MINNESOTA B3 GUIDELINES

www.b3.umn.edu/guidelines/

www.msbgtracking.com

Print Version for the Minnesota Sustainable Building Guidelines

for New Buildings and Major Renovations

Version 2 .2 Update

March 2013

MINNESOTA B3 GUIDELINES

B3 GUIDELINES VERSION 2.2

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GLOSSARY

Acknowledgements

The development of the Minnesota Sustainable Building Guidelines has been a multiyear process in collaboration with many people and departments in the state. The Executive Team provided direction and oversight while the Core Team provided ideas and review. We are grateful for all their contributions.

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Introduction

Background

In 2000, The Minnesota Legislature required the Departments of Administration and Commerce, with the assistance of other agencies, to develop sustainable building design guidelines mandatory for all new buildings receiving funding from the bond proceeds fund after January 1, 2004. In 2008 this legislation was expanded to include development of sustainable building guidelines mandatory for all major renovations receiving funding from the bond proceeds fund after January 1, 2009. The legislation defined major renovations as at least 10,000 square feet and including the replacement of the mechanical, ventilation, or cooling system of the building or a section of the building. According to the legislation, the guidelines for both new buildings and major renovations must:

- Exceed the state energy code by at least 30 percent
- Focus on achieving the lowest possible lifetime costs
- Encourage continual energy conservation improvements
- Include air quality and lighting standards
- Create and maintain a healthy environment
- Facilitate productivity improvements
- Specify ways to reduce material costs
- Consider the long-term operating costs of the building including the use of renewable energy sources and distributed electric energy generation that uses a renewable source or natural gas or a fuel that is as clean or cleaner than natural gas.

To achieve these goals, The State of Minnesota Sustainable Building Guidelines (B3 Guidelines) built on previous local and national efforts. The guidelines are designed to be clear, simple and easily monitored with explicit documentation that will record progress. They are designed to be compatible with national guidelines such as LEED™ while maintaining regional values, priorities and requirements. Most importantly, the guidelines set up a process that will eventually lead to a full accounting of the actual costs and benefits of sustainable building design. The State has further clarified the scope of the guidelines to focus on office and higher education classroom facilities, although the guidelines are also suitable for most other building types. After Version 1.0, Version 1.1 of The State of Minnesota Sustainable Building Guidelines was released in July 2004 and tested on several pilot projects. Version 2.0, released September 2006 reflected improvements based on lessons learned from the pilot projects. Version 2.1 released February 1, 2009 will incorporate the expansion of the guidelines to include major renovations, as well as other updates. Version 2.2 includes updated Site and Water and Commissioning guidelines, a new Bird-Safe guideline and some clarification and updated resources across the rest of the guidelines.

Sustainable design is a means to reduce energy expenditures, enhance the health, well-being and productivity of the building occupants, and improve the quality of the natural environment. All of these can contribute to high-performance buildings with lower life cycle costs. To move toward ensuring these outcomes, the guidelines attempt to quantify the human, community, environmental, and life-cycle economic costs and benefits for each project.

The guidelines are a part of the Buildings, Benchmarks & Beyond (B3) Project. Project management and delivery is led by LHB, Inc.; the guideline development process is led by the Center for Sustainable

Building Research (CSBR) at the University of Minnesota; and public building benchmarking is led by The Weidt Group. Benchmarking will identify the energy performance of existing public buildings in order to direct energy conservation improvements where they are most needed and most cost-beneficial. As new state-funded projects are constructed and operated in accordance with the State of Minnesota Sustainable Building Guidelines, more detailed information on energy and other sustainable performance factors will also be tracked.

Applicability

With the expansion of the legislation in 2008 to include major renovations, there are now two main types of projects subject to the B3 Guidelines: "New Buildings" and "Major Renovations," each with their own criteria for required use.

