Evaluation of LEED Green Building Rating Potential for the Engineering Building at the University of Texas at San Antonio

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Abstract

The U.S. Green Building Council in October 2004 issued the Leadership in Energy and Environmental Design for Existing Buildings, a green building rating system for existing buildings where previously criteria has been only for new building construction. An evaluation of the Engineering Building at the University of Texas at San Antonio has been conducted to determine what it will take to make it the first LEED certified green building on the UTSA campus. This study was prompted by (1) recent indoor air quality issues in the building, (2) recent roof leaks which required renovation and mold remediation within the building, (3) the planned departure of two engineering departments (Electrical and Civil) from the building in the Fall 2005, and (4) the UTSA's commitment to renovate the building for continued use by the Mechanical Engineering department. This study focuses on the LEED certification process for existing buildings, especially the point awarding schedule and different levels of green rating. A detailed assessment of the green and non-green features of the existing building has been completed. Three key features of this assessment have been (1) a broad survey of occupant feedback on indoor environmental quality and satisfaction with the building, (2) specific temperature and humidity measurements conducted over multi-week periods in offices, and (3) discussions with UTSA facility services personnel to assess energy and resource use in the building. This study highlights where the building currently stands and what key "green" renovations can be implemented. Overall, this study is focused on improving occupant comfort and health, while attaining a LEED certification for this building by 2006 after planned renovations.

Introduction

The U.S. Green Building Council (USGBC) finalized the Leadership in Energy and Environmental Design (LEED) Green Building Rating System for Existing Buildings in October 2004. The rating system addresses building sustainability in its maintenance and operation, as well as reducing environmental concerns. Ten cities currently require LEED certification for new construction, as outlined by LEED-NC (LEED for New Construction).[1] LEED-EB (LEED for Existing Buildings) was created to focus on building operation, encouraging the development of sustainability features

Table 1: *LEED-EB Certification Levels*

Certification Level	Points
Certified	32-39
Silver	40-47
Gold	48-63
Platinum	64-85

and a healthier, more productive work environment. The rating system for the LEED-EB is divided into four levels based on points awarded for the specified credits. The categories are listed in Table 1. Points are awarded by assessing the credits listed in each of the six main sections—Sustainable Sites; Water Efficiency; Energy and Atmosphere; Materials and Resources; Indoor Environmental Quality; and Innovation in Upgrades, Operations and Maintenance.

From the 600 acres of land set aside for the University of Texas at San Antonio (UTSA) in May 1970 to the 26,340 students that attend the university in Fall 2004, UTSA has experienced tremendous growth in facilities and attendance.[2] Enrollment has increased by 42 percent since the appointment of Dr. Ricardo Romo, UTSA President, in 1999.[3] To accommodate the growing student population, there is a projection of new construction to the year 2030 or until enrollment totals reach 30,000 students. Achieving this goal would require an expansion of 3.5 million gross square feet, costing more than $1.6 billion at the current construction value.[4] In terms of enrollment, UTSA now ranks second in the University of Texas System.[3] Thus, the need arises for maintaining a sustainable institution to create a balance between the environment, the community, and the economy.

The goal of this project is to assess different aspects of the Engineering Building, shown in Figure 1. These include energy consumption and indoor air quality (IAQ), as well as water conservation, sustainability, materials, and design, as outlined in the LEED-EB rating system. The assessment will help determine whether the Engineering Building meets the minimum requirements of the recently adopted LEED-EB. Furthermore, the assessment will highlight areas of improvement to be able to attain the minimum points required for LEED certification. A LEED certified building will serve as an example of the university's endeavors to promote energy efficiency, as well as health and environmental benefits. The building will then be used as a showcase for educational purposes, demonstrating the characteristics of a LEED certified building.

Figure 1: *UTSA Engineering Building*
The Engineering/Biotechnology Building was dedicated in April 1991.

A survey was created and administered to collect information from the building occupants. Respondents were asked to evaluate temperature and humidity, noise level, lighting, daylight, odors, and thermal comfort by rating sixteen questions. The surveys were distributed to faculty and staff members due to their continuous occupancy of the building throughout the day.

Field sensors were used to record temperatures and relative humidity in the three department offices of the Engineering Building—Mechanical, Civil, and Electrical. Two measurement trials were conducted during the winter season. Graphs of indoor and outdoor temperature and relative humidity were established. Conditions in each office were then related to the thermal comfort levels specified by ASHRAE Standard 55 by generating the thermal comfort graphs for each of the offices. Results obtained are explained but should be verified with successive trials in different seasons.

The analysis is divided into sections corresponding to the LEED-EB project checklist. Due to the complexity of obtaining data to verify compliance with LEED prerequisites and credits as well as accurately analyzing each requirement, certain assumptions were made regarding each area. A more accurate and comprehensive analysis can be achieved by a LEED-EB certified individual with access to specifications as detailed in the LEED-EB Reference Guide. Information that could only be obtained for the university as a whole is defined in the text. The findings were based on observations and tests in addition to consulting with engineers, occupants, and facilities services employees. Prerequisites and credits not applicable to the Engineering Building are not discussed.

LEED Certification Evaluation

The LEED-EB checklist contains the following criteria: sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; and innovation in upgrades, operations and maintenance.

