Tennessee High Performance Building Requirements: Manual

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The HPBr Manual is the main reference guide for the High Performance Building Requirements. All State of Tennessee projects will comply with the credits detailed in this document; it is adaptable to individual project objectives and scope.

HPBr
Manual
Version 1.0

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1 Tennessee High Performance Design

1.1 Introduction

The State of Tennessee High Performance Building Requirements, an Office of the State Architect (OSA) program acknowledged by the State Building Commission (SBC), are to be used in conjunction with Designer and Contractor contracts and related documents as well as other state manuals, standards, and guidelines. Referenced standards within the HPBr are intended to supplement and/or exceed the requirements of these other documents.

1.2 Purpose and Intent

The Tennessee HPBr is to be utilized by the three State Procurement Agencies (SPAs): State of Tennessee Real Estate Asset Management (STREAM), Tennessee Board of Regents (TBR), and the University of Tennessee (UT), as their minimum high performance building standard for Designers and Contractors. This is to ensure that the principles of high performance building design, construction, and operational practices are being implemented on State Building Commission projects. The HPBr has been created by the OSA, in collaboration with the three SPAs and with the assistance of consultant Smith Seckman Reid. Consideration of the Owner's operations profile (staff, resources and abilities), costs (first, life cycle, and long term operating), and benefits (economic, environmental, and social) has been taken in the development of the document. The HPBr is to be used as a mandatory design, construction, and operations tool for all SBC projects including: new construction, additions, and renovation/maintenance.

1.3 Procedure

This Manual is to be used in conjunction with the Owner's Project Requirements (OPR) and the Checklist (both explained below) to provide a high performance framework to the project team. At the beginning of each project, the Owner will use the Checklist and the OPR to determine and record the applicability of each credit to the particular project. Credit applicability is based on the building/site scope as well as classification according to the Applicability Tree (located in the OPR). Each project with more than 5 applicable credits must achieve a minimum of 50% of all applicable points, including all applicable Required credits and as many Elective credits as is necessary to achieve the project performance target.

The Manual (this document) functions as a reference document, outlining the specific requirements of each credit.

The OPR is to be used as an Owner's tool for identifying project goals, outlining special building requirements, and providing commissioning guidance.

The Checklist is a tracking tool to develop the list of applicable credits, determine minimum point requirements, set project point targets, and track progress towards those targets. The Checklist represents the HPBr compliance documentation for a project and must be maintained with the project records and submitted to the Office of the State Architect upon project close-out.

This program expects all Designers and Contractors to only propose solutions which are consistent with the implied intent of each pursued credit and in compliance with the Owner's expectations as documented in the OPR and Checklist. The proposed solutions should also consider total cost of ownership, the project budget, and the maintainability of the solution.

1.3.1 Roles and Responsibilities

1.3.1.1 **Owner**: The State of Tennessee SPA, as Owner, shall assume the responsibilities of the "Owner", as referenced in HPBr documents for the relevant project and shall be responsible for decisions on credits associated with project location consideration, site design**,** project scope, and ongoing building operations and maintenance.

1.3.1.2 **Designer**: The Designer shall be responsible for tracking the project's high performance design criteria on the HPBr Checklist/Tracking Form and reporting progress to the Owner at each phase of the project. The Designer shall evaluate all credits of the HPBr for feasibility of

implementation in the project Design. The Designer shall coordinate the implementation of assigned credits into the construction documents.

1.3.1.3 **Contractor**: The Contractor shall be responsible for executing high performance design criteria during construction, recording progress of assigned credits, and generating and reporting required documentation to the Designer per the forms in the HPBr Checklist.

1.3.2 **Checklist** – The Checklist distinguishes whether credits are "Required," or "Elective."

Required: Compliance with credit criteria is mandatory for all applicable projects

Elective: Elective Credits are split into Priority 1 and Priority 2 categories. Priority 1 credits have higher performance benefits than Priority 2 credits. Compliance with Elective credit criteria is recommended where applicable to project program and supported by project budget (first cost) and future operating criteria. It will not always be possible for a given project to achieve all Elective points.

With input from the Designer, the Owner identifies which credits are applicable to the building/site scope (e.g. if the project is new construction on a site with no existing buildings, LM1.1 'Reuse existing buildings' would not be applicable). Where a credit is deemed not applicable to the building/site scope by the Owner, it will be classified as not applicable in the HPBr checklist (regardless of its status as Required or Elective).In case of Project Team disagreement on the applicability of a particular credit, the Owner will make final determination.

Credit Responsibility – Design criteria of the HPBr are applicable during all phases of a project from initiation, approval, design, and construction. The Owner, Designer, and Contractor shall be responsible for specific credits as designated on the HPBr Checklist. The Owner will complete the OPR and a draft Checklist at the beginning of the project. The Designer shall submit an updated Checklist to the Owner at the end of each project design phase (Programming, SD, DD, CD) as a required deliverable before a Notice to Proceed (NTP) for the next phase of contracted work can be obtained.

The Checklist automatically calculates the minimum point requirement to be 50% of the points identified as "applicable." The Owner and Designer will then determine which of the applicable credits will be pursued. The Checklist is an Excel Workbook that tracks the status of each credit. Within the Checklist workbook are the following tools:

1.3.2.1 **Credit Verification Form** – During each phase (Programming, SD, DD, CD) the Project Team will verify the status of each credit the project is attempting by signing this form.

1.3.2.2 **One-Time Completion Form –** If the Owner determines that 5 (five) or fewer HPBr credits are applicable to the project's building/site scope of work, this form may be used to identify those applicable credits. In this specific case, the project team must achieve the minimum performance threshold for each applicable credit.

Once the form is complete, it is signed by the Owner, design team, and Contractor and filed. Using this form commits the project team to designing and constructing/implementing the applicable credits. Submission and approval of Verification Forms or any other information is subsequently not required. This form is intended for minor or routine projects with limited opportunities for enhancing building performance.

1.3.2.3 **Materials and Resources Calculator** – This tab of the Checklist document is used to inform credit achievement and compliance with a number of Materials and Resources credits.

1.3.2.4 **Daylight and Views Calculator –** This tab of the Checklist document is used to inform credit achievement and compliance with a number of Indoor Environmental Quality credits.

1.3.3 **Owner Project Requirements (OPR)** – The OPR is completed as early as possible in the project, preferably during the pre-planning phase, and identifies the project objectives that will define its success. If the OPR is not completed during pre-planning, it should be done as soon as otherwise possible. The project Commissioning Agent shall review the OPR against the Checklist and the design documents, providing feedback to the owner throughout the design process.

1.3.3.1 **Project Applicability Tree** – This decision tree, included in the OPR template document, should be used by the Owner during completion of the OPR to determine which credits in the Energy Efficiency section will be considered Required or Elective (Priority 1 or 2 explained below). The Tree uses criteria including the Maximum Allowable Construction Cost (or MACC) and project building/site scope to inform the level of performance and key credit requirements.

1.3.4 **HPBr Manual** – The Manual provides detailed information about each credit. It should be used for reference and guidance on what is required to comply with (and claim) each credit. Project teams may refer to Appendix A for technical definitions.

1.4 Organization

The HPBr categories include groups of credits with the performance and sustainability criteria for state projects. The HPBr was developed based on the existing framework of the State of Tennessee Sustainable Design Guidelines (SDG), which borrowed structure and content from the LEED Rating System.

1.4.1 **Land Management (LM**) **–** The focus of this category is to encourage the Owner and design teams to consider opportunities to reuse previously developed sites, limit erosion impacts during construction, consider the site's proximity to public transit systems, design landscape for native planting and reduced irrigation, reduce heat island effects, managing stormwater runoff, and exterior lighting pollution.

1.4.2 **Water Efficiency (WE) –** The focus of this category is to encourage the design team to decrease the demand for potable water. Strategies include reduced irrigation demand with native plantings, stormwater reclamation and management, and low-flow interior fixtures.

1.4.3 **Energy Efficiency (EE) –** The focus of this category is to encourage design teams to consider opportunities to improve energy performance, track and monitor building performance, and use renewable energy. These opportunities include commissioning, the evaluation of building systems (HVAC), lighting, etc.), the implementation of metering and controls to measure actual energy performance, as well as evaluating onsite renewable energy opportunities (solar PV, wind, etc).

1.4.4 **Materials and Resources (MR) –** The focus of this category is to encourage the design team to use more sustainable materials and divert construction waste from landfills. The project team should recycle all possible materials during the construction and demolition processes such as cardboard, wood, plastics, and metals. The design team should consider specifying and utilizing Tennessee products and regional materials. The team should also consider rapidly renewable materials, materials with high recycled content, and other sustainable materials whenever possible.

1.4.5 **Indoor Environmental Quality (EQ) –** The focus of this category is to encourage health and comfort for building occupants. The design team should emphasize pollutant source control, thermal comfort controls, lighting controls, ventilation, and filtration. An Indoor Air Quality (IAQ) Management Plan should be developed and implemented during construction and before occupancy.