"New Buildings" Overall Applicability Criteria:
All new buildings funded in whole or part by Minnesota bond monies after January 1, 2004 must comply with the guidelines. Additions are considered "New Buildings" that require compliance with the guidelines if they have both of the following characteristics when applicable:

- If heated, the addition has its own heating plant(s) (eg. boiler, etc.) whether or not its source of energy (eg. fuel) is from an adjacent building
- If cooled, the addition has its own cooling plant(s) (eg. chiller, rooftop unit, etc.) whether or not its source of energy (eg. electricity) is from an adjacent building

If construction is not considered a building under the Minnesota Building Code then it is not considered a "New Building" under the State of Minnesota Sustainable Building Guidelines. Exceptions to compliance with the Minnesota Sustainable Building Guidelines as a whole are *not* allowed based on size of building, number of utility connections, or whether a building is heated, cooled or electrically lit. However, some individual guideline criteria are customized based on these or other variations. If an agency or design team feels certain guideline criteria do not apply to a particular building, this is handled for those specific criteria through a variance process, using variance forms described in guideline P.1 Guideline Management. Exceptions are allowed if a New Building project has completed Design Development Phase before January 15, 2003 (when the guidelines applicable to New Buildings were released,) and subsequently received or will recieve new or additional bond funding after January 1, 2004.

"Major Renovations" Overall Applicability Criteria:
All major renovation work funded in whole or part by Minnesota bond monies after January 1, 2009 must comply with the guidelines. Renovation work is considered "Major Renovations" that require compliance with the guidelines if it has both of the following characteristics:

- Renovated area includes 10,000 square feet or more
- It does not encompass less than the replacement of the mechanical, ventilation, or cooling system of the building or a section of the building.

Exceptions to compliance with the Minnesota Sustainable Building Guidelines as a whole are *not* allowed based on number of utility connections, or whether the renovated area is heated, cooled or electrically lit. However, some individual guideline criteria are customized based on these or other variations. If an agency or design team feels certain guideline criteria do not apply to a particular building, this is handled for those specific criteria through a variance process, using variance forms described in guideline P.1 Guideline Management. Exceptions are allowed if a Major Renovations

project has completed Design Development Phase before February 23, 2009 (when the guidelines for Major Renovations were released,) and subsequently gets new or additional bond funding after January 1, 2009.

"Non-Applicable" versus "Not Compliant" Status:
Any construction project that receives bond funding after January 1, 2004 which is believed to not be subject to the B3 Guidelines should have a completed an Applicability Form available from the B3 Guidelines Website. This form is not needed if a project is following the B3 Guidelines. This form is used to review projects to determine whether or not the B3 Guidelines is applicable to them and thus whether or not they need to comply with the guidelines as a whole. Projects that have completed this form and are deemed "Not Applicable" will be listed as such on the B3 Guidelines Bonded Project Tracking Table and need not interact any further with the guidelines. Projects listed on the B3 Guidelines Bonded Project Tracking Table as receiving bond funds that have not received "Not Applicable" status and appear to not be following the guidelines will be listed as "Pending" until their status can be confirmed. If it is confirmed that bond-fund receiving projects are applicable but still are not following the guidelines, they will be listed as "Not Compliant." Note that if the guidelines are being used, but the team is seeking variances on specific guidelines, use the variance process and variance forms described elsewhere, not the Applicability Form.

Use of the Two Paths to Determine Required Guidelines:
Once it has been confirmed that a project must comply with B3 Guidelines under one of the two paths listed above, the specific guidelines within the B3 Guidelines that are required or recommended are determined by the B3 Guidelines Compliance Path Table which is described and shown in the Process Section. This table distinguishes requirements for New Buildings from Requirements for Major Renovations while allowing reference to a common master set of guidelines. It also distinguishes which guidelines are required for different types of renovations.

Guideline Development

In the past 15 years, many international, national and regional sustainable building guidelines have been developed. In this region, the Minnesota Sustainable Design Guide (MSDG) was initiated in 1997 by Hennepin County with a grant from the Minnesota Office of Environmental Assistance (OEA) and had been maintained by the University of Minnesota until its recent replacement by the B3 Guidelines. The LEED™ Rating System (Leadership in Energy and Environmental Development) developed by the U.S. Green Building Council (USGBC) has emerged in recent years as a national standard with a high level of visibility and increasing market acceptance. Recently Green Globes™, used for many years in Canada, has been introduced into the U.S. as a sustainable building rating system and guide.

Sustainable or green building design is still an evolving field with rapid advances in knowledge, technology, and methods of measuring outcomes. Rating systems and guidelines continue to adapt and improve over time. The State of Minnesota B3 Guidelines attempt to address some fundamental problems that have not yet been resolved adequately in existing guidelines. For example, current guidelines such as LEED™ use prescriptive, point-based, and proxy measures that simplify both compliance and enforcement but in many cases do not connect to real human, environmental, and life-cycle economic outcomes and in some cases may lead away from desired results.