1. Sustainable Sites (SS) – 14 Potential Points

SS Prerequisite 1 deals with erosion and sedimentation control. Figure 2 shows that the UTSA is located over the Edwards Aquifer Recharge Zone, indicating additional environmental issues that must be considered. Construction projects must abide by Texas Commission on Environmental Quality (TCEQ) regulations, which define erosion and sedimentation control. The TCEQ codes are also used to establish storm water plans with each new building.[5] SS Prerequisite 2 requires that the age of the building be at least two years. The Engineering Building was dedicated in 1991. UTSA meets the requirement for one credit of the green site management SS Credits 1.1 and 1.2 by satisfying the following four requirements: on-site maintenance equipment; a grounds crew for landscaping; pest control; and irrigation management with the use of sprinkler systems. A point is awarded for every four requirements met. The sprinkler system operation is designed with rain sensors for supplying water as needed, rather than on a conventional time clock; this is overridden when the Aquifer Management Plan goes into effect.[4,6] SS Credit 3.1 requires public transportation access. The university is served by public transportation through Vía bus lines. The UTSA shuttle buses, also allow people to commute from distant parking lots to institutional facilities. By developing a car-pooling plan with designated parking spaces for building occupancy, SS Credit 3.4

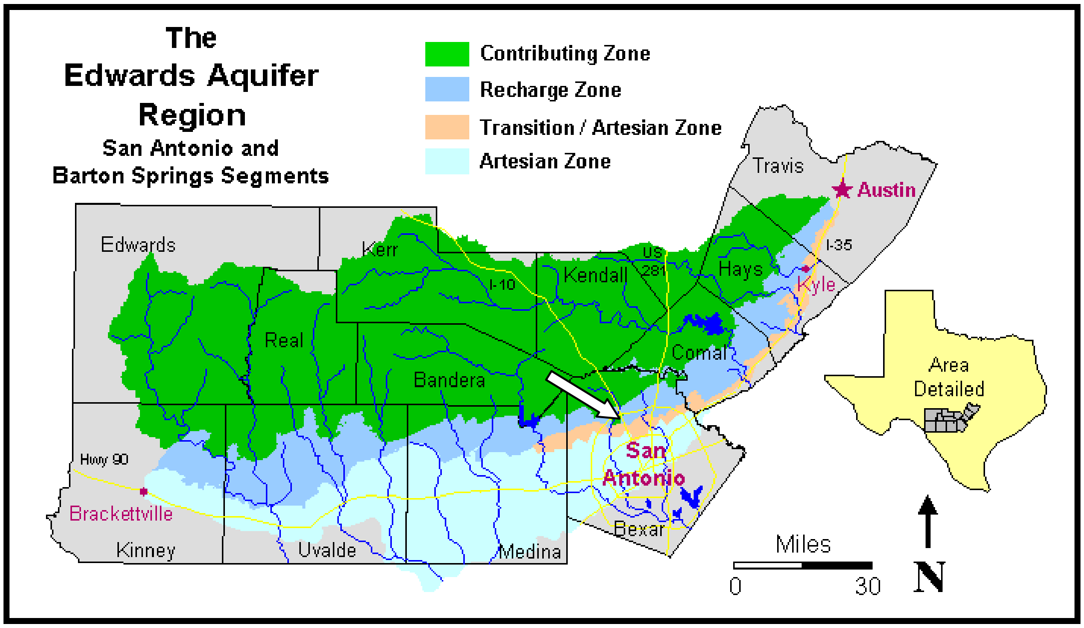

Figure 2: *UTSA over the Recharge Zone*
The figure is a layout of surrounding Edwards Aquifer areas and their relation to the Recharge Zone. The marker at I-10 and Loop 1604 shows that UTSA is situated directly over the Edwards Aquifer Recharge Zone.[7]

can be achieved. SS Credit 4.1 deals with reducing site disturbance to protect open space. Due to its location over the Edward's Aquifer Recharge Zone, the university prepares a Water Pollution Abatement Plan and Sewage Collection System Plan for construction projects.[8] To determine if SS Credit 5.1 can be met, annual stormwater documentation must be obtained to establish a baseline for 25% stormwater reduction. Calculations are needed to determine if illumination levels meet SS Credit 7, which requires reducing light emitted into the night sky. Table 2 is a summary of credits and points for the Sustainable Sites section of the LEED-EB.

- Engineering Building meets Sustainable Sites prerequisite requirements.
- 2 points at current status
- 4 points with improvements

Table 2: *Sustainable Sites Summary of Results*

Sustainable Sites	Description	Potential Points	Points at Current Status	Points with Improvements
SS Prerequisite 1	Erosion and Sedimentation Control	Required	Meet Requirement	--
SS Prerequisite 2	Age of Building	Required	Meet Requirement	--

