficiently and effectively as possible, will help to maintain a high standard of indoor air quality in the building.

The requirement for this credit is a 30% increase in ventilation rates beyond the amounts required by ASHRAE 62.1-2004 in office buildings at the breathing zone. The ASHRAE 62.1-2004 rates are approximately 15% to 20% lower than the ASHRAE 62.1-2001 rates. The threshold for this credit was developed based on documented research demonstrating indoor air quality benefits from ventilation rates in the 25 cfm/person range. To achieve 25 cfm/person, the increase would be closer to 50%. 30% was chosen as a compromise between indoor air quality and energy efficiency.

Planning & Design Phase

Most projects decide early on whether to have a mechanical ventilation system, a passive ventilation system, or a combination of both. This decision may be influenced by the building size and type, as well as climatic, economic and organizational influences. Figure 1 from CIBSE AM10 provides a decision diagram to aid in making a knowledgeable evaluation. In addition to these considerations, project teams considering natural ventilation

should evaluate site conditions and building design. Potential IAQ problems might result from heavy traffic, nearby polluting industries and neighboring waste management sites.

For mechanical ventilation, the design and operating setpoints of the HVAC system will be the primary influence on ventilation rates in the building. Building owners and designers should determine if increasing ventilation rates beyond ASHRAE Standard 62.1-2004 requirements is a good idea for their facility. The HVAC design and sizing should account for increased ventilation rates if this strategy is applied.

Occupants generally take a primary role in managing ventilation conditions in naturally ventilated buildings by opening and closing windows as necessary and appropriate. Naturally ventilated buildings generally have somewhat more variable ventilation rates than actively conditioned buildings, whose systems are often designed to maintain no less than minimum ventilation requirements through all periods of occupancy.

Strategies

There are three basic methods for ventilating buildings:

- Active Ventilation (i.e., mechanical ventilation)
- Passive Ventilation (i.e., natural ventilation)
- Mixed-mode Ventilation (i.e., both mechanical and natural ventilation)

Projects employing both mechanical and natural ventilation (i.e., mixed-mode ventilation) strategies will need to exceed minimum ventilation rates required by ASHRAE Standard 62.1-2004, Chapter 6 by at least 30%.

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Mechanically Ventilated Spaces— Ventilation Rate Procedure

For mechanical ventilation systems, ASHRAE Standard 62.1-2004, Section 6, outlines procedures for determining ventilation rates for various applications, using either the Ventilation Rate Procedure or the Indoor Air Quality Procedure. The Ventilation Rate Procedure is more straightforward to apply and much more common in practice—and it is the prescribed approach used in EQ Prerequisite 1, Minimum IAQ Performance.

The Ventilation Rate Procedure methodology is found in Section 6.2 of ASHRAE 62.1-2004. The breathing zone outdoor airflow is equal to the sum of the outdoor airflow rate required per person times the zone population, plus the outdoor airflow rate required per unit area times the zone floor area. The standard's Table 6-1 "Minimum Ventilation Rates in Breathing Zone" provides information by occupancy category to determine both the amount of outdoor air needed to ventilate people-related source contaminants and area-related source contaminants. The people-related sources portion of the outdoor air rate addresses actual occupancy density and activity. The area-related sources portion accounts for background off-gassing from building materials, furniture and materials typically found in that particular occu-

pancy. Finally, the required zone outdoor airflow is the breathing zone outdoor airflow adjusted to reflect the "zone air distribution effectiveness" using adjustment factors in Table 6-2 of the Standard. For multiple-zone systems, outdoor air intake flow is adjusted to reflect the "system ventilation efficiency" for the air distribution configuration, using adjustment factors in Table 6-3 of the Standard.

This LEED for New Construction credit requires that applicants demonstrate that the delivered minimum zone outdoor airflow is at least 30% higher than is the minimum airflow required by ASHRAE Standard 62.1-2004 for each zone. Table 1 shows how the sample space used in EQ Prerequisite 1 has attained the 30% increase.