The development of the State of Minnesota Sustainable Building Guidelines is based on the following key concepts.

1. *Reduction in Guidelines*
   Guidelines have been eliminated that are either already required by code or do not apply in this region.

2. *Required Guidelines*
   There are no points for meeting certain criteria. Guidelines are simply required when they clearly contribute to the desired outcomes. Some guidelines are recommended rather than required until their benefits to the State can be clearly demonstrated. Where any inconsistencies may appear as to the extent of performance required or whether an item is recommended or required, the more strict (higher performing) case shall apply.

   Guidelines required for Major Renovations projects are generally limited to those types of disciplines or work already in the proposed scope (for example, if plumbing scope is not included, water efficiency guidelines are not required.) By legislative definition, the scope includes new mechanical systems and it is assumed that Major Renovations include new finishes.

3. *Connection to Real Outcomes*
   Performance-based guidelines replace prescriptive measures wherever appropriate. The outcomes are documented within the B3 Guidelines Tracking Tool (www.msbgtracking.com) with embedded calculation tools. The purpose is to collect data on outcomes wherever possible and educate all participants in the process of determining outcomes. The performance indicators of real outcomes to be calculated in applying these guidelines (to be further developed in following phases) include the following:

   Project Lifecycle Costs
   - Project capital costs
   - Operation and maintenance costs

   Human Impacts and Related Cost
   - Health and Well-being
   - Productivity
   - Absenteeism
   - Employee turnover
   - Health care costs

   Environmental Impacts
   - Primary energy
   - Global warming potential
   - Waste production

   Community Impacts and Related Cost
   - Community infrastructure demand and associated costs
   - Community assets contributed by project
   - Economic impacts
   - Social impacts

4. *Relationship to LEED™ and the prior Minnesota Sustainable Design Guide (MSDG)*
   It is not the intent of The State of Minnesota Sustainable Building Guidelines to follow LEED™ requirements specifically, but wherever requirements are the same or similar, documentation required for these guidelines may be useful in achieving LEED™ credit. There is no guarantee,

however, that compliance with these guidelines will result in a LEED™ credit. Refer to LEED™ sources for specific requirements and documentation required for certification. One benefit of making The State of Minnesota Sustainable Building Guidelines transparent to LEED™ and other guidelines is that LEED™ certification serves as one incentive to achieve higher performance than the basic requirements of these guidelines. The Prior *Minnesota Sustainable Design Guide (MSDG)* is replaced by the B3 Guidelines.

Guideline Organization

The guidelines are organized into the following topic categories.

- Performance Management
- Site and Water
- Energy and Atmosphere
- Indoor Environmental Quality
- Materials and Waste

To address the differing issues in guidelines for "New Buildings" versus "Major Renovations," while not duplicating what is the same, there is a master set of guidelines in these five topic areas that covers all projects which is complemented by an "B3 Guidelines Compliance Path Table," described below, that indicates which guidelines are required or recommended for New Buildings versus Major Renovations. For Major Renovations, some required guidelines depend on the scope of the renovation, and are noted as such.

At the beginning of each topic section, there is an B3 Guidelines Compliance Path Table for guidelines in that section, an overview, goals, objectives, and a list of guidelines for that topic. Parts or all of some guidelines are noted as recommended. This is followed by documentation for each guideline that states the intent, performance criteria, compliance tools and resources, related MSBG documents, and supplementary resources. Suggested implementation steps for each guideline are in the first Appendix in each section. These suggested steps are meant as helpful and are not the only way to achieve the performance criteria, nor do they ensure achievement of criteria. A glossary is included at the end of the guidelines.

Process

The process for implementing the guidelines is explained in the Performance Management section. Refer to Guideline P.0 for complete explanations and requirements for the guideline management process. Highlights of the process are described below.

Determine Path and Required Guidelines:

- Once it has been confirmed that a project must comply with B3 Guidelines under either the New Buildings Path or Major Renovations Path, the specific guidelines within the B3 Guidelines that are required or recommended are determined by the B3 Guidelines Compliance Path Table. This table distinguishes requirements for New Buildings from requirements for Major Renovations while allowing reference to a common master set of guidelines. It also distinguishes which guidelines are required for different types of renovations that include different kinds of renovation work.