Table 2: *Sustainable Sites Summary of Results (continued)*

Sustainable Sites	Description	Potential Points	Points at Current Status	Points with Improvements
SS Credit 1.1 & 1.2	Plan for Green Site and Building Exterior Management	1-2	1	0
SS Credit 2	High Development Density Building and Area	1	0	0
SS Credit 3.1	Alternative Transportation: Public Transportation Access	1	1	0
SS Credit 3.2	Alternative Transportation: Bicycle Storage & Changing Rooms	1	0	0
SS Credit 3.3	Alternative Transportation: Alternative Fuel Vehicles	1	0	0
SS Credit 3.4	Alternative Transportation: Car Pooling & Telecommuting	1	0	1
SS Credit 4.1	Reduced Site Disturbance – Protect or Restore Open Space: 50% of Site Area	1	0	1
SS Credit 4.2	Reduced Site Disturbance – Protect or Restore Open Space: 75% of Site Area	1	0	0
SS Credit 5.1 & 5.2	Stormwater Management: Rate and Quantity Reduction	1-2	0	1
SS Credit 6.1	Heat Island Reduction: Non-Roof	1	0	0
SS Credit 6.2	Heat Island Reduction: Roof	1	0	0
SS Credit 7	Light Pollution Reduction	1	0	1
Subtotal		14	2	4
Total		14	6	

2. Water Efficiency (WE) – 5 Potential Points

WE Prerequisite 1 requires minimum water efficiency. In 2001, the UTSA began an Energy Performance Contract that initiated several modifications in lighting, plumbing, and facility infrastructure.[4] Through implementation of the Energy Performance Contract, water fixtures were retrofitted throughout the campus. The Engineering Building had already met or exceeded water conservation specifications as determined by the Energy Policy Act of 1992; thus, no alterations were needed. The campus is regulated by the U.S. Environmental Protection Agency National Pollution Discharge Elimination System (NPDES) regulations as enforced by the TCEQ. The San Antonio Water System (SAWS) is the university's permitting entity.[9] Thus, WE Prerequisite 2 is met. WE Credits 1.1 and 1.2 regarding water efficient landscape requires metering the irrigation system to determine water savings resulting from the alternate irrigation system adopted by the university, as explained in SS Credits 1.1 and 1.2. The UTSA is currently considering a project for recycling wastewater, as specified by WE Credit 2. According to the water fixture savings report produced from the Energy Performance Contract, there was a 51.7% reduction from baseline water consumption in the entire university[10], as applicable to WE Credits 3.1 & 3.2, which requires a 20% baseline reduction. A summary of results is shown in Table 3.

- Engineering Building meets Water Efficiency prerequisite requirements.
- 2 points at current status
- 2 points with improvements

Table 3: *Water Efficiency Summary of Results*

Water Efficiency	Description	Potential Points	Points at Current Status	Points with Improvements
WE Prerequisite 1	Minimum Water Efficiency	Required	Meet Requirement	--
WE Prerequisite 2	Discharge Water Compliance	Required	Meet Requirement	--
WE Credit 1.1 & 1.2	Water Efficient Landscaping: Reduce Water Use	1-2	0	1
WE Credit 2	Innovative Wastewater Technologies	1	0	1
WE Credit 3.1 & 3.2	Water Use Reduction	1-2	2	0
Subtotal		5	2	2
Total		5	4	

3. Energy and Atmosphere (EA) – 23 Potential Points

In order to meet EA Prerequisite 1, a commissioning plan for verifying that systems are operating as indicated in original specifications must be implemented. Currently, maintenance is applied to building systems; however, due to understaffing, continuous commissioning is hindered. For EA Prerequisite 2 overall testing of system components should be carried out to comply with building operation plans. There is no permanent way of measuring energy usage by the air conditioning system in the Engineering Building. The university's chilled water plant provides water for every building on campus. One recommendation is to install a flow meter to be able to measure the amount of chilled water consumed by the Engineering Building. The LEED-EB Reference Guide must be reviewed for calculating building energy efficiencies. Ozone protection is addressed by EA Prerequisite 3. The Engineering Building has no CFC-based refrigerants in its equipment.[11] To meet EA Credit 1, energy performance in the Engineering Building can be evaluated by comparing records of the building utility consumption to the LEED-EB Reference Guide. For EA Credit 3.1, which pertains to staff education, a program can be implemented to continuously educate building operators and maintenance staff on the operation and maintenance of building systems. Maintenance staff attends seminars and classes, such as those for variable frequency drive (VFD) operations. The UTSA is currently trying to establish an in-house program to better achieve the goal set by EA Credit 3.1. Regarding EA Credit 3.2, UTSA has in place a preventative maintenance program—Computerized Maintenance Management System (CMMS)—that applies to post warranty maintenance. As required by EA Credit 3.3, temperature trend logging is currently performed on campus by Facilities Services with the use of an operations program, MS 2000. The lacking components are CO_2 and humidity monitoring. A recommendation is to install CO_2 sensors to monitor CO_2 levels in the Engineering Building and to determine if further actions must be taken based on those levels. An additional proposal is to replace the current thermostats with thermostats equipped with temperature/humidity sensors and limited occupant control. EA Credit 4 deals with additional ozone protection regarding HCFCs and halons. The UTSA does not have halons for fire suppression systems; however HCFCs are still contained in the ten water coolers of the Engineering Building. This amounts to approximately 185 ounces of R-22. Refrigerant losses are recorded on the Refrigerant Compliance Management Software.[11] The Biotechnology, Sciences and Engineering (BSE) Building, schedule for completion in Summer 2005, will be utilizing two 275-ton chillers to assist the main campus chillers in providing chilled water to the BSE. The new chillers are equipped with hydrofluorocarbon (HFC) R-134a, an ozone-safe refrigerant. Chillers containing refrigerants that are harmful to the ozone will be replaced as the life cycle of the equipment is reached. This will coincide with the Clean Air Act Amendment of 1990, which calls for phase out of all harmful ozone refrigerants. Regarding EA Credits 5.1-5.3, water, electric, and natural gas meters are present for most buildings on the campus. Heat exchanger efficiencies can be monitored in lieu of boiler efficiencies. Metering of the standard motors was performed with the Energy Performance Contract to evaluate necessity for variable frequency drives (VFD) on motors rated above 15 hp. VFDs are operating in the Engineering Building—two hot water pumps, two chilled water pumps, three supply fans, and three return fans—as well as in other buildings on campus.[4] To meet an additional four requirements listed under EA Credits 5.1-5.3, a recommendation can be made to upgrade the HVAC control system, which would include replacing the thermostats as previously mentioned and verifying air distribution, static pressure, and ventilation rates. As previously mentioned, a chilled water flow meter, as well as a steam flow meter would need to be installed to measure the air conditioning load and heating load in the Engineering Building. Building operating costs can be documented to meet EA Credit 6. This can be achieved by applying the recommended actions in EA Credits 5.1-5.3 to evaluate overall building performance and associated costs. Table 4 shows a summary of the Energy and Atmosphere section.