1.4.6 **Innovation in Design and Construction (ID) –** The focus of this category is to encourage the design team to develop and incorporate innovative ideas and standards that move beyond the minimum requirements discussed in the previous categories.

1.5 Tracking Form and Calculation Tools (Appendix B - Electronic)

Design teams may obtain current versions of the HPBr Manual, Checklist, and OPR from the State project manager or each SPA's website described below.

1.5.1 State of Tennessee Real Estate Asset Management (STREAM): Within the STREAM website, the Designer Manual and HPBr documents can be found by going to the Office of State Architect page.

1.5.2 Tennessee Board of Regents: Within the TBR's website, the Designer Manual can be found within the Office of Facilities Development at the Facilities sub-page. The Designer's Manual contains a link to download the HPBr.

1.5.3 University of Tennessee: Within the UT website, the Designer Manual can be found on the page of the Division of Facilities Planning, one of the departments on the site. The Designer's Manual contains a link to download the HPBr.

1.6 Assessment Review

1.6.1 The Checklist and required documentation for all projects shall be submitted by the Designers and Contractors and reported to the project Owner for review.

1.6.2 While utilizing the HPBr, Designers and state project Owners should review all references and the latest editions of adopted codes, standards, regulations, etc. If any references are believed to be incorrect or out of date, this information should be communicated to the OSA for review.

LM Land Management Credits

LM1. Site Selection – If the design team is involved in site selection, document the following:

LM1.1 Re-use buildings and sites before building new. If the project is re-using an existing building, document the percentages of building components to remain.

- Percent area of existing walls, floor and roof
- Percent area of interior non-structural elements

LM1.2 Select land that does not have the following attributes:

- Prime Farmland, per the USDA Code of Federal Regulations, or state or local guidelines.
- Previously undeveloped land within 5 vertical feet of a 100-year FEMA designated floodplain
- Land that is habitat to endangered or threatened species on a Federal or State list
- Land within 100 horizontal feet of a wetland, designated by Federal, State, or Local jurisdiction.
- Previously undeveloped land within 50 horizontal feet of a body of water that could support fish or recreation: rivers, lakes, and streams.

LM1.3 Remediate/restore and use contaminated sites. Brownfields are defined under an ASTM Phase II Environmental Assessment, EPA Brownfields definitions, or other federal, state, or local assessments or cleanup programs.

LM1.4 Re-develop or develop sites in urban environments with existing infrastructure and Pedestrian Access to goods and services.

LM2. Site Disturbance

LM2.1 Site Disturbance During Construction

- In order to effectively reduce erosion and sedimentation impacts, Best Management Practices (BMP's) must be designed, implemented, and maintained during land disturbing activities for all projects.

- The Tennessee Erosion and Sediment Control Handbook provided by the Tennessee Department of Environment and Conservation (TDEC) is designed to provide information to planners, developers, engineers, and contractors on the proper selection, installation, and maintenance of BMP's. The handbook is intended for use during the design and construction of all projects to protect the waters of the State. It also aids in the development of Storm Water Pollution Prevention Plans (SWPPP's) and other reports, plans, or specifications required when participating in Tennessee's water quality regulations. The handbook is currently available for download at the Tennessee Erosion Prevention and Sedimentation Control website by clicking on the direct link to the TDEC handbook.

LM2.2 Limit all site disturbance to the following:

- 40 horizontal feet beyond the building perimeter,
- 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter;
- 15 feet beyond primary roadway curbs and main utility branch trenches, and;
- 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.

The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:

- Submittals
- 'Construction Issue' plans
- 'As Built' plans
- Other appropriate records

LM3. Transportation

LM3.1 Identify and/or plan for public mass transit near the building.

- Locate two or more public or city funded bus lines within ¼ mile of the primary building entrance or locate a train station within ½ mile of the primary building entrance.
- Verify that routes to and from bus stops and train stations have Pedestrian Access.
- Ensure that a covered bus stop is available if the bus route cannot stop within 100 yards of any building entrance.

LM3.2 Design and construct bicycle storage for 5% of building occupants (full-time equivalent employees) and showering/changing facilities for 0.5% of building occupants, within 200 yards of a building entrance.

LM3.3 Design and construct preferred parking for carpool transit for 5% of all parking spaces.

LM3.4 Design and construct preferred parking for low emitting/fuel efficient vehicles for 5% of all parking spaces

LM4. Landscape Design

LM4.1 Vegetated Open Space:

- Design vegetated open space adjacent to the building equal to or greater than the building footprint.

LM4.2 Drought Tolerant Plantings:

- Utilize Native and Adapted Vegetation that are climate-tolerant to Tennessee and applicable to sustainable design techniques for all landscaping. See definitions in Appendix A for more guidance.
- www.plantnative.org provides information regarding plant species native to Tennessee, including suppliers.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - 'Construction Issue' plans
  - 'As Built' plans
  - Other appropriate records

LM5. Design to Reduce Heat Island Effects

Mitigating the Heat Island Effect through paving surfaces, light colored roofing or a green roof, should be considered within several factors, including but not limited to effect on the local ecology, energy conservation, glare control, stormwater control, maintenance, and return on investment (ROI).

LM5.1 Non–roof surface

- Design 50% of site area as Highly Reflective or non-absorptive (excluding building footprint). Possible strategies are as follows:
  - Use pervious/open-grid paving materials to promote infiltration and reduce heat island effect.

- o Utilize a parking deck to reduce the area of asphalt contributing to heat island effect and to reduce the overall impervious area contributing to runoff.
- o Use light colored paving surfaces with a Solar Reflectance Index (SRI) greater than 29 to limit heat island effect. For further guidance regarding SRI values, please reference the ASTM E1980 standard.
- o Plant tree types that will shade hardscape surfaces within 5 years to reduce urban heat islands.

LM5.2 Roof Surfaces

- For low-sloped roofs (slope ≤ 2:12), finished roof surface should have an SRI of 78 or greater for 75% of the roof surface.
- For steep-sloped roofs (slope > 2:12), finished roof surface should have an SRI of 29 or greater for 75% of the roof surface.
- When utilizing vegetated roof surfaces, the vegetated space should cover at least 50% of the roof surface.
- When utilizing a combination of vegetated and high solar reflectance roof surfaces, install them such that the following equation is satisfied:

$$\frac{\text{Area of SRI Roof}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

- For further guidance regarding SRI values, please reference the ASTM E1980 standard.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - o Submittals
  - o 'Construction Issue' plans
  - o 'As Built' plans
  - o Other appropriate records

LM6. Stormwater Design

Note that points cannot be achieved for both LM6.1 and LM6.2.

LM6.1 Design the stormwater management system for post-development site discharge rate and volume to not exceed pre-development discharge rate and volume. The design and calculations should be based on a 2-year 24-hour storm, or local code guidelines, whichever requirement is more stringent.

LM6.2 Meet the requirements of credit LM6.1 and reduce post-development discharge rate by 25% or more below pre-development discharge rate and volume.

LM6.3 Design to remove 80% Total Suspended Solids from the first inch of rain for each rainfall event (90% of the average annual rainfall), or local code guidelines, whichever is more stringent. Recommended BMPs are as follows:

- Bioswales and vegetated filter strips
- Retention ponds
- Vegetated roof
- Stormwater harvesting for re-use
- Pervious paving materials

LM6.4 Design storm water system per Tennessee Department of Environment and Conservation (TDEC) Storm Water Permitting Phase II MS4s.

LM7. Exterior Site Lighting:

Design building façade and site lighting that promote safety but minimize light pollution from the building site.

LM7.1 Design exterior area lighting power to be at least 10% less than is allowed by ASHRAE 90.1-2010, Section 9.4.3.

LM7.2 Use fixture types designed as “cutoff” and “full-cutoff” styles to minimize fixture lumens emitted at 90 degrees or higher from straight down.

LM7.3 Design the placement and fixture styles of site and all exterior lighting to minimize light trespass at the site boundary. Document the foot-candle levels at the site boundary with a site illumination model.

WE Water Efficiency Credits

WE1. Water Efficient landscaping

WE1.1 Irrigation: Design systems that use at least 50% less potable water than conventional means. Demonstration of 50% less water consumption shall be based on irrigation demand during the month of July. Water conservation strategies may include the following:

- Use of native/adapted species
- Placement and density of plantings

WE1.2 Non potable water sources: Minimize potable water use by incorporating as many water conservation measures listed below as feasible. When possible, also consider captured rainwater, recycled graywater, cooling tower blowdown, and/or municipally treated waste water for site landscape irrigation. Recommended water conservation measures include:

- Mulching of trees, shrubs, flower beds
- High efficiency technologies such as drip irrigation and micro-spray
- Daily and yearly irrigation schedules
- Moisture and weather-based irrigation control

WE2. Wastewater Treatment and Conveyance

WE2.1 Evaluate on-site treatment of wastewater for projects that do not have sewer access.

WE2.2 Use of non-potable water for sewage conveyance or composting. This strategy should be considered on a project-by-project basis. If utilized, collaborate closely with the local authority having jurisdiction regarding system design and implementation.