Project Planning & Work:

- At the start of each phase (or year of operation), the Guideline Leader reviews the B3 Guidelines and required documentation, plans the tasks to be done for that phase to keep on track for meeting the guidelines, and communicates this with the work team.
- If exceptions to the B3 Guidelines are sought, the Guideline Leader shall request the variance from the Appropriated Agency (the agency building and operating the building) for Variance Review before the completion of the schematic design phase. This variance request is made for individual guidelines using the B3-Guidelines Tracking Tool (www.msbgtracking.com).

- The Work Team for the responsible organization (planning team, design team, construction team, or operations team depending on phase) incorporates B3 Guidelines requirements into the work.

Documentation:

- At the end of the phase, the work team completes the appropriate documentation via the B3-B3 Guideline Tracking Tool at www.msbgtracking.com.
- The Guideline Leader, at the end of each phase (or annually during facility operation,) submits online documentation to the Appropriated Agency for compliance review. The team should archive relevant documentation for that phase (or year) for future reference.

Review and Tracking:

- The Appropriated Agency reviews and determines if they approve the level of compliance reported by the work team and also any variances requested if applicable.
- CSBR tracks the status of compliance, variances, documentation, and performance outcomes and summarizes these for the State.

B3 Guidelines COMPLIANCE PATH TABLE

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	PERFORMANCE MANAGEMENT		
P.0	Guideline Management	Required	Required
P.1	General Project Data	Required	Required
P.2	Planning for Conservation	Required	Required
P.3	Integrated Design Process	Required	Required
P.4	Design and Construction Commissioning	Required	Required
P.5	Operations Commissioning	Required	Required
P.6	Lowest Life Cycle Cost	Recommended	Recommended
	SITE AND WATER		
S.1	Identification and Avoidance of Critical Sites	Required	Documentation Required
S.2	Stormwater Management	Required	Required for Minimum Site Scope (See Guideline)
S.3	Soil Management	Required	Required for Minimum Site Scope (See Guideline)
S.4	Sustainable Vegetation Design	Required	Required for Minimum Site Scope (See Guideline)
S.5	Light Pollution Reduction	Required	Required for Exterior Lighting Scope
S.6	Erosion and Sedimentation Control during Construction	Required	Required for Any Site Scope
S.7	Landscape Water Efficiency	Required	Required for Minimum Site Scope (See Guideline)
S.8	Building Water Efficiency	Required	Required if Plumbing Scope (See Guideline)
S.9	Appropriate Location and Development Pattern	Recommended	Not Applicable
S.10	Brownfield Redevelopment	Recommended	Not Applicable
S.11	Heat Island Reduction	Recommended	Reccommended if Roof or Site Scope
S.12	Transportation Impacts Reduction	Recommended	Recommended
S.13	Wastewater Management	Recommended	Recommended if Plumbing or Site Scope
S.14	Bird Safe Building	Required	Required if glazing in scope
	ENERGY AND ATMOSPHERE		
E.1	Energy Efficiency	Required	Required
E.2	Renewable Energy	Required	Recommended
E.3	Efficient Equipment and Appliances	Required	Required
E.4	Atmospheric Protection	Recommended	Recommended
	INDOOR ENVIRONMENTAL QUALITY		
I.1	Restrict Environmental Tobacco Smoke	Required	Required
I.2	Specify Low-emitting Materials	Required	Required for Newly Installed Materials
I.3	Moisture Control	Required	Required if Exterior Envelope is in Scope
I.4	Ventilation Design	Required	Required
I.5	Thermal Comfort	Required	Required
I.6	Quality Lighting	Required	Required if Lighting Replacement is in Scope
I.7	Effective Acoustics	Required	Required
I.8	Reduce Vibration in Buildings	Required	Recommended if Structural is in Scope
I.9	Daylight	Required	Required (Partial - See Guideline)
I.10	View Space and Window Access	Recommended	Recommended
I.11	Personal Control of IEQ Conditions & Impacts	Recommended	Recommended
I.12	Encourage Healthful Physical Activity	Recommended	Recommended
	MATERIALS AND WASTE		
M.1	Life Cycle Assessment of Materials	Required	Required if Exterior Envelope is in Scope
M.2	Environmentally Preferable Materials	Required	Required
M.3	Waste Reduction and Management	Required	Required

Changes in Version 2.2:

Updates to all guidelines

All guidelines have been general edited for clarity. Links and updated referenced standards have been referenced across the guidelines.