- Engineering Building can meet Energy and Atmosphere prerequisite requirements with recommended actions.
- 3 points at current status
- 5 points with improvements

Table 4: *Energy & Atmosphere Summary of Results*

Energy & Atmosphere	Description	Potential Points	Points at Current Status	Points with Improvements
EA Prerequisite 1	Existing Building Commissioning	Required	--	Met with Improvement
EA Prerequisite 2	Minimum Energy Performance	Required	--	Met with Improvement

Table 4: *Energy & Atmosphere Summary of Results (continued)*

Energy & Atmosphere	Description	Potential Points	Points at Current Status	Points with Improvements
EA Prerequisite 3	Ozone Protection	Required	Meets Requirement	--
EA Credit 1	Optimize Energy Performance	1-10	0	1
EA Credit 2.1 – 2.4	Documenting Sustainable Building: Cost Impacts	1-4	0	0
EA Credit 3.1	Building Operations and Maintenance: Staff Education	1	0	1
EA Credit 3.2	Building Operations and Maintenance: Building Systems Maintenance	1	1	0
EA Credit 3.3	Building Operations and Maintenance: Building Systems Monitoring	1	0	1
EA Credit 4	Additional Ozone Protection	1	1	0
EA Credit 5.1 – 5.3	Performance Measurement: Enhanced Metering	1-3	1	1
EA Credit 5.4	Performance Measurement: Emission Reduction Reporting	1	0	0
EA Credit 6	Documenting Sustainable Building Cost Impacts	1	0	1
Subtotal		23	3	5
Total		23	8	

4. Materials and Resources (MR) – 16 Potential Points

MR Prerequisite 1.1 requires material auditing of the building's waste stream. An assessment of the waste products, including paper, plastic, glass, cardboard, and metal must be conducted to meet this prerequisite. The institution currently recycles paper, cardboard, steel and copper. A contingency plan is being discussed to introduce a recycling program for glass and plastic.[12] This action would address MR Prerequisite 1.2. Currently the only recyclable in the Engineering Building is paper. MR Prerequisite 2 deals with reducing toxic material, such as mercury. As part of the Energy Performance Contract, the university retrofitted the lighting system with more efficient fixtures. T-5 fluorescent fixtures were installed in the building.[10] These fixtures are mercury free and environmentally safe for disposal. MR Credit 1.1 & 1.2 pertains to waste management on the construction site. The UTSA currently recycles certain construction waste, such as concrete and rock, although records would need to be reviewed to determine the exact percentage of diverted material. Referencing MR Credit 4.1-4.3, a plan could be implemented for purchasing sustainable cleaning materials and supplies. MR Credits 5.1-5.3 could be met by establishing a recycling program through which at least 30 percent of the waste stream is diverted, and batteries and fluorescent lamps are recycled. Reduction of mercury content in light bulbs, as specified by MR

Credit 6, was achieved through the lighting upgrade explained for MR Prerequisite 2. Table 5 displays a summary of results.

- Engineering Building can meet Materials and Resources prerequisite requirements with recommended actions.
- 1 point at current status
- 3 points with improvements

Table 5: *Materials & Resources Summary of Results*

Materials & Resources	Description	Potential Points	Points at Current Status	Points with Improvements
MR Prerequisite 1.1	Source Reduction and Waste Management: Waste Steam Audit	Required	--	Met with Improvement
MR Prerequisite 1.2	Source Reduction and Waste Mgt.: Storage and Collection of Recyclables	Required	--	Met with Improvement
MR Prerequisite 2	Toxic Material Source Reduction: Reduced Mercury in Light Bulbs	Required	Requirement Met	--
MR Credit 1.1 & 1.2	Construction, Demolition and Renovation Waste Management	1-2	0	1
MR Credit 2.1 – 2.5	Optimize Use of Alternative Materials	1-5	0	0
MR Credit 3.1 & 3.2	Optimize Use of IAQ Compliant Products	2	0	0
MR Credit 4.1 – 4.3	Sustainable Cleaning Products and Materials	1-3	0	1
MR Credit 5.1 – 5.3	Occupant Recycling	3	0	1
MR Credit 6	Additional Toxic Material Source Reduction: Reduced Mercury in Light Bulbs	1	1	0
Subtotal		16	1	3
Total		16	4	