WE3. Reduced Potable Water Demand

WE3.1 Exceed the Energy Policy Act of 2005 fixture flow and use rates by at least 20% by installing high efficiency fixtures as specified below:

Commercial Fixtures	EPAct Baseline	High Efficiency Fixtures
Commercial Toilets	1.6 gallons per flush (gpf)	1.28 gpf
Commercial Urinals	1.0 gpf	0.5 gpf
Commercial Lavatory (restroom) Faucets	0.5 gallons per minute (gpm)	0.5 gpm
Showerheads	2.5 gpm	1.5 gpm
Kitchen Faucet	2.2 gpm	1.8 gpm

- Tankless type toilets that use dual-mode flushometers, 1.6/1.1 gpf on the up/down flush, are an acceptable alternative.
- Tank type toilets that use a dual-mode operation, 1.6/0.9 gpf on the up/down flush, are an acceptable alternative.
- Ultra-high efficiency urinals that use 0.13 gpf or water-free urinals shall be considered on a project-by-project basis.

WE3.2 Utilize auto-flow/auto-flush valves on lavatories, urinals, and toilets.

EE Energy Efficiency Credits

Energy Efficiency General Requirements:

- Refer to the Project Applicability Tree and Owner's Project Requirements to determine whether each Energy Efficiency credit is Required or Elective.
- When Life-Cycle Cost Analyses (LCCA) are utilized for energy efficiency or on-site renewable energy credits (EE3.2 and EE7.1), they shall be performed using the most recent version of the publicly-available BLCC5 software provided by the National Institute of Standards and Technology (NIST), or other equivalent methods, using the following parameters:
  - Assume the project is a Financed Project, unless otherwise notified by the Owner.
  - Study Period = 20 years
  - Nominal Discount Rate = Shall be equal to the 20-year Treasury Yield at Constant Maturity rate posted in the Federal Reserve release H.15 for the first month of the year in which the project design was initiated. Monthly Treasury Yields can be found on the Federal Reserve website: http://www.federalreserve.gov/releases/h15/data.htm
  - Fuel cost escalation rates = Use the most current DOE Projections for each fuel type included in BLCC5
  - Inflation on capital investment costs, residual values, O&M costs, and replacement costs for use during the study period shall be based on the most recent annual average increase in the Consumer Price Index, as can be determined using this calculator on the website of the U.S. Bureau of Labor Statistics: http://www.bls.gov/data/inflation_calculator.htm
    - For example, to determine the applicable inflation rate, calculate the percentage increase in the buying power of $100 between the year in which the project design was initiated and the previous year.
  - O&M Costs: Include maintenance and equipment replacement costs in the LCCA. Assumptions regarding preventative vs. deferred maintenance and capital renewal should be equally applied to each design option investigated.
  - Salvage Value: If equipment replacement costs are included in the LCCA, include a salvage or residual value at the end of the study period proportional to the remaining effective life of the equipment.
  - For financed projects, assume bonds are paid in annual, interest-only payments for the study period (at a rate equal to the discount rate). At the last month of the study period (19 years 11 months), the initial loan amount is to be paid in a lump sum.

EE1. Commissioning Requirements

- The Owner will determine what level of commissioning is to be applied to each project based on budget and goals. Please refer to OPR for project-specific determination on Basic , or Advanced levels of commissioning. See below for commissioning requirements.
- Only one commissioning credit can be pursued per project.

EE1.1 Basic Commissioning

- Basic commissioning allows the Design Engineer of Record or Owner to perform the commissioning, as assigned by the SPA.

- In general, the Basic Commissioning process includes testing during construction of individual systems or the building as a whole. Functional performance tests are carried out to verify that systems are performing in accordance with specified parameters. Testing may be observed or overseen by a project designer or by a representative of the owner.
- The commissioning requirements should be modified based on the specific type of project and how many systems will be impacted (i.e. all of them in a New Construction project, but perhaps only some in a Renovation).
- Review the Owner Project Requirements (OPR) with the Owner to align with project objectives.
- Reference and follow the State developed specifications as applicable:
  - Commissioning, Std 01 91 13
  - Performance Testing Identification Form, Std 01 91 23
  - Performance Testing Procedures Form, Std 01 91 26
  - Functional Performance Testing Certification, Std 01 91 29
  - Mech'l &Control Systems Commissioning, Std 23 08 00
  - Sensor Point Calibration Check Sheet, Std 23 08 13
  - Terminal Box Point Calibration Check Sheet, Std 23 08 16
  - Electrical & Lighting Commissioning, Std 23 08 00
  - Panelboard check sheet, Std 23 08 06
  - Power Circuit Check Sheet, Std 23 08 13
  - Generator Testing Procedures Form, Std 23 08 30
  - Generator Testing Findings Form, Std 23 08 32
  - Lighting Check Sheet, Std 23 08 50

EE1.2 Advanced Commissioning

- In general, the Advanced Commissioning process shall be carried out by a third party commissioning agent, independent of the designer and contractor, throughout the project. During the design phase the commissioning agent reviews the design documents to help insure that the Owner's Project Requirements are being fulfilled. During the construction phase the commissioning agent reviews the installations of various systems to help ensure that the systems function in accordance with the design documents and the Owner's Project Requirements.
- Refer to "State Commissioning Contract Attachment 6.6" for commissioning requirements
- Additional requirements may be added to specific projects as needed (with approval from the Owner).

EE2. Energy Efficient Purchasing Policy

EE2.1 In accordance with Tennessee Code Annotated section 12-3-905, purchase and install Energy Star qualified equipment for all Energy Star eligible equipment types including appliances, office equipment, electronics, and commercial food service equipment.

EE3. Energy Efficiency in New Construction and Renovation Projects

Building Energy Modeling responsibility and workflow:

- The engineer of record and the commissioning agent typically have the knowledge and expertise to execute the energy modeling, LCCA, and M&V scopes of work. The procured consultant for these tasks will be determined by the Owner on a project by project basis

Building Energy Modeling Concepts:

- A building energy model is to be used as a decision-making and goal-tracking tool throughout the design process. Energy modeling at each phase is intended to inform decisions that may be more difficult or costly to change later in the design process. In order to meet this intent, modeling results for each applicable phase (as defined below) should be communicated to all appropriate members of the Project Team in enough time for any energy saving measures to be incorporated into the design documents.
- All anticipated end-use load components should be included in the energy model.
- The following counties of Southwest TN are considered Climate Zone 3A: Chester, Crockett, Dyer, Fayette, Hardeman, Hardin, Haywood, Henderson, Lake, Lauderdale, Madison, McNairy, Shelby, and Tipton. All other counties in TN are defined as Climate Zone 4A (per 90.1 Table B-1).
- If the building area of a renovation or addition project is served by an HVAC air-side system outside the project scope, the entire area served by that HVAC air-side system shall be included in the energy model.
    - Exception: Existing building plans are not available for those areas outside of the project scope. In this case, areas outside the project scope shall be ignored, and HVAC fan power shall be normalized in terms of kW/cubic feet of air per minute (CFM) within the energy model.

EE3.1 Schematic Design Energy Modeling

- Timing: Project Teams shall complete this credit as soon as feasible, but no later than the end of the Schematic Design phase.
- Modeling protocols in ASHRAE 90.1-2010, Appendix G must be used, including provisions for Simulation Program requirements (G2.2), Climatic Data (G2.3), and Energy Rates (G2.4).
- Building Design Criteria: Identify and report the appropriate indoor design temperatures, desired horizontal illuminance levels, estimated peak internal loads, number of peak occupants, hourly internal load profiles and operations schedules, code-mandated HVAC requirements, and any known requirements for system redundancy, flexibility, and future capacity.
- Site Assessment: Identify and report the feasibility of potential site-specific and climate-specific passive and active design strategies and concepts such as, but not limited to, the following: passive solar heating, sun shading of windows, use of high thermal mass, night flushing, natural ventilation, evaporative cooling, daylight harvesting, on-site solar photovoltaics, and on-site wind turbines.
- Energy Model Creation: Create a building energy model based on the available plans, specifications, narratives, and BIMs. If the architectural building layout is not yet fully designed, a geometrically-simplified model may be used for this phase of analysis, provided that the appropriate weather data, gross floor area, number of floors, and appropriate internal loads and load profiles for the given building type (office, school, etc.) are applied to the energy model.