Updates to the numbering system for appendices:

Appendices have been renumbered to allow easier reference to specific guidelines: Appendices that provide guidance entire guideline categories are labeled as P-0, S-0, E-0, I-0, M-0. Multiple appendices that refer to the same guideline are labeled as X-#y, where X-# is the guideline letter and number and y is a letter: Such as appendices P-3a and P-3b which both correspond to guideline P.3. Note that this results in multiple appendices related to individual guidelines, and some guidelines that do not have associated appendices.

Updated appendix names

Appendices v2.1	V2.2
P-1	Appendix P-0a Suggested Implementation for All Performance Management Guidelines
P-2	Appendix P-0b Guideline Management Supporting Information
New Appendix	Appendix P-3a Integrated Design Process Supporting Information
New Appendix	Appendix P-3b Integrated Design Process Matrix
P-9b, P-9c, P-9d, P-9e	Appendices P-3c,d,e Integrated Design Process Plan Templates
P-4	Appendix P-4a Design and Construction Commissioning Supporting Information
P-5	Appendix P-4b Design and Construction Commissioning Matrix
P-9a. P-9b	Appendices P-4c,d Design and Construction Commissioning Plan Templates
P-6	Appendix P-5a Operations Commissioning Supporting Information
P-7	Appendix P-5b Operations Commissioning Matrix
P-8	Appendix P-6 Life Cycle Cost Supporting Information
S-1	Appendix S-0 Suggested Implementation for All Site and Water Guidelines
S-3	Appendix S-7 Irrigation Water Consumption
S-4	Eliminated in lieu of reference to Minnesota Stormwater Manual
S-5	Appendix S-8 Building Water Calculator
New Appendix	Appendix S-14a Bird-Safe Calculator
New Appendix	Appendix S-14b
New Appendix	Appendix S-14c
E-1	Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines
E-4	Appendix E-1a Compliance and Reporting Instructions (SB2030 document)
E-5	Appendix E-1b Building Performance Evaluation Guide (SB2030 document)
E-6	Appendix E-1c Building Strategy Checklist (SB2030 document)
E-7	Appendix E-1d Meter Plan Guidelines (SB2030 document)
E-8	Appendix E-1e Calculation of Cost-Effectiveness for Variance Application (SB2030 document)
E-2	Appendix E-1f Small Building Methodology (SB2030 document)
E-3	Appendix E-4 Refrigerant Properties
I-1	Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines
I-2	Appendix I-4 Calculating CO2 Concentrations in a Zone
I-3	Appendix I-9 Daylighting Factor Calculator
I-4	Appendix I-10 View Space Diagrams and Tables for I.10
M-1	Appendix M-0 Suggested Implementation for All Material and Waste Guidelines
M-2	Appendix M-3a Example Specification for Construction Waste Management
M-3	Appendix M-3b Construction Waste Recycling Economics Worksheet
M-4	Appendix M-3c Packaging Waste Recycling Economics Worksheet

Updates to Specific Guidelines P3, P4, P5

P.3

Several Items previously required under P.4: Design and Construction Commissioning that are not part of the typical scope of service performed by a commissioning agent have been moved to guideline P.3.B. Version 2.1 guideline P.3.B and P.3.C have been moved to P.3.C and P.3.D respectively. This change has been made to better align the guidelines with typical professional scopes of service. This change necessitated the creation of two new appendices, P-3a and P-3b, with content primarily derived from the version 2.1 appendices P-4, P-5, P-6 and P-7.

P.4

Guideline (and related appendices) P.4 has been edited to reflect the following:

- coordination with SB2030 and required energy model requirements
- user comments regarding the current MSBG requirements and process
- Some requirements have been moved to P-3
- The budget requirement for commissioning as a percentage of construction cost has been removed in lieu of the requirement that the required commissioning scope is appropriately budgeted

P.5

Guideline P.5 (and related appendices) has been edited to reflect the following:

- coordination with SB2030
- user comments regarding the current MSBG requirements and process
- The B3 Operations program (in development)
- The sections related to IPMVP have been removed and replaced
- The B3-POE process has been clarified, with POE's required on some building types at 9 and 18 months

S.2

Guideline S.2 (and related appendices) has been edited to reflect the following:

- General simplification of the requirements
- Alignment with more common methods and calculations
- Clarify treatment system requirements

S.3

Guideline S.3 (and related appendices) has been edited to reflect the following:

- Update and clarify bulk density requirements for plantings
- Update and clarify soil disturbance limits
- Update and clarify other soil requirements

S.14

New in this release is the required Bird-safe building guideline, complete with several calculators that will assist teams in compliant designs.