5. Indoor Environmental Quality (IEQ) – 22 Potential Points

IEQ Prerequisite 1 requires minimum air quality levels in the building. The Engineering Building was designed to follow ASHRAE Standard 62. Verification of systems operation and measurement of CO_2 levels in classrooms and laboratories is necessary to ensure that outdoor air levels comply with the standards. This reinforces the recommendation made in EA Credit 5.1-5.3. Option one of IEQ Prerequisite 2 requires that smoking be prohibited in the building and that outside smoking areas be located at a minimum 25-foot distance from any entryway, window, and outdoor air intake. Although smoking is not allowed inside the Engineering Building, the current smoking regulations must be strictly enforced, and the minimum smoking distance from the building can be increased to the LEED requirement of 25 feet. Observations indicate that the Engineering Building is not under continuous positive pressure: outside smoke can be detected inside the building with constant opening of doors. This should be corrected to help prevent outdoor odors and particulates from entering the building. According to the survey administered to faculty and staff in the Engineering Building, 62% of the respondents indicated that smoke odors were present in the office or building throughout the day. Prerequisite 3 requires a management program for asbestos removal. The Engineering Building has no asbestos; however, a Campus Asbestos Operation and Maintenance Plan is in place to reduce potential hazards. A PCB management program is required for IEQ Prerequisite 4. The Engineering Building does not have any PCBs on-site due to the lighting upgrade; however a management program exists for PCB control in new materials.[13] For IEQ Credit 1, CO_2 sensors can be installed to measure and indicate extreme CO_2 levels. ASHRAE Standard 62 specifies "indoor CO_2 concentrations less than 700 ppm above the outdoor air concentration" to meet comfort/odor criteria.[14] A standard IAQ construction plan is already in place for UTSA renovation and construction projects, as required by IEQ Credit 3.[4] The plan must be evaluated to determine if all specified requirements listed for LEED are met. Credits 4.1 and 4.2 can be achieved by documenting employee absenteeism and health care costs, as well as productivity impacts from improvements made in the building. In the current filter system, outside air is pre-filtered to 15/40 link filters, which are 23% efficient.[10] To meet IEQ Credit 5.1, it is suggested that an upgrade be made to MERV 13 filters with 80 to 85 percent efficiency. IEQ Credit 6.1 requires lighting control by at least 50% of occupants. Classrooms in the Engineering Building have lighting controls that can be adjusted to accommodate different tasks. The computer labs also have additional lighting systems that can be controlled by students. One question on the administered survey asked respondents to rate the adequacy of lighting in the office or building. The average score was 4.1 on a scale of one to five, indicating that for the most part respondents felt that the lighting was "good." IEQ Credit 6.2 involves allowing occupant controllability of temperature systems; occupant controllability of temperature in the Engineering Building is non-existent. According to the survey, nineteen of the twenty-one respondents indicated a preference to control the temperature settings in their office. Eight already have temperature sensors in their office. A proposal can be made to allow at least 50 percent of building occupants to have temperature sensors and be able to adjust the temperature in their office.

IEQ Credit 7.1 pertains to compliance with ASHRAE Standard 55-2004 and can be addressed with testing of systems operation. By recording indoor temperature and relative humidity, the data can be applied to ASHRAE Standard 55 to determine if the thermal comfort level in the Engineering Building is adequate. Sample results from the experiments conducted with the field sensors are included. The Mechanical, Civil, and Electrical Engineering offices (ME, CE, and EE, respectively) of the Engineering Building were measured for temperature and relative humidity. Figures 3, 4, 5, and 6 graph the temperatures and relative humidity values recorded in the ME office along with outdoor data over a 24 hour span of the two testing periods. The average temperature for the 8 am to 5 pm period was 70.5°F on November 4th and 71.5°F on January 21st. The relative humidity averages for the same sample days in November and January were 33.5% and 41.5%, respectively. Using the temperature and relative humidity averages, thermal comfort graphs were generated with

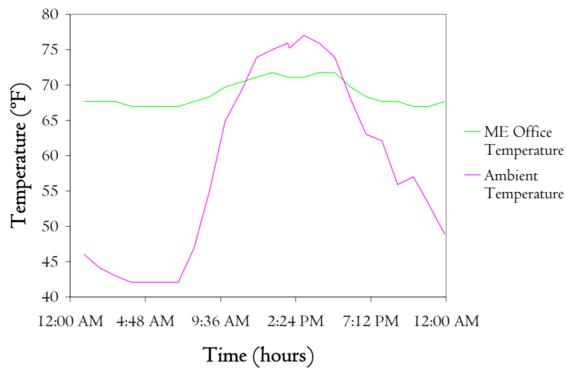

Figure 3: *ME Office Sample Day Temperature Graph – November 4th*

The temperature data collected for the ME office on November 4th is displayed in the graph, indicating relatively constant indoor temperatures as compared with outdoor temperature variation.