- Load Reduction Strategies: Use the building energy model to analyze a minimum of four (4) of the following load reduction strategies and identify the sensitivity of the building to various parametric changes on a base case model. This list should not be interpreted as an exhaustive list of load reduction strategies.
  - Investigate the effect of alternate building massing or building forms
  - Rotate the building from its original orientation
  - Incrementally decrease window-to-wall ratio
  - Application of permanent exterior shading devices to various building facades.
  - Change building location (near other buildings for shade, open field, near water, etc.
  - Incrementally increase wall insulation above the Baseline Design
  - Incrementally increase roof insulation above the Baseline Design
  - Incrementally decrease lighting power density below the Baseline Design
  - Incrementally decrease window U-value below the Baseline Design
  - Incrementally decrease window solar heat gain coefficient below the Baseline Design
- HVAC System Options: Use the building energy model to test the energy savings potential of at least two (2) HVAC systems options other than that in the Baseline Design. This analysis is independent of the load reduction analysis and should use a consistent set of building envelope and internal load parameters among all system options. HVAC system options are intended to be based on high performance cooling/heating technologies, alternative air or water distribution systems, etc.
- Documentation Requirements:
  - Project teams shall provide a report detailing the following elements of the schematic design energy model:
  - A brief description of the project, modeling software used, summary of pertinent inputs and assumptions from the Building Design Criteria and Energy Model Creation sections shall be provided to the Owner.
  - A narrative shall be provided to the Owner that summarizes the results and recommendations of the site assessment.
  - A report shall be provided to the Owner that describes the Load Reduction Analysis and HVAC System Options study and shall consist of an executive summary, description of evaluation methods and means, analysis results, recommendations, and calculations. This report shall quantitatively show the relative effect on energy costs and peak heating and cooling loads for each of the analyzed load reduction measures and HVAC system options. It shall also provide interpretation of the data and recommendations based on the results. The intent of this report is to provide the HVAC sizing and energy cost implications of the various system options and load reduction measures to inform Owner decisions on maximizing building performance within the total project budget.
  - List applicable mandatory provisions that must be met as described by ASHRAE 90.1 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4.

EE3.2 Energy Efficiency Life Cycle Cost Analysis

- If EE3.1 or EE3.3 is pursued, it is preferable that the same project team member completes the required analyses for all credits.

- Referring to criteria given in Energy Efficiency General Requirements section, utilize Life-Cycle Cost Analysis (LCCA) to compare the cost-effectiveness of at least two (2) building design options or Energy Conservation Measures (ECMs) investigated as part of the EE3.1, EE3.3 or EE3.4 credits.
  - These options and measures may include various HVAC system options or controls, building envelope improvements, lighting equipment or controls, service water heating equipment or controls, or a combination of these.
  - LCCA is typically applied to design options that are mutually exclusive (LED vs. Fluorescent lighting, Chiller manufacturer 'A' vs. Chiller manufacturer 'B', VAV Air Handling Units vs. DOAS Units serving Fan Coil Units, Baseline Design vs. Proposed Design)
  - Note that LCCA provides the largest benefit when used to evaluate building systems that comprise a relatively large portion of the construction costs, O&M costs, and energy costs (such as the HVAC system).
- Documentation Requirements:
  - Project teams shall provide a report detailing the following:
  - A summary of pertinent inputs and assumptions for the LCCA shall be provided to the Owner.
  - A report shall be provided to the Owner describing the quantitative results of the LCCA. These results must be accompanied by an interpretation of the data and recommendations. The intent of this report is to provide the life-cycle cost implications of various options to inform Owner decisions on maximizing building performance within the total project budget.
  - The LCCA report should be utilized as a decision making tool, but it should not necessarily provide the final determination on whether a particular energy saving measure should be implemented. The goal is to facilitate a more informed building owner, capable of weighing all information available to make a decision. If the option with lowest TCO (Total Cost of Ownership) is not chosen, the other factors going into the decision should be discussed. Examples of reasons why this might be the case include, but are not limited to, special acoustics requirements, a first-cost not supported by the budget, maintainability or interoperability with existing systems, etc.
  - If the analysis for this credit is performed concurrently with the analysis for either EE3.1,EE3.3, or EE3.4 the LCCA input and outputs may be combined with the reports for that credit.

EE3.3 Minimum Energy Performance

- Code Compliance: The project shall comply with ASHRAE/ANSI/IESNA Standard 90.1-2010, "Energy Standard for Buildings Except Low-Rise Residential Buildings," according to the project scope. Compliance shall be shown by meeting all mandatory provisions and by following either the Prescriptive compliance path, the Energy Cost Budget method in Chapter 11, or the Performance Rating Method in Appendix G. Note that if EE 3.4 "Improved Energy Performance" will be pursued, the Performance Rating Method in Appendix G should be utilized for code compliance. Individual addenda to ASHRAE Standard 90.1-2010 may be optionally applied by the Project Team if used in each addendum's entirety.

EE3.4 Improved Energy Performance

- The HPBr awards points based on the total energy cost savings demonstrated in the energy model when comparing the final Proposed Design to the ASHRAE 90.1 Baseline Design defined in 90.1, Appendix G.
- In order to assist in the design of a high performance building, project teams must complete Design Development energy modeling as defined below.
- At the completion of design, perform the Construction Documents energy modeling as defined below. Where a project exceeds the Minimum Energy Cost Savings defined in EE3.3 utilizing Appendix G, additional points will be awarded, as presented in the table below.

% Energy Cost Savings	
Over ASHRAE 90.1-2010	Points Awarded
3	1
6	2
9	3
12	4
15	5
18	6
21	7
24 and above	8

- Design Development Energy Modeling
  - Update building usage assumptions and inputs based on latest design documents.
  - Preferably during Schematic Design, but no later than the Design Development phase, evaluate at least nine (9) additional load reduction measures or ECMs that contribute to meeting the Owner's energy cost saving goals relative to the ASHRAE Baseline model. These ECMs must be in addition to those performed as a part of EE3.1, if pursued. To ensure that a sufficient variety of measures are investigated, ECMs from at least 3 of the following categories must be modeled:
    - Building Envelope
    - Lighting: Equipment, daylighting, and controls
    - HVAC: Equipment and controls
    - Plug/Process Loads
    - Service Water Heating: Equipment and controls
  - Documentation Requirements:
    - Project teams shall provide a report detailing the following:
    - A summary of inputs and assumptions shall be provided to the Owner.
    - The results of this analysis shall be communicated to the Owner and shall include, at a minimum:
      - energy costs of each ECM analyzed (in terms of total cost, cost per square foot, by end use, % savings to Baseline, and by fuel type)

- energy consumption of each ECM analyzed (in terms of total consumption, consumption per square foot, by end use,% savings to Baseline and by fuel type)

- Construction Document Energy Modeling
  - A building energy model of the proposed and baseline designs shall be created based on 100% Construction Documents or later. This model shall include all final HVAC and lighting control sequences, equipment capacities, and equipment efficiencies.
  - A summary of inputs and assumptions shall be provided to the Owner.
  - A comparison of the energy consumption and energy costs of the Proposed and Baseline Designs shall be provided to the Owner.

EE4. Existing Building Energy Efficiency

All projects shall comply with ASHRAE/ANSI/IESNA Standard 90.1-2010, "Energy Standard for Buildings Except Low-Rise Residential Buildings", according to the project scope. Individual addenda to ASHRAE Standard 90.1-2010 may be optionally applied by the project team if used in each addendum's entirety.

EE4.1 Lighting Power Reduction – For projects including the addition or alteration of interior lighting, demonstrate a reduction in installed lighting power density below that allowed by ASHRAE 90.1-2010, Chapter 9, using either the Building-Area method or the Space-by-Space method. The HPBr awards points for reductions in installed lighting power as follows:

% Lighting Power Reduction	Points
10	1
20	2
30	3
40	4
50	5

EE4.2 Daylight Harvesting – For projects including the addition or alternation of interior lighting, install daylight responsive controls that control either 1) all regularly occupied daylit spaces within 15 feet of windows or 2) at least 50% of the connected load of all daylight responsive interior lighting within the project scope. Controls must dim or switch electric lights in response to presence or absence of daylight illumination in the space. Design documents must list the illumination set point for each daylight control zone to allow for lighting control system to be properly commissioned.

EE4.3 Vacancy Sensors – For projects including the addition or alternation of interior lighting, when it does not affect the safety or security of building occupants, vacancy sensors (auto-off / manual on or partial automatic on) must be installed that automatically control lighting based on vacancy in the space. These sensors must be used to control 50% of the connected lighting power not already required to be controlled by ASHRAE 90.1-2010.

EE4.4 High Efficiency HVAC – For projects including the HVAC equipment installation or replacements, install HVAC equipment as a part of the project scope that complies with the minimum efficiency requirements listed in ASHRAE Standard 189.1-2011, Appendix C.

EE5. Energy Metering, Monitoring, and Reporting

Energy Metering General Concepts:

- To facilitate cost-effective energy sub-metering, new or altered energy distribution systems should be designed such that each primary circuit, panel, feeder, piping system, or supply mechanism provides only one of the following energy end-uses:
  - HVAC system total energy use (including fans, pumps, space cooling, space heating, etc.)
  - Lighting system total energy use (Interior and Exterior lighting)
  - Plug loads (including all equipment connected to convenience receptacle outlets).
  - Separate process loads exceeding 5% of peak connected load (including data centers, commercial kitchens, etc.)

EE5.1 Building-Level Metering

- For each applicable energy source below, utility meters or supplemental permanent sub-meters shall be provided and equipped with a local data port connected to the Building Automation System (BAS) or a separate Energy Information System (EIS):
  - Grid-provided Electricity
  - Natural Gas
  - District/Campus Chilled Water
  - District/Campus Steam / Hot Water
  - On-site Renewable Electric Power
- Data Centers with dedicated cooling systems shall be sub-metered downstream of the UPS (this sub-metering configuration is a requirement for achieving an Energy Star Rating).
- Provide the IT/Telecommunications infrastructure and capability to allow for the installation of a permanent, readily accessible and visible display near the main building entrance or on a publicly available Internet web site. The display shall be capable of providing current and historical energy demand and consumption for each fuel type as well as total energy consumption. The resulting information is meant to support decisions on efficient energy use and reduction through operational change, maintenance, control adjustment, and facility upgrade.