Naturally Ventilated Spaces

Project teams electing natural ventilation have two primary means of demonstrating credit compliance:

- The compliance path found in Chapter 2 of The CIBSE Applications Manual 10 (AM10)

OR

- Documentation using a macroscopic, multi-zone, analytic model that predicts room-by-room outdoor air flow rates.

Table 1: ASHRAE Std 62.1-2004 Ventilation Rate Procedure

Zone Identification			Standard Case: ASHRAE Std 62.1-2004 Verification Rate Procedure								Design Case			
Zone	Occupancy Category	Area (sf)	People Outdoor Air Rate (cfm/person)	Table 6-1 Area Outdoor Air Rate (cfm/sf)	Occupant Density (#/1000 sf)	Breathing Zone Outdoor Air Flow Vbz (CFM)	Table 6-2 Zone Air Distribution Effectiveness Ez	Zone Outdoor Air Flow Voz (CFM)	Table 6-3 System Ventilation Efficiency Ev	Outdoor Air Intake Flow Vot (CFM)	Outdoor Air Intake Flow (CFM)	Zone Primary Air Flow Fraction Vpz (CFM)	Primary Outdoor Air Fraction Zp = Voz/Vpz	% Increase Over Standard
General Office	Office Space	8000	5	0.06	5	680	1.0	680	1.0	680	900	8000	0.09	32%
Training Room	Lecture Classroom	750	7.5	0.06	65	411	1.2	342	0.9	380	500	1400	0.24	32%
Break Room	Conference Meeting	250	5	0.06	50	63	1.0	63	1.0	63	85	500	0.13	36%
Total		9000				1154		1085		1123	1485	9900		32%

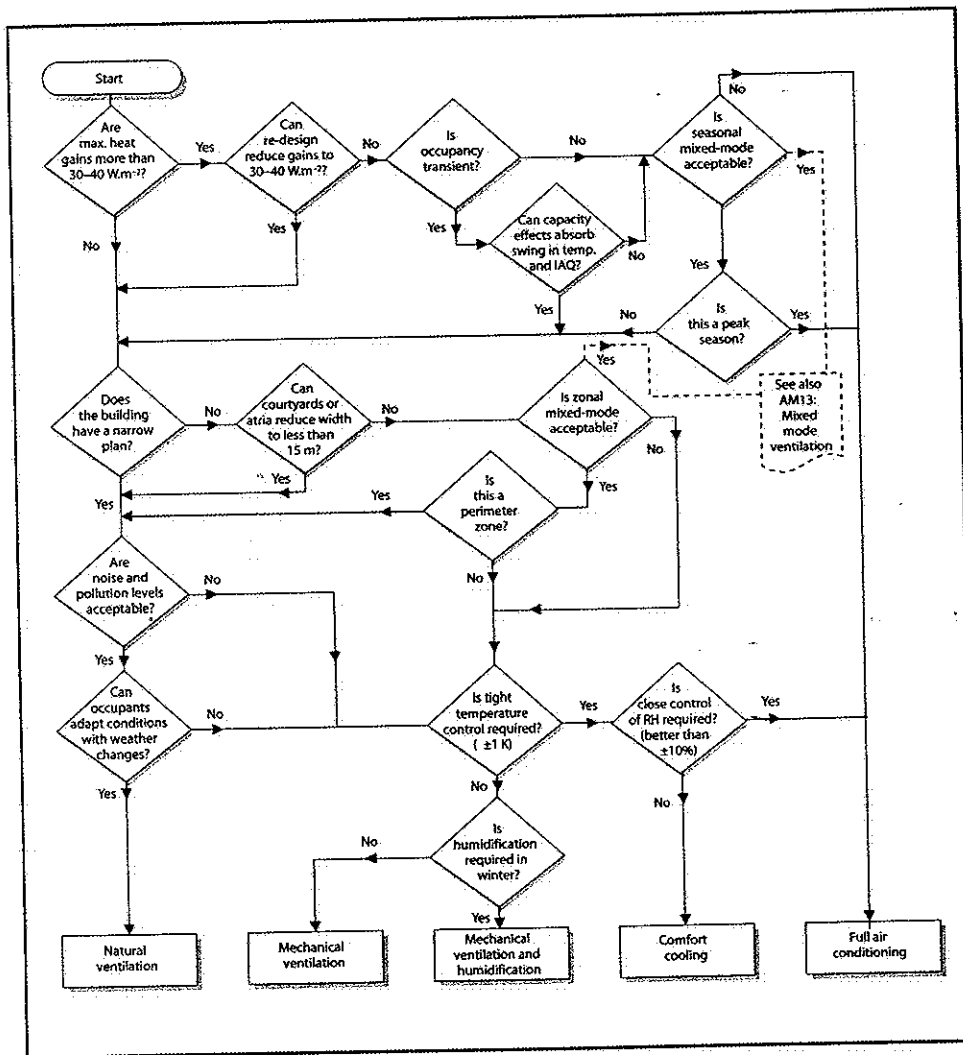
Notes: For the general office space air distribution is overhead, hence $E_z = 1.0$. Outdoor air fraction, $Z_p < 0.15$, hence System Ventilation Efficiency is 1.0. For the training room, air distribution is underfloor, hence $E_z = 1.2$. Outdoor air fraction, $Z_p < 0.25$, hence System Ventilation Efficiency is 0.9. For the break room, air distribution is overhead, hence $E_z = 1.0$. Outdoor air fraction, $Z_p < 0.15$, hence System Ventilation Efficiency is 1.0.