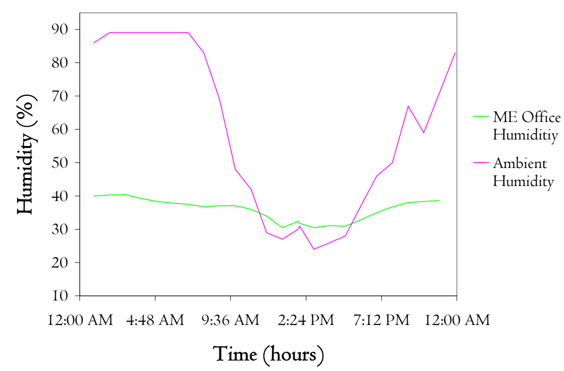

Figure 4: *ME Office Sample Day Relative Humidity Graph – November 4tht*

The relative humidity data collected for the ME office on November 4th is displayed in the graph, indicating relatively constant indoor relative humidity compared with outside variation.

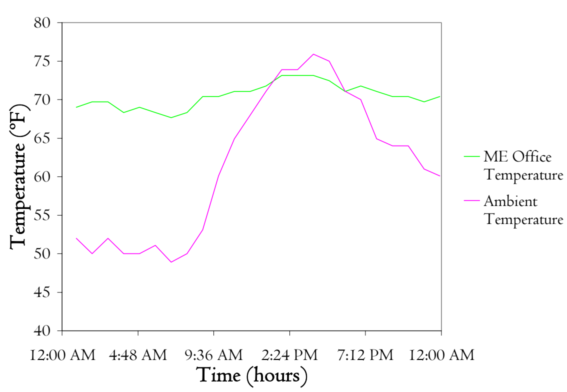

Figure 5: *ME Office Sample Day Temperature Graph – January 21st*

The temperature data collected for the ME office on January 21st is displayed in the graph, indicating relatively constant indoor temperatures as compared with outdoor temperature variation.

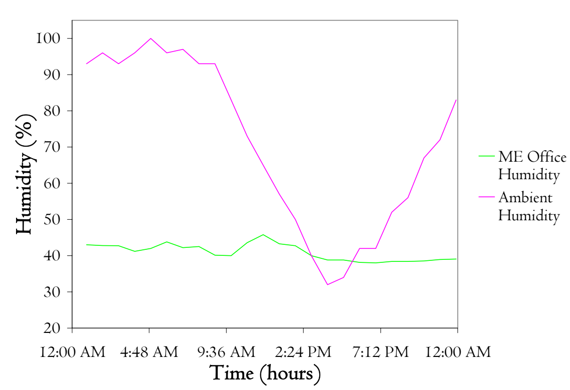

Figure 6: *ME Office Sample Day Relative Humidity Graph – January 21st*

The relative humidity data collected for the ME office on January 21st is displayed in the graph, indicating relatively constant indoor relative humidity compared with outside variation.

the point representing the conditions in the office marked on the graph.[15] Figures 7 and 8 show graphs of the thermal comfort range for the selected sample days of the two testing periods, with the following parameters: metabolic rate: 1.1, clothing level: 1.0 (assumed from ambient conditions), air speed: 20 fpm. Metabolic rate and clothing level were retrieved from Appendix A and B, respectively, of ASHRAE Standard 55-2004. Air speed was assumed. Operative temperature was taken to be the room temperature as listed in Appendix C of ASHRAE Standard 55-2004. ME office conditions fall in the range of comfort level as indicated in the figures, with a predicted mean vote (PMV) set at -0.5 to 0.5. The PMV at this level correlates to an 80% occupant acceptability. The acceptable predicted percentage dissatisfied (PPD) is rated at less than 10%.[16] The program generated a PPD value of 7.4% for ME office conditions on November 4th and a PPD of 5.4% for ME office conditions on January 21st, indicating that the ME office is in the acceptable range of thermal comfort as determined by ASHRAE. The CE and EE offices were also determined to fall in the acceptable thermal comfort range. The administered survey asked respondents to rate the thermal comfort level in their office or building. An average score of 3.4 on a scale of one to five (five being "good") was obtained for this question, indicating that in general, the respondents are satisfied with the thermal comfort level in their office. Similar testing and a more expansive survey assessment in laboratories, classrooms, and additional office spaces are needed to determine if the Engineering Building falls in the thermal comfort range, thus meeting Credit 7.1.

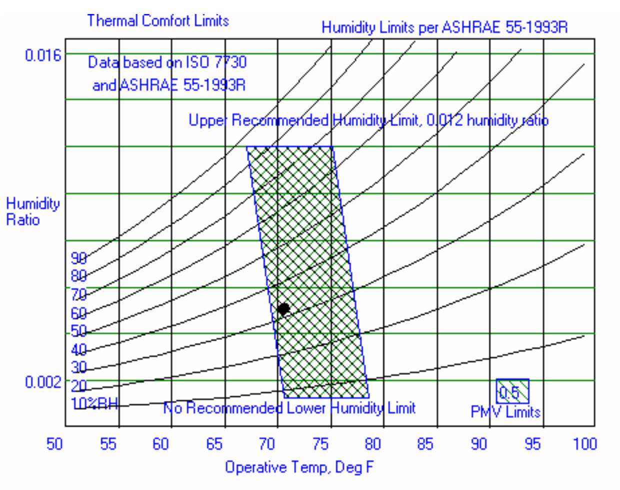

Figure 7: *ME Office Thermal Comfort Graph – November 4th*
A thermal graph for the ME Office based on ASHRAE Standard 55 was generated using the Comfort program. November 4th data indicated acceptable comfort levels in the office.