EE5.2 System Level Energy Metering with Measurement and Verification for New Construction

- The Project Team shall develop and implement a Measurement & Verification (M&V) Plan in accordance with Option D (Calibrated Simulation) of the 2006 International Performance Measurement & Verification Protocol (IPMVP) Volume III. The initial M&V Period shall include at least one continuous 12-month period. The M&V Plan shall include at a minimum the following:
  - State which option and savings method from the IPMVP will be used
  - Identify roles and responsibilities involved with the M&V program
  - State assumptions about significant variables or unknowns
  - Create an accurate baseline using techniques appropriate to the project
  - Describe the method of ensuring accurate energy savings determination
  - Define post-installation inspection plan
  - Specify criteria for equipment metering, calibration, and measurement period.
  - Define the level of accuracy to be targeted.
  - Indicate quality assurance measures

- o Describe the contents of reports to be prepared, along with a schedule
- Determine the most cost effective method to provide permanent measuring devices with remote communication capability to monitor all energy loads listed in Energy Metering General Concepts above which are installed within the project scope. To facilitate this, all control devices and sensors should have the capability to be easily integrated into the BAS. In addition to direct energy measurements, trending HVAC equipment statuses, temperatures, flow rates, and pressures may assist in reconciling predicted and actual energy performance. An example of HVAC trended points is provided in the table below.

Instrument	Unitary or Packaged AC	Air handling units	AHUs with humidifiers	Chillers	Cooling Towers	Boilers	Pumps	
supply air temp	x	x	x					
return air temp	x	x	x					
mixed air temp		x	x					
return air humidity			x					
chilledwater supply temp				x				
chilled water return temp				x				
condenser water supply temp				x				
condenser water return temp				x				
hot water supply temp						x		
hot water return temp						x		
status on/off				x	x		x	

- At a minimum, all trended data points shall be recorded every 15 minutes and produce hourly energy profiles.
- The BAS, or a separate EIS, shall be specified to record all energy load data programmed with the required data trending and storage capacity to meet the intent of the M&V Plan. At a minimum, the system shall generate building level and system level reports on an hourly, daily, monthly, and annual basis. The system shall be capable of storing or archiving all data for a minimum of 36 months.
- At the end of the initial 12-month M&V period, a contracted M&V Analyst shall submit a Final M&V Report to the Owner and Project Team, including the following information:
  - o The results of the reconciliation between actual energy use and energy use predicted during the design phases.
  - o Discussion of variances between actual and predicted energy use, operational parameters, and other design phase assumptions that affected these results.
  - o Actual avoided energy use and energy costs compared to design phase model. Use either Savings Estimation Method 1 or 2 from the 2006 IPMVP Volume III, Option D.
  - o Based on the results of the energy model reconciliation, as well as gathered trended data and observations, make recommendations for corrective or future actions to improve ongoing building energy performance.

EE5.3 System Level Energy Metering with Measurement and Verification for Existing Buildings

- The Project Team shall develop and implement a Measurement & Verification (M&V) Plan in accordance with Option B (Retrofit Isolation) or Option D (Calibrated Simulation) of the 2006 International Performance Measurement & Verification Protocol (IPMVP) Volume III. The initial M&V Period shall include at least one continuous 12-month period. The M&V Plan shall, at a minimum:
  - State which option and savings method from the IPMVP will be used
  - Identify roles and responsibilities involved with the M&V program
  - State assumptions about significant variables or unknowns
  - Create an accurate baseline using techniques appropriate to the project
  - Describe the method of ensuring accurate energy savings determination
  - Define post-installation inspection plan
  - Specify criteria for equipment metering, calibration, and measurement period.
  - Define the level of accuracy to be targeted.
  - Indicate quality assurance measures
  - Describe the contents of reports to be prepared, along with a schedule
- Determine most cost effective method to provide permanent measuring devices with remote communication capability to monitor all energy loads listed in Energy Metering General Concepts above which are installed within the project scope. To facilitate this, all control devices and sensors should have the capability to be easily integrated into the BAS or EIS.
- At a minimum, all trended data shall be recorded every 15 minutes and produce hourly energy profiles.
- The BAS or a separate EIS shall be specified to record all energy load data programmed with the required data trending and storage capacity to meet the intent of the M&V Plan. At a minimum, the system shall generate building level and system level reports on an hourly, daily, monthly, and annual basis. The system shall be capable of storing or archiving all data for a minimum of 36 months.
- At the end of the initial 12-month M&V period, the contracted M&V Analyst shall submit a Final M&V Report to the Owner and Project Team, including the following information:
  - The results of the reconciliation between actual energy use and energy use predicted during the design phase.
  - Discussion of variances between actual and predicted energy use, operational parameters, and other design phase assumptions that affected these results.
  - Actual avoided energy use and energy costs compared to design phase model. Use either Savings Estimation Method 1 or 2 from the 2006 IPMVP Volume III, Option B or D.
  - Based on the results of the energy model reconciliation, as well as gathered trended data and observations, make recommendations for corrective or future actions to improve ongoing energy performance.

EE6. Long-Term Energy Reporting

EE6.1 Before substantial completion of the project, the Owner shall designate a dedicated member of the operations staff with the ongoing role of entering energy and water consumption data as well as building operational parameters into Energy Star Portfolio Manager.

EE7. Renewable Energy

EE7.1 Onsite Renewable Energy

- Evaluate project site for on-site renewable energy opportunities to offset the building's energy consumption from local grid power by means of life-cycle cost analysis (LCCA).
- This credit may still present a good opportunity for large-scale renovations or additions to existing facilities, however, it is only a Required credit for New Construction projects.
- Evaluating on-site renewable energy by means of life-cycle cost analysis is required by TCA 4-3-1012 for New Construction projects. Possible on-site energy sources include:
  - Solar photovoltaic
  - Solar water heating
  - Wind generated electricity
  - Low-impact ("micro") hydro-electric systems
- LCCA of onsite renewable energy should include the incremental costs above the base design. For example, using building-mounted PV panels on the south face of a building may be more cost-effective when used as an alternative to window overhangs. In this case, the first costs of PV, for the purposes of the LCCA, would not be the installed cost of the PV panels, but instead be the difference in cost between the window overhangs and the PV panels.
- A report summarizing the process and results of the LCCA must be provided to the Owner at the end of the Schematic Design phase.

EE7.2 Green Power

- Provide Renewable Energy Credits (RECs) equal to 10% of annual site electrical costs over at least 2 years through TVA or other local power authority OR
- Provide RECs equal to 35% of annual site electrical costs over at least 2 years from another source.

MR Material and Resource Credits

MR1. Recyclable Collection & Storage

- Coordinate all recycling efforts with the State organization that will occupy the building. Many State agencies have pre-existing recycling programs.

MR1.1 Comply with the following requirements:

- Identify local / regional availability for collection of recyclables from the facility.
- Identify recyclable materials to be generated by building occupants and operations. Including but not limited to the following:
  - paper / cardboard
  - plastic
  - metal
  - glass
- Allocate space in building for central collection and storage of recyclables. Size collection area to meet demand of building occupants, below are guidelines for recycling areas, these figures can be used at the discretion of the Project Team:

Building Square Footage	Minimum Recycling Area (sq. ft.)
0 to 5,000	80
5,001 to 15,000	120
15,001 to 50,000	170
50,001 to 100,000	220
100,001 to 200,000	270
200,001 or greater	500

MR2. Construction Waste Management

MR2.1 Comply with the following requirements:

- Identify availability of local construction waste hauling and recycling facilities within the region of the construction site, such as:
  - One stop facilities
  - Specified material facilities (i.e. wood only, metal only….)
- Identify recyclable waste materials anticipated during construction, including, but not limited to, the following:
  - Rubble: concrete, brick, block debris, etc.
  - Wood
  - Plastics
  - Metals
  - Drywall
  - Cardboard, packaging materials, etc
- The Designer shall instruct the Contractor to develop a waste management plan, including, but not limited to, the following:
  - Plan to address procedure for sorting, hauling, and tracking rate of recyclables from construction site
  - Address training of onsite personnel to ensure participation in program.

- Design to maximize material with standard modular dimensions and encourage reduced overage in construction material orders to minimize waste on site.
- The Designer shall instruct the Contractor to provide documentation during construction that 50% or more material (excluding soil) has been diverted from the landfill to be salvaged or recycled. Percentage shall be determined either by weight or volume. Point thresholds are as follows:
  - 50% – 1 pt
  - 75% – 2 pt
  - 90% – 3 pt

MR3. Sustainable Material Preferences

MR3.1 Recycled Materials

- Select construction materials that are high in recycled content, such that 10% (based on cost) of all building materials are recycled. This credit excludes mechanical, electrical, and plumbing (MEP) equipment.
- Research local availability of fly-ash concrete and synthetic gypsum board for use in construction when appropriate.
- Specify submittals to include percentages of recycled material by weight and identify post-consumer and post-industrial recycled content.
- The Designer shall instruct the Contractor to provide material verification with submittals necessary to document that 10% of building materials (excluding MEP equipment) by cost, are recycled.