Those using the CIBSE AM10 (see Figure 1) begin by establishing the required flow rates through each space. There is an acceptable average rate needed for IAQ and thermal comfort; increasing this rate results in wasted energy during the heating seasons. There is also additional ventilation needed for the summer cooling requirements.

CIBSE AM10 lists several natural ventilation analysis methods, either using a separate manual or simulation software. Project teams should confirm their choice with justification. Submittals will need to include a narrative that provides informa-

tion on the building, its orientation and the glazing ratios. Include a summary of the internal heat gains and weather conditions. Explain the ventilation strategy, including the airflow paths, the rates planned for different operational periods during the day and night, the peak internal temperatures, and means of shading for summer solar gains. Provide sample calculations on the determination of opening size for operable windows, trickle vents and louvers. Finally, include the calculations for the driving pressure showing the effects of both wind and stack-induced pressure differentials.

Figure 1: Selecting a Strategy, from CIBSE Applications Manual 10:2005, Natural ventilation in non-domestic buildings



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Project teams using a macroscopic, multi-zone, analytic model that predicts room-by-room air flow rates will need to provide a narrative providing the same information listed above. They will also need to demonstrate that 90% of the occupied areas are effectively ventilated, that is to provide minimum ventilation rates required by ASHRAE 62.1-2004, Chapter 6, by natural ventilation and should provide room-by-room outdoor airflow rates predicted by the analysis.

Calculations

For mechanical ventilation systems, project teams should prepare calculations to demonstrate that the design ventilation rates for each zone are at least 30% above the minimum rates required by the Ventilation Rate Procedure of ASHRAE 62.1-2004. This calculation should take the form of a table or spreadsheet similar to **Table 1**. The same calculation may be used to document both EQ Prerequisite 1 and EQ Credit 2.

If this credit is pursued, the design ventilation rates, at least 30% higher than standard ventilation rates, should be incorporated into the energy calculations EA Credit 1. Depending on the system design and climatic factors, increased ventilation may reduce the calculated and actual energy performance of the building.

For naturally ventilated spaces, project teams should provide sample calculations demonstrating how opening size for operable windows, trickle vents and louvers were determined in accordance with CIBSE AM10 and the Carbon Trust Good Practice Guide 237. See **Figure 1**.