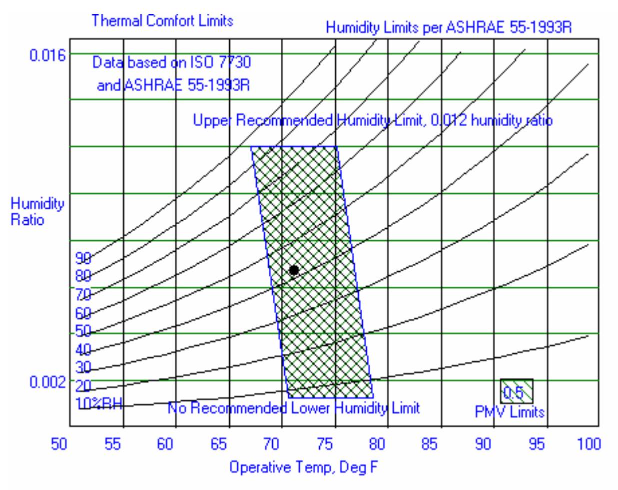

Figure 8: *ME Office Thermal Comfort Graph – January 21st*
A thermal graph for the ME Office based on ASHRAE Standard 55 was generated using the Comfort program. January 21st data indicated acceptable comfort levels in the office.

IEQ Credit 7.2 can be met by upgrading thermostats as previously stated, in addition to establishing permanent monitoring systems for temperature, relative humidity, and CO_2 levels. IEQ Credits 8.1 and 8.2 pertain to daylight. Although the Engineering Building has several windows throughout the building, all classrooms and labs, as well as some office spaces do not have daylight view. The design of the Engineering Building does however, incorporate a skylight on the third floor. According to survey results, approximately half of respondents have daylight view and half do not. When asked if there is a preference for daylight view, seventeen of the respondents indicated they "very much" prefer to have daylight in their office. Considering total building occupancy, however, at least 50% have daylight view. The effects of incorporating windows into the classrooms should be evaluated to determine if comfort or productivity would increase. IEQ Credit 9 deals with prevention of IAQ problems and correcting them when they occur in order to avoid extensive damage. To achieve this goal, the UTSA has an Environmental Health, Safety and Risk Management Office. The need for this type of program is illustrated in Figure 9, which shows the remediation project for an isolated mold case in the Engineering Building**.**

Figure 9: *Mold Remediation Project*
This picture depicts the after effects of an isolated mold problem in an area of the Engineering Building. Mold remediation requires removal of mold-infested components. UTSA's IAQ management program helped to prevent extensive damage.

Monitoring of systems operation as well as observations of the building infrastructure is necessary to prevent issues that can result in property damage and health hazards. The IAQ management program can be improved to achieve this goal. UTSA has already placed mats at every entryway to help prevent dirt from entering the buildings, addressing IEQ Credit 10.1. Regarding the isolation of janitorial closets as specified in IEQ Credit 10.2, the Engineering Building has janitorial closets with deck-to-deck partitions. Cleaning chemicals used by janitorial services are water-based and do not require a special drainage system for their disposal. Janitorial services use a specific measuring tool for providing correct mixing ratio of chemicals to water, thus limiting exposure to cleaning chemicals.[12] The dilution system for cleaning chemicals applies to IEQ Credit 10.3 on green cleaning; however, products must be evaluated to determine if they can be classified as sustainable products. Credits 10.4, 10.5, and 10.6 required verification of the pest management and cleaning equipment policies. A summary of results for the Indoor Environmental Quality section is shown in Table 6.

- Engineering Building can meet Indoor Environmental Quality prerequisite requirements through recommended actions.
- 4 points at current status
- 12 points with improvements