MR3.2 Recycled Content Materials 20%

- The Designer shall instruct the Contractor to provide material verification with submittals necessary to document that 20% of building materials (excluding MEP equipment) by cost, are recycled.

MR3.3 Tennessee Produced Materials (non-wood): utilize building materials/products such that 10% (based on cost, excluding MEP equipment) of the project is comprised of materials harvested AND manufactured in the state of Tennessee. For a product that is only harvested OR manufactured in TN, 50% of that material cost will contribute to this credit.

- Materials which satisfy the MR3.3 requirements can be automatically included in MR3.5 Regional Materials.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

MR3.4 Tennessee Produced Wood Products: utilized materials/products such that 50% of the wood products (based on cost) in the project are comprised of wood materials harvested and manufactured in Tennessee. For products that are only harvested OR manufactured in TN, 50% of that material cost will contribute to this credit.

- Materials which satisfy the MR3.4 requirements can be automatically included in MR3.5 Regional Materials.

- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

MR3.5 Regional Materials: utilize building materials that are regional to the project site, regardless of which state they are produced in, such that 20% (based on cost, excluding MEP equipment) of the project is comprised of materials harvested AND manufactured within 500 miles of the project site. For products that are only harvested OR manufactured within 500 miles, 50% of that material cost will contribute to this credit.

- Any materials which qualify for either MR3.3 or MR3.4 can also be counted for this credit.
- Additional credit is available under credit ID1.5 for achieving a 30% threshold, refer to ID1.5 for further details
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

MR3.6 Where practical, utilize salvaged materials in design and construction of state projects.

- Identify locally available resources for salvaged materials that may meet the projects functional and aesthetic needs.
- The Designer shall instruct the Contractor to provide material verification of credit compliance with submittals and cost data.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

MR3.7 Where practical, specify and utilize natural materials of rapidly renewable origins.

- Rapidly renewable materials replenish in 10 years or less.
- Preferred renewable materials for use include linoleum, cotton batt insulation, wool carpet, cork and bamboo flooring.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

EQ Indoor Environmental Quality Credits

EQ1. Tobacco Smoke Control - Non-Smoking Facilities

EQ1.1 Comply with all of the following:

- All State-owned and operated buildings must be non-smoking.
- Any designated smoking areas must be located as required by State law, Owner requirement, or at least 25 feet away from entries, outdoor air intakes, and operable windows, whichever requirement is most stringent.

EQ2. Minimum Ventilation

EQ2.1 Design to comply with ASHRAE Standard 62.1-2007 "Minimum Ventilation for Acceptable Indoor Air Quality," or the 2012 International Mechanical Code (IMC).

- If ASHRAE 62.1-2007 is used for compliance, utilize either the Ventilation Rate Procedure (VRP) or IAQ procedure as described in the reference standard.

EQ3. Outdoor Air Delivery Monitoring

EQ3.1 Outdoor air delivery monitoring is required for mechanical systems that utilize direct measurement of outdoor air as a method for determining the ventilation rates.

- The measurement system must provide an alarm when sensed airflow rate is 10% below design minimum outdoor air rate (see ASHRAE 62.1-2007 or the 2012 IMC).

EQ4. CO_2 Monitoring

EQ4.1 Provide carbon dioxide monitors within all densely occupied spaces (greater than 25 people per 1000 sq.ft.) served by the air handling unit that measures outside air. Locate monitors between 3 and 6 feet above the floor. Monitors shall communicate with the building automation system to provide an alarm when sensed carbon dioxide is 10% above the setpoint for the space. To avoid nuisance alarms, appropriate CO_2 setpoints should be calculated using methods in ASHRAE 62.1–2007, Appendix C.

EQ5. Air Quality Management

EQ5.1 During Construction - Develop and implement an Indoor Air Quality (IAQ) Management Plan for the Construction phase as follows:

- Meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
- Protect stored on-site or installed absorptive materials from moisture damage.
- If permanently installed air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 shall be used at each return air grille. (The procedure for determining MERV ratings is contained in ASHRAE 52.2-1999.) Replace all filtration media immediately prior to occupancy.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - 'Construction Issue' plans
  - 'As Built' plans
  - Other appropriate records

EQ5.2 Before Occupancy – The Designer shall instruct the Contractor to develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase as follows:

- OPTION 1 — Flush-Out
  - After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of between 80 and 60 degrees F and relative humidity no higher than 60%.
  - If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3,500 cu.ft. of outdoor air per sq.ft. of floor area to the space. Once a space is occupied, it shall be ventilated per the design minimum outside air rate determined from ASHRAE 62.1-2007 or the 2012 IMC.
  - During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cu.ft./sq.ft. of outside air has been delivered to the space.
- OPTION 2 — Air Testing
  - Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the United States Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air.
  - All materials used in the construction of the building shall meet the requirements or credits EQ6.1-EQ6.5. The VOC content of the materials listed in credit EQ6must be less than the limits indicated unless the only materials available do not also meet the functional needs of a given space. The Designer shall instruct the Contractor to provide material verification with submittals.
  - The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
    - Submittals
    - 'Construction Issue' plans
    - 'As Built' plans
    - Other appropriate records

EQ6. Material VOC Limits

EQ6.1 The Volatile Organic Compounds (VOC) content of adhesives, sealants, and paints / coatings used must not exceed the limits established below for interior products (those inside the weather barrier). The Designer shall instruct the Contractor to provide material verification with submittals.

EQ Table – Material VOC Limits	
Architectural Adhesives (g/L less water):	
a. Indoor Carpet:	50
b. Carpet Pad:	50
c. Wood Flooring	100
d. Rubber Floor:	60
e. Subfloor:	50
f. Ceramic Tile:	65

g. VCT & Asphalt:	50
h. Drywall & Panel:	50
i. Cove Base:	50
j. Multipurpose:	70
k. Structural Glazing:	100
Specialty Adhesives (g/L less water):	
a. PVC Welding:	510
b. CPVC Welding:	490
c. ABS Welding:	325
d. Plastic Cement:	250
e. Primer for Plastic:	550
f. Contact:	80
g. Special Purpose Contact:	250
h. Structural Wood Member:	140
i. Sheet Applied Rubber:	850
j. Top & Trim:	250
Substrate Specific (g/L less water):	
a. Metal to Metal:	30
b. Plastic Foams:	50
c. Porous Material (except wood):	50
d. Wood:	30
e. Fiberglass:	80
Sealants (g/L less water):	
a. Architectural:	250
b. Architectural Porous:	775
c. Nonmembrane Roof:	300
d. Roadway:	250
e. Single-Ply Roof Membrane:	450
f. Other:	750
g. Aerosol General Purpose mist spray:	65% VOCs by weight
h. Aerosol General Purpose web spray:	55% VOCs by weight
i. Aerosol Special Purpose:	70% VOCs by weight

Paints (g/L less water):	
a. Flats:	50
b. Non-Flats	
Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates:	
a. VOC limit is (g/L less water):	250
Coatings (g/L less water)	
a. Clear wood finish, varnish:	350
b. Clear wood finish, lacquer:	550
c. Floor coatings:	100
d. Sealers and undercoaters:	200
e. Shellac, clear:	730
f. Shellac, pigmented:	550
g. Stain:	250

EQ6.2 Adhesives and Sealants

- Adhesives and sealants used must not exceed the limits established in the EQ Table. The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - 'Construction Issue' plans
  - 'As Built' plans
  - Other appropriate construction records

EQ6.3 Paints

- Paints used must not exceed the limits established in the EQ Table.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - 'Construction Issue' plans
  - 'As Built' plans
  - Other appropriate construction records

EQ6.4 Coatings and anti-corrosive paints

- Coatings and anti-corrosive paints used must not exceed the limits established in the EQ Table.
  - The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals

- ‘Construction Issue’ plans
- ‘As Built’ plans
- Other appropriate construction records

EQ6.5 Flooring Systems

- All carpet systems must meet or exceed the requirements of the Carpet and Rug Institute’s Green Label Plus Indoor Air Quality Test Program.
- All carpet cushion installed in the building interior shall meet the requirements of the Carpet and Rug Institute Green Label program.
- All carpet adhesive: VOC limit of 50 g/L.
- All hard surface flooring must meet the testing and product requirement of FloorScore certification.
- Tile, masonry, terrazzo, cut stone and solid wood flooring without coatings or sealants qualify for credit without testing.
- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

EQ6.6 Composite wood and agrifiber products must contain no added urea-formaldehyde resins.