For naturally ventilated spaces, project teams using a macroscopic, multi-zone, analytic model that predicts room-by-room air flow rates will need to provide the room-by-room outdoor airflow rates predicted by the analysis and a comparison to minimum ventilation rates

required by ASHRAE Standard 62.1-2004, Chapter 6.

Exemplary Performance

This credit is not eligible for exemplary performance under the **Innovation in Design** section.

Submittal Documentation

This credit is submitted as part of the **Design Submittal**.

The following project data and calculation information is required to document credit compliance using the v2.2 Submittal Templates:

Mechanically Ventilated Buildings

- Confirmation that the breathing zone ventilation rates in all occupied spaces have been designed to exceed the minimum rates required by ASHRAE Standard 62.1-2004 or the applicable local code, whichever is more stringent, by a minimum of 30%.
- Design narrative describing the project's ventilation system design. Include specific information regarding the fresh air intake volume for each specific occupied zone to demonstrate that the design exceeds the referenced standard or the applicable local code, whichever is more stringent, by at least 30%.

Naturally Ventilated Buildings

- Confirmation that the natural ventilation system has been designed to meet the recommendations set forth in the Carbon Trust Good Practice Guide 237 [1988].
- Design narrative describing the design method (CIBSE Method/Analytic Model) utilized in determining the natural ventilation design for the project. Provide specific information regarding calculation methodology

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American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

www.ashrae.org

(404) 636-8400

Advances the science of heating, ventilation, air conditioning and refrigeration for the public's benefit through research, standards writing, continuing education and publications. To purchase ASHRAE standards and guidelines, visit the bookstore on the ASHRAE Web site and search for the desired publication.

Building Assessment, Survey and Evaluation Study

U.S. Environmental Protection Agency

www.epa.gov/iaq/largebldgs/base_page.htm

Building Air Quality Action Plan

U.S. Environmental Protection Agency

www.epa.gov/iaq/largebldgs/actionpl.html

The Chartered Institution of Building Services Engineers (CIBSE)

www.cibse.org

This organization, located in London, on its own and in collaboration with other entities, publishes a full series of guides on the topic of ventilation, including natural ventilation.

Definitions

Air Conditioning is the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness and distribution. (ASHRAE 62.1-2004)

Breathing Zone is the region within an occupied space between planes 3 and 6 ft. above the floor and more than 2 ft. from the walls or fixed air-conditioning equipment.

Conditioned Space is that part of a building that is heated or cooled, or both, for the comfort of occupants. (ASHRAE 62.1-2004)

Contaminant is an unwanted airborne constituent that may reduce acceptability of the air. (ASHRAE 62.1-2004)

Exfiltration is uncontrolled outward air leakage from conditioned spaces through unintentional openings in ceiling, floors and walls to unconditioned spaces or the outdoors caused by pressure differences across these openings due to wind, inside-outside temperature differences (stack effect), and imbalances between supply and exhaust airflow rates. (ASHRAE 62.1-2004)

Exhaust Air is the air removed from a space and discharged to outside the building by means of mechanical or natural ventilation systems.

Infiltration is uncontrolled inward air leakage from conditioned spaces through unintentional openings in ceilings, floors and walls from unconditioned spaces or the outdoors caused by the same pres-

and/or model results to demonstrate that the ventilation design complies with the referenced standards.

Considerations

Cost Issues

Increasing ventilation rates by 30% beyond ASHRAE Standard 62.1-2004 will yield higher HVAC energy costs and potentially greater HVAC capacity than associated with the ventilation rates established in the standard. This increase in HVAC capacity and energy use will be more pronounced in extreme climates than in mild, temperate climates. Some projects may choose to increase the outdoor air rate, and accept higher HVAC equipment and energy costs, because research indicates that the resulting indoor air quality is associated with improved employee health, welfare, well-being and productivity.