Table 6: *Indoor Environmental Quality Summary of Results*

Indoor Environmental Quality	Description	Potential Points	Points at Current Status	Points with Improvements
IEQ Prerequisite 1	Outside Air Introduction and Exhaust Systems	Required	Meet Requirement	--
IEQ Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required	--	Met with Improvement
IEQ Prerequisite 3	Asbestos Removal or Encapsulation	Required	Meet Requirement	--
IEQ Prerequisite 4	PCB Removal	Required	Meet Requirement	--
IEQ Credit 1	Outside Air Delivery Monitoring	1	0	1
IEQ Credit 2	Increased Ventilation	1	0	0
IEQ Credit 3	Construction IAQ Management Plan	1	0	1
IEQ Credit 4.1	Documenting Productivity Impacts: Absenteeism and Healthcare Cost Impacts	1	0	1
IEQ Credit 4.2	Documenting Productivity Impacts: Other Impacts	1	0	1
IEQ Credit 5.1	Indoor Chemical and Pollutant Source Control: Non-Cleaning-Reduce Particulates in Air Distribution	1	0	1
IEQ Credit 5.2	Indoor Chemical and Pollutant Source Control: Non-Cleaning-High Volume Copying/Print Rooms/Fax Stations	1	0	0
IEQ Credit 6.1	Controllability of Systems: Lighting	1	1	0
IEQ Credit 6.2	Controllability of Systems: Temperature and Ventilation	1	0	1
IEQ Credit 7.1	Thermal Comfort: Compliance	1	0	1
IEQ Credit 7.2	Thermal Comfort: Permanent Monitoring System	1	0	1
IEQ Credit 8.1 & 8.2	Daylight and Views: Daylight	1-2	0	1
IEQ Credit 8.3 & 8.4	Daylight and Views: Views	1-2	0	0
IEQ Credit 9	Contemporary IAQ Practice	1	1	0
IEQ Credit 10.1	Green Cleaning: Entryway Systems	1	1	0
IEQ Credit 10.2	Green Cleaning: Isolation of Janitorial Closets	1	1	0

Table 6: *Indoor Environmental Quality Summary of Results (continued)*

Indoor Environmental Quality	Description	Potential Points	Points at Current Status	Points with Improvements
IEQ Credit 10.3	Green Cleaning: Low Environmental Impact Cleaning Policy	1	0	1
IEQ Credit 10.4 & 10.5	Green Cleaning: Low Environmental Impact Pest Management Policy	1-2	0	1
IEQ Credit 10.6	Green Cleaning: Low Environmental Impact Cleaning Equipment Policy	1	0	1
Subtotal		22	4	12
Total		22	16	

6. Innovations in Upgrades, Operations and Maintenance (IUOM) – 5 Potential Points

IUOM Credit 1 can be met by implementing additional credits. To prevent negative pressure differences that can cause contamination of indoor air, permanent pressure monitoring of the building interior and exterior can be performed. UTSA can meet IUOM Credit 2 by having a university member educated in LEED-EB accreditation be responsible for collecting data and implementing policy that can lead to higher ratings for the green building criteria. The university can also hire a LEED professional. A summary of results is shown in Table 7.

- 2 points with improvements

Table 7: *Innovations in Upgrades, Operations and Maintenance Summary of Results*

Innovations in Upgrades, Operations and Maintenance	Description	Potential Points	Points at Current Status	Points with Improvements
IUOM Credit 1	Optimize Energy Performance	4	0	1
IUOM Credit 2	Documenting Sustainable Building: Cost Impacts	1	0	1
Subtotal		5	0	2
Total		5	2	

Conclusions

Based on observations of the Engineering Building and some investigation on building systems operation, UTSA has incorporated several green building measures. A possible score of 12 in the LEED point system may be achieved by the Engineering Building's current state. With observations made, in addition to interviews and minimal testing, the Engineering Building at the UTSA does not meet basic LEED certification under the LEED-EB guidelines, which require 32 to 39 points for basic certification. With proposed verification and improvements the Engineering Building will achieve a silver certification for LEED-EB (Table 8).

Table 8: *LEED-EB Certification Points*

Sector	Points at Current Status	Points with Improvements
1. Sustainable Sites	2	4
2. Water Efficiency	2	2
3. Energy & Atmosphere	3	5
4. Materials and Resources	1	3
5. Indoor Environmental Quality	4	12
6. Innovation in Upgrades, Operations and Maintenance	0	2
Section Totals	**12**	**28**
Certification	**No**	**Silver**
Total for Certification Level	**40 points**	

Additional points may be obtained by acquiring detailed data on all criteria listed in the LEED-EB rating system, conducting more extensive research on initiatives currently being taken by the UTSA, as well as accessing and researching the LEED-EB Reference Guide. This project serves to highlight certain issues that require attention to be able to achieve green building status in the Engineering Building and the university; however, it also demonstrates the university's endeavors to implement energy conservation programs as well as alter current facility features to more energy efficient standards. Although some complexities arise when attempting to address all LEEB-EB green building criteria as applied to an older existing building like the Engineering Building, the importance of incorporating certain green building features is nonetheless apparent. Performing a more thorough analysis of the Engineering Building can help determine what can be done to raise the thermal comfort level of the occupants in the building as well as improve the energy efficiency of the building. While several LEED criteria have been addressed in the building and university, there is room for implementing policy for testing and monitoring of building systems operation, which is the basic requirement for several of the LEED-EB criteria. Although the rating system is important for LEED certification, following a more budget-feasible program at the start may help promote future improvements in existing buildings and encourage green building certification in new construction on campus. This paper proposes changes to current building design and may help launch LEED certification processes of existing buildings as well as new construction in the

University of Texas campus system. Upon becoming certified, these buildings will serve as showcases of sustainable buildings, achieving less environmental impact. Already serving more than 26,000 people, the university will attract individuals from the community and surrounding areas and serve to demonstrate the operation of a LEED building. Educational tours and incorporation of LEED in the curriculum will make students more knowledgeable of important issues to consider in design. Becoming more educated on the benefits of achieving LEED certification will result in a concerted effort to make UTSA "green." As a showcase of characteristics in balance with the environment, UTSA can lead the way for a greener San Antonio.

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