- The Designer shall instruct the Contractor to provide verification of credit compliance through any of the following documents:
  - Submittals
  - ‘Construction Issue’ plans
  - ‘As Built’ plans
  - Other appropriate construction records

EQ7. Pollutant Control

EQ7.1 Entryway Systems - design to minimize and control pollutant entry into buildings and later cross-contamination of regularly occupied areas:

- Employ permanent entryway systems at least six feet long in the primary direction of travel to capture dirt and particulates from entering the building at all entryways that are directly connected to the outdoors. Acceptable entryway systems include permanently installed grates, grilles, or slotted systems that allow for cleaning underneath. Roll-out mats are only acceptable when maintained on a weekly basis. Qualifying entryways are those that serve as regular entry points for building users.

EQ7.2 Where hazardous gases or chemicals may be present or used, including garages, housekeeping/laundry areas, and designated copying/printing rooms, exhaust each space sufficiently to create negative pressure with respect to adjacent spaces with the doors to the room closed. For each of these spaces, provide self-closing doors and deck to deck partitions or a hard lid ceiling. The exhaust rate shall be at least 0.50 cfm/sq.ft. or as required by the International Mechanical Code 2012 (whichever requirement is more stringent) with no air recirculation.

EQ7.3 In mechanically ventilated buildings, each ventilation system that supplies outdoor air to regularly occupied areas of the building shall be provided with particle filters or air cleaners to clean the outdoor air which comply with one of the following criteria:

- Filtration media rated at a Minimum Efficiency Reporting Value (MERV) of 13 or higher in accordance with ASHRAE 52.2.
- Filtration media having a minimum dust spot efficiency of 80% or higher and greater than 98% arrestance on a particle size of 3-10 µg.
- Clean filtration media shall be installed immediately prior to occupancy.

EQ8. Thermal Comfort

EQ8.1 Design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy.

EQ9. Individual Occupant System Controls

EQ9.1 Lighting Controls

- Provide individual lighting controls for 90% of building occupants.
- Provide lighting system controllability for all shared multi-occupant spaces to allow lighting level adjustments that meet group needs.

EQ9.2 Thermal Comfort

- Provide individual comfort controls to 50% of building occupants.
- Provide comfort system controls for all shared multi-occupant spaces per ASHRAE standard 55-2004.

EQ10. Daylight to Occupied Spaces

EQ10.1 Design the building envelope to achieve a 2% glazing factor in a minimum of 75% of all regularly occupied areas. The glazing factor is calculated as follows:

$$\text{Glazing Factor} = \frac{\text{Window Area}}{\text{Floor Area}} \times \text{Window Geometry Factor} \times \frac{\text{Actual } T_{vis}}{\text{Minimum } T_{vis}} \times \text{Window Height Factor}$$

- A spreadsheet calculator has been developed to calculate the Glazing Factor from the information provided. This spreadsheet program includes all necessary instructions for calculating Glazing Factor from building geometry.
- At the option of the design team, a daylight simulation model may be used instead of or in addition to the above calculation method. Using a computer simulation model, demonstrate that a minimum daylight illumination level of 25 foot-candles has been achieved in a minimum of 75% of all regularly occupied areas. Modeling must demonstrate 25 horizontal foot-candles under clear sky conditions, at noon, on the equinox, at 30” above the finished floor.

EQ11. Views from Occupied Spaces

EQ11.1 Design the building envelope and space layout to allow a direct line of sight to the outdoor environment via vision glazing between 2’6” and 7’6” above finish floor for building occupants in 90% of all regularly occupied areas. Determine the area with direct line of sight by totaling the regularly occupied square footage that meets the following criteria:

- In plan view, the area is within sight lines drawn from perimeter vision glazing.
- In section view, a direct line of sight can be drawn from the area to perimeter vision glazing.
- Line of sight may be drawn through transparent interior glazing.

- For private offices, the entire square footage of the office can be counted if 75% or more of the area has direct line of sight to perimeter vision glazing.
- For multi-occupant spaces, the actual square footage with direct line of sight to perimeter vision glazing is counted.
- $\frac{\text{Total floor area with direct line of sight}}{\text{Total regularly occupied floor area}} \text{x}100\% = \text{Views Percentage}$
- A spreadsheet calculator has been developed to calculate the views percentage from the information provided. This spreadsheet program includes all necessary instructions for calculating views percentage from building geometry.

ID Innovation in Design and Construction Credits

The design team, Owner, and Contractor are encouraged to demonstrate greater accomplishments in project design and performance by either exceeding the established standards throughout the HPBr, or by seeking innovative performance in sustainable categories not specifically addressed by this document. This category provides project teams the opportunity to highlight dynamic and effective high performance features of their projects and to enhance the credits within HPBr.

The following are suggested topics that can be addressed with the goal of moving beyond the minimum requirements. For credit categories not listed, the design team must submit a statement of intent for the proposed innovation, a measurable method of compliance, and a benchmark for acceptable performance to be reviewed by the State project manager. The proposed credits will be assessed by the Office of State Architect for applicability, individual approval, and possible adoption into the HPBr.

ID1. Tennessee Advancement

- Owner, design team, or Contractor (at the direction of the Designer) shall provide verification of credit compliance through any of the following documents:
  - Submittals
  - 'Construction Issue' plans
  - 'As Built' plans
  - Other appropriate records

ID1.1 Watershed Restoration

- Tennessee waters support an astonishing variety of wildlife, including more than 325 species of fish, 132 species of mussels, and 101 species of crayfish. In addition, Tennessee's 70 amphibian, 61 reptile, 300 bird and 89 mammal species all rely on Tennessee's water resources. Four of the eight most ecologically rich rivers in North America are in Tennessee. Project Teams are encouraged to assess nearby streams and watersheds regarding water quality and overall health of flora and fauna and engage in restoration practices in conjunction with TDEC guidelines.

ID1.2 Green Housekeeping Practices

- Select building materials that require minimal cleaning and maintenance.
- Provide information on proposed cleaning agents and the independent certification those agents adhere to. Document that the cleaning agents and building materials are compatible and that the building materials will maintain their integrity through their expected useful life.

ID1.3 Exemplary Efforts

- Recycled Content:
  - Specify and install construction materials with 30% recycled content by cost, not including MEP equipment.
- Exemplary performance in Water Use Reduction:
  - Exceed the Energy Policy Act of 2005 fixture flow and use rates by 40% by installing high efficiency fixtures.

ID1.4 Construction Site Energy Efficiency

- Meet at least two of the following requirements during construction:
  - Utilize alternative fuels such as bio-diesel in construction equipment.
  - During construction, meet the site lighting criteria of LM7.
  - During construction, coordinate evening site lighting with local curfew hours.

ID1.5 Regional Materials

- Utilize building materials that are regional to the project site, regardless of which state they are produced in, such that 30% (based on cost, excluding MEP equipment) of the project is comprised of materials harvested AND manufactured within 500 miles of the project site. For products that are only harvested OR manufactured within 500 miles, 50% of that material cost will contribute to this credit.

ID2. Environmentally Accredited Project Team

ID2.1 Provide certification that a design or construction project team leader meets at least one of the following professional accreditations:

- LEED AP (Accredited Professional) – from the US Green Building Council
- Certified Energy Manager (CEM) – from the Association of Energy Engineers
- Certified Measurement & Verification Professional (CMVP) – from the Association of Energy Engineers
- Green Globes Professional (GGP) – from the Green Building Initiative
- Additional energy or environmental accreditations may be submitted to the OSA for approval or possible inclusion into future revisions of the HPBr.

Appendix A – Definitions

Adhesive- A substance used to bond two surfaces together by attachment. Adhesives include all bonding and adhesive primers.

Aerosol Adhesive- An adhesive deployed as a spray/aerosol. These adhesives include special purpose, mist and web spray adhesives.

Agrifiber Board- A composite panel product derived from recovered agricultural waste fiber and agricultural prunings. The recovered fibers are processed and mixed with resins to produce products with characteristics similar to those derived from wood fiber.

Baseline Design- A computer representation of a hypothetical design based on the proposed building project, but adjusted according to ASHRAE 90.1, Appendix G. This representation is used as the basis for calculating the baseline building performance for rating above-standard design.

Best Management Practices (BMP)- These are standards of design or planning as defined by national, state, or local codes and guidelines.

Brownfield- Property with the potential presence of hazardous substances, pollutants or contaminants which may complicate redevelopment efforts. See also www.epa.gov/brownfields

Building Envelope- The envelope includes the exterior of a building's construction, including the walls, windows, roofs and floors.

Building Footprint- The area on a building site defined by the perimeter of the building plan. Any non building facilities are not included in the footprint, including landscaping parking areas, walkways, and other similar areas.

Commissioning Agent- An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.

Contaminant- An unwanted airborne constituent that may reduce air quality (ASHRAE 62.1).

Daylighting- the controlled admission of natural light into a space, used to reduce or eliminate electric lighting.

Daylit Area- The total floor area that meets the performance requirements for daylighting.

Energy Conservation Measures (ECMs)- Installations of equipment or systems, or modifications of equipment or systems, for the purpose of reducing energy use and/or costs.

ENERGY STAR® Rating- The rating a building earns using the ENERGY STAR Portfolio Manager to compare building energy performance to similar buildings in similar climates. A score of 50 represents average building performance.