M.2

Guideline M.2 has been edited to reflect the following:

- Reused and recycled content material requirements have been combined in M.2.A to allow flexibility and to credit the use of recycled content material in a required category.
- Bio-based requirement has been clarified

Performance Management Guidelines

B3 Guidelines Compliance Path Table for Performance Management Guidelines

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	PERFORMANCE MANAGEMENT		
P.0	Guideline Management	Required	Required
P.1	General Project Data	Required	Required
P.2	Planning for Conservation	Required	Required
P.3	Integrated Design Process	Required	Required
P.4	Design and Construction Commissioning	Required	Required
P.5	Operations Commissioning	Required	Required
P.6	Lowest Life Cycle Cost	Recommended	Recommended

Required Tools

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendices

Appendix P-0a	Suggested Implementation for All Performance Management Guidelines
Appendix P-0b	Guideline Management Supporting Information
Appendix P-3	Integrated Design Process Supporting Information
Appendix P-3b	Integrated Design Process Supporting Information Matrix
Appendix P-4a	Design and Construction Commissioning Supporting Information
Appendix P-4b	Design and Construction Commissioning Matrix
Appendices P-4c	Design and Construction Commissioning Plan Template
Appendix P-5a	Operations Commissioning Supporting Information
Appendix P-5b	Operations Commissioning Matrix
Appendix P-6	Life Cycle Cost Supporting Information

Overview

The Performance Management section outlines a process to support successful performance improvements intended by the *State of Minnesota Sustainable Building Guidelines (B3 Guidelines)* by documenting progress towards performance criteria throughout the planning, design, and construction phases. Monitoring of key systems throughout occupancy provides information for continuous improvement of operations and for planning and constructing future State projects. In addition, the Performance Management guidelines address the creation and use of the team necessary for a well-integrated solution, and the thorough evaluation of current and future needs so that all facilities are well-utilized and represent a responsible use of economic and natural resources over time.

Goal

To employ processes that improve the ongoing performance of facilities towards the lowest lifetime costs, and to promote design and operational decisions based on improving environmental, human, and economic outcomes.

Objectives

- Define a process for tracking progress towards guideline compliance throughout the project development and operation.

- Document information that captures design intent and actual performance to track progress towards desired guideline outcomes and to facilitate guideline improvement.
- Define a planning, control and tracking process to ensure that specific steps take place that are needed to support the operational achievement of performance criteria.
- Initiate and utilize an integrated team approach to produce integrated solutions.
- Review needs and resources thoroughly so as to maximize utilization of space.
- Provide guidance on determining the lowest life cycle cost for project alternatives.

P.0 Guideline Management

Intent

Track compliance, define a method of variances and collect information to measure outcomes leading to continual improvement of the Guidelines.

Required Performance Criteria

A. Follow Agency process for guideline management or follow Appendix P-0b Guideline Management Supporting Information. In either case, contact msbghelp@umn.edu to set up the project in the B3 Guidelines Tracking Tool at www.msbgtracking.com and then starting in Agency Planning Phase complete required information and submit at the end of each phase. Use of the online tracking tool is required for compliance with B3 Guidelines.

B. Use Agency Variance process or follow Variance Review Process when appropriate (see Appendix P-0b). The agency variance process must include at least the elements shown in the Variance Review Process. Requirements related to the SB2030 Program are not subject to the Agency Variance Process.

Recommended Performance Criteria

C. Share the story of your project and apply for awards programs for recognition.

D. Use the B3 Guidelines Tracking Tool as a Project Archive that serves as the performance planning, design, and ongoing maintenance history of the project (see Appendix P-0a). Utilizing optional narrative fields and file uploads, this body of information could include: performance parameters and basis for design, design actions taken towards B3 Guidelines criteria, ongoing monitoring, measurement and verification over time, actions to resolve problems over time, and results of those actions. It includes all reports. The Guideline Leader and Work Team maintain the Project Archive in each phase and facilitate its transition to leaders of following phases.