While a naturally ventilated building may have less equipment than a comparable mechanically ventilated building, natural ventilation designs may require additional costs for operable windows, increased thermal mass, and other architectural elements which allow for passive ventilation and space conditioning. Energy and maintenance costs of naturally ventilated buildings tend to be lower than for comparable mechanically ventilated spaces.

Regional Issues

Additional ventilation is more practical for mild climates, where increasing ventilation rates beyond the ASHRAE 62.1-2004 minimum rates will not have as great an impact on HVAC systems capacity and energy consumption as in hot, humid or cold climates. Natural ventilation and passive conditioning approaches are also more typical in mild and temperate climates, although there are precedents for passively conditioned buildings in all climates. There may be variable conditions in naturally ventilated buildings,

but occupants are satisfied because they control their environment.

Synergies and Trade-Offs

In addition to designing the HVAC systems properly and selecting appropriate building materials, increasing ventilation rates beyond standard practice may be one strategy to provide superior indoor air quality. Managing indoor air quality concerns during construction and operations is also appropriate for many green building projects.

For mechanically ventilated and air-conditioned buildings, increasing ventilation rates will require somewhat larger HVAC system capacity and greater energy use adding to both capital and operational costs. Natural ventilation systems can provide increased ventilation rates, good indoor air quality, and occupant control over thermal comfort and ventilation via operable windows while potentially reducing operating costs compared to mechanical ventilation systems.

Resources

Please see the USGBC Web site at www.usgbc.org/resources for more specific resources on materials sources and other technical information.

Web Sites

ASHRAE Standard 62.1-2004: Ventilation For Acceptable Indoor Air Quality

American Society of Heating, Refrigerating and Air-Conditioning Engineers

www.ashrae.org

(800) 527-4723

The Carbon Trust Good Practice Guide 237—Natural ventilation in non-domestic buildings—a guide for designers; developers and owners (1998)

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sure differences that induce exfiltration. (ASHRAE 62.1-2004)

Makeup Air is any combination of outdoor and transfer air intended to replace exhaust air and exfiltration. (ASHRAE 62.1-2004)

Mechanical Ventilation is ventilation provided by mechanically powered equipment, such as motor-driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows. (ASHRAE 62.1-2004)

Natural Ventilation is ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional openings in the building. (ASHRAE 62.1-2004)

Outdoor Air is the ambient air that enters a building through a ventilation system, through intentional openings for natural ventilation, or by infiltration. (ASHRAE 62.1-2004)

Recirculated Air is the air removed from a space and reused as supply air. (ASHRAE 62.1-2004)

Return Air is the air removed from a space to be then recirculated or exhausted. (ASHRAE 62.1-2004)

Supply Air is the air delivered by mechanical or natural ventilation to a space, composed of any combination of outdoor air, recirculated air, or transfer air. (ASHRAE 62.1-2004)

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Case Study

**Navy Federal Credit Union,
Remote Call Center
Pensacola, FL**

Owner: Navy Federal Credit Union

The Navy Federal Credit Union's Remote Call Center is a LEED® v2.0 Gold Project that is located on 19 acres of Live Oak forest (only one tree was removed to accommodate the new building). The project achieved all but one credit in the Indoor Environmental Quality section of LEED for New Construction v2.0, ensuring an optimal environment for the employees of the call center. The project's inclusion of an underfloor air system enhances ventilation effectiveness for 95% of the building occupants, thereby achieving the intent of EQ Credit 2.

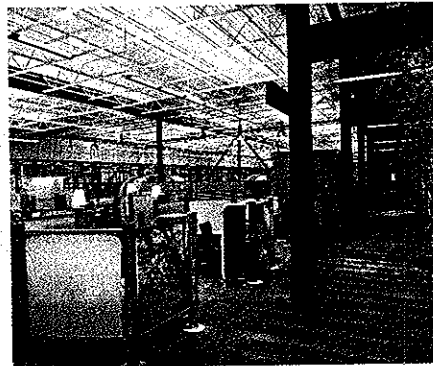


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