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

Footcandle (fc)- A unit of illuminance equal to one lumen of light falling on a one-square foot area from a one candela light source at a distance of one foot.

Formaldehyde- Formaldehyde is a naturally occurring volatile organic compound which is carcinogenic and an irritant when present in relatively high concentrations. It has been known to cause headaches, dizziness, mental impairment, and other symptoms. When present in air at levels above 0.1 ppm (parts

per million), it may cause watery eyes, burning sensations in the eyes, nose, and throat; nausea; coughing; chest tightness; wheezing; skin rashes; as well as asthmatic and allergic reactions.

Functional Performance Testing (FPT)- FPT is used to determine the ability of commissioned systems to perform in accordance with the Owner's Project Requirements, Basis of Design, and construction documents.

Full-Time Equivalent (FTE)- A metric for building occupants equal to one person occupying a building for an eight-hour period per workday.

Glare Control-Device or control method used to reduce excessively bright sources of light within the visual field that creates discomfort or loss in visibility.

Glazing Area- The entire area taken up by transparent light-transmitting glazing surfaces, including windows and skylights. The area includes the rough opening or glass and excludes the frame, sash, and other non-glazed components.

Glazing Factor- The ratio of interior illuminance at a given point on a given plane (usually the work plane) to the exterior illuminance under known overcast sky conditions. LEED uses a simplified approach for its credit compliance calculations. The variables used to determine the daylight factor include the floor area, window area, window geometry, visible transmittance (T_{vis}) and window height.

Greenfield Sites- These are sites which have not been previously cleared, developed or graded and remain in a natural state.

Heat Island Effect- Solar energy is absorbed by various constructed surfaces (e.g. roads, walkways, buildings, parking lots, etc) which are found in high concentrations in dense urban areas. The storage and buildup of this solar energy leads to warmer temperatures in large urban areas compared to surrounding rural areas, affecting energy consumption and the local ecology

HVAC Systems- Include heating, ventilating, and air-conditioning systems used to provide thermal comfort and ventilation for building interiors.

Hybrid Vehicles- Hybrids which use a gasoline engine to drive an electric generator which then stores power in batteries to run electric motors to propel the vehicle.

Impervious Surfaces- Surfaces which do not allow infiltration of water into the subsurface. This effects the stormwater runoff potential of the material, which can be estimated for various surface materials.

Indoor Air Quality- The quality of air inside a space or building. Indoor air quality affects the health and well-being of building occupants.

Laminate Adhesive- A type of adhesive commonly used in wood/agrifiber products as a bonding agent.

Landscaped Area- The landscapes area of the site is equal to the total site area, less the building footprint, paved surfaces, water bodies, and other non planted areas.

LEED Accredited Professional (AP) - A design and construction industry professional who has been recognized by the US Green Building Council as an individual with expertise in the principles of green building Design, construction, and operation.

Life Cycle Cost Analysis (LCCA) Method- A technique of economic evaluation that sums over a given study period the costs of initial investment (less resale value), replacements, operations (including energy use), and maintenance and repair of an investment decision (expressed in present or annual value terms).

Light Pollution- Waste light from building sites and lighting installations produces glare, when directed upward or off site.

Micro-irrigation- Micro-irrigation is an irrigation technique which involves systems with small sprinklers, micro-jets, or drippers designed to release small volumes of water to meet (and not exceed), irrigation requirements. Sprinklers and micro-jets are often installed within a few centimeters of the ground, while drippers are commonly positioned on or below grade.

Native and Adaptive Vegetation- plants that are adapted to a given area during a defined time period and are not invasive. In North America, the term often refers to plants growing in a region prior to the time of settlement by people of European descent.

Open Space Area- Open Space areas shall be defined by local zoning requirements. If local zoning requirements do not clearly define these areas, they shall be defined for the purposes of this document as the property area minus the development footprint. It must also be vegetated and pervious, except where noted in the credit requirements. For projects located in urban areas which qualify for LM4.1, open space also includes non-vehicular, pedestrian-oriented hardscape areas.

Open-grid Pavement- This is defined as pavement which is greater than 50% pervious and contains vegetation in the open cells.

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

Owner's Project Requirements (OPR)- An explanation of the ideas, concepts and criteria that are determined by the Owner to be important to the success of the project (previously called the Design Intent).

Pedestrian Access- Implies that pedestrians can gain access to services comfortably without being blocked by walls, freeways or other unreasonable barriers.

Perviousness- Perviousness describes a material which allows moisture to pass through it. In the context of this document, perviousness pertains primarily paving materials and their ability to allow moisture to penetrate through them and into the ground.

Post-consumer- Post-consumer describes waste material generated by households or by commercial and industrial facilities in their role as end-users of the product, which can no longer be used for its original purpose. This waste includes returns of materials from the distribution chain (source: ISO 14021). Examples of this kind of waste category include construction and demolition debris, materials collected through many recycling programs, , discarded products (e.g., furniture, cabinetry and decking) and urban maintenance waste (e.g., leaves, grass clippings, tree trimmings, etc.).

ppm- Parts per million

Pre-consumer Content- Pre-consumer content is material diverted from the waste stream during the manufacturing process. If materials are reworked, reground, or scrap generated in a process (and capable of being reclaimed within the same process) (source ISO 14021). Examples include planer shavings, ply trim, sawdust, chips, bagasse, sunflower seed hulls, walnut shells, culls, trimmed materials, print overruns, over-issue publications, and obsolete inventories. (Previously referred to as Post-industrial Content.)

Preferred Parking- Preferred parking spots are those that are closest to a main entrance, exclusive of handicapped spaces.

Previously Developed Site- A site that previously contained buildings, roadways, parking lots, or were graded or altered by direct human activities.

Proposed Design - A computer representation of the actual building design, as reflected in the design documents, used as the basis for calculating the design energy cost.

Rapidly Renewable Materials- Material considered to be agricultural products, both fiber and animal, which take 10 years or less to produce and harvest in an ongoing and sustainable manner.

Recycling- The collection, reprocessing, and re-use of waste materials which have been diverted or recovered from the conventional solid waste stream.

Regularly Occupied Spaces- Areas where workers are normally seated or standing during an average work day; in residential applications it refers primarily to living and family rooms.

Relative Humidity- The ratio of partial density of water vapor in the air to the saturation density of water vapor at the same temperature and the same total pressure (ASHRAE 55).

Renewable Energy Certificates (RECs)- RECs are sold separately from the electrons that make up the electricity and represent an investment in green, renewable power.

Sealant- Any adhesive with properties that have been specifically formulated to fill, seal, or waterproof gaps or joints between two surfaces. These may include primers and caulks.

Sedimentation- Sedimentation is the addition of soils to water bodies. This may occur through natural or human-caused processes. Sedimentation decreases water quality and can damage the ecosystems of lakes, rivers and streams.

Shared (Group) Multi-occupant Spaces- These areas Include retail sales floors, conference rooms, classrooms and other indoor spaces which may be used as places of congregation for presentations, training, etc.

Solar Reflectance Index (SRI)- SRI is the measure of a material's ability to reject solar heat. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. Once the maximum and minimum temperature rises of a given material have been computed, the SRI can be found by interpolating between the values for white and black. Materials with the highest SRI values are the coolest choices. Due to the way SRI is defined a relative scale, particularly hot materials may have slightly negative values, and particularly cool materials can sometimes exceed 100. (Lawrence Berkeley National Laboratory Cool Roofing Materials Database)

Square Footage- Square footage is the total area in square feet of all rooms of a building. This figure should include corridors, elevators, stairwells and shaft spaces.

Stormwater Runoff- Runoff water volumes are created during precipitation events and flow across surfaces into sewer systems or receiving bodies of water. Any precipitation waters that leave project site boundaries on the surface are considered stormwater runoff.

Threatened Species- Threatened species are animals or plants which are vulnerable to endangerment within the near future.

Total Cost of Ownership (TCO)- The TCO is defined as a financial cost/benefit analysis method intended to account for total economic value over the course of the project's entire life cycle.

Total Suspended Solids (TSS)- TSS are particles or flecks that are too small or light to be separated from stormwater through simple gravity settling. Suspended solids of this small size are typically removed via filtration.

T_{vis}; Visible Light Transmittance- The ratio of total light transmitted to total incident light. It is the amount of visible light passing through a glazing surface divided by the amount of light striking that glazing surface. Tvis is typically represented number from 0 to 1. A higher Tvis value indicates that a greater amount of visible spectrum incident light is passing through the glazing.

Urea Formaldehyde- A combination of urea and formaldehyde that is used in some adhesives and will sometimes emit formaldehyde at room temperature.

Ventilation- The process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space (ASHRAE 62.1).

Vision Glazing- Any exterior windows above 2'-6 and below 7'-6 which permit views from inside a building to the outside of the project space are considered vision glazing.

VOCs (Volatile Organic Compounds)- VOCs are carbon compounds that participate in atmospheric photochemical reactions. These do not include carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonates, or ammonium carbonate. VOCs vaporize or exist in a gaseous state at room temperatures.