Related B3 Guidelines Documents

- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- Appendix P-0b Guideline Management Supporting Information

Supplemental Resources

- The Minnesota Governor's Office, the Minnesota Environmental Initiative and the Minnesota Waste Wise Initiative offer awards and recognition programs, including the coveted Governors Awards for Excellence in Waste and Pollution Prevention, the Enviromental Initiative Award and the Minnesota Waste Wise Leaders Awards. http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/p2-pollution-prevention/awards-and-recognition/index.html
- The United States Green Building Web Site: "The LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings." Buildings can be rated as Certified, Silver, Gold or Platinum. www.usgbc.org

P.1 General Project Data

Intent
Support the compliance and outcome tracking process with general reference data for the project.

Required Performance Criteria

Provide Required Data in the B3 Guideilnes Tracking Tool on the following Topics: Note that more than one data field may be required in each of the following topics

A. Building Occupancy
B. Project Budget (Estimated Construction Cost)
C. Property / Site Data
D. Building Data

Related B3 Guidelines Documents

- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- B3 Guidelines Tracking Tool at www.msbgtracking.com

P.2 Planning for Conservation

Intent

Maximize utilization of facilities and modify them less over time by careful analysis of needs and resources. Strategies of building less, remodeling existing facilities, and designing for flexibility lead to reductions in cost, energy, and environmental impacts of materials.

Required Performance Criteria

A. Evaluate the assumptions to build, expand or remodel facilities using these questions.
   - Can the current facilities be shared or better utilized to reduce or eliminate the need for additional space?
   - Can the current facilities be used more hours of the day or more days of the week to reduce or eliminate the need for additional space?
   - Can the current space be reconfigured within its shell to meet the need?
   - If not, can an existing building be reconfigured within its shell to meet the need?
   - If not, would an addition to the current space or another existing building meet the need?
   - If not, how can new space be optimized (including shared use of some facilities) and the building footprint be minimized?
   - For all options, how can the space be configured best for future use and adaptability?

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines

Supplemental Resources

- Building Green in PA videos
  www.greenworks.tv/green_building/archives.htm

P.3 Integrated Design Process

Intent

Create an integrated approach to the design process by involving key design team members, users, occupants and operators. An integrated design process leads to improved communication and a systems approach to problem solving resulting in optimizing performance at the lowest cost. This guideline also requires the creation of documentation of select processes related to an integrated design approach. Process documentation which falls within the typical scope of the commissioning agent is found in Guideline P.4.

Required Performance Criteria

A. Conduct an organization/kick-off meeting including the team. At least one representative of the following disciplines or groups shall be in attendance if they have been assigned for the project:
   - Architecture
   - Civil Engineer
   - Commissioning Agent
   - Contractor or construction manager
   - Electrical Engineering
   - Energy Modeling
   - Facility Management / Operations
   - Interior Design
   - Mechanical Engineering
   - Owner and/or tenant
   - Landscape Architect

B. Incorporate the following into the design, construction and operation of the project:
   a. Create and revise the Design Intent Document (DID), which shall quantify functional performance expectations and parameters for each system to be commissioned.
   b. Create and revise the Basis of Design (BOD) document, a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria
   c. Perform a safety risk assessment of Indoor Air Quality issues for projects that will be attached to existing buildings (New Building additions or Major Renovations) according to the Pre-Commissioning Air Quality Management Plan (See Appendix P-3a)
   d. Develop indoor air quality procedures during construction and warranty period according to a Construction Air Quality Management Plan and Warranty Period Air Quality Management Plan. (See Appendix P-3a.) Note that this also includes safety risk-assessment of existing building conditions, and protection of occupants in spaces adjacent to construction work.
   e. Develop construction waste management procedures during construction according to the Construction Waste Management Plan. See Appendix P-3a and Guideline M.3 Waste Reduction and Management for criteria that the plan must meet.
   f. Track user complaint/ work request logs related to user comfort and satisfaction as an indicator of ongoing IEQ performance

Recommended Performance Criteria

C. Assemble appropriate stakeholder team
Include representation from every discipline that will be involved in the project: Owner's decision-making team, users, occupants, operations and maintenance representatives, at least one representative from the community, and at least one agency "client" or visitor representative. Also include Owner Representative and commissioning agent if applicable. Choose members who can make a commitment through post-occupancy review phase.

D. Conduct planning/ review workshops at key phases with all team members.
- Comprehensive Business Planning Workshop at Agency planning phase
- Programming Workshop during Predesign Programming
- Facility Performance Workshop within the first 2-3 weeks of the schematic design phase
- Convene multi-disciplinary team at least once per design phase for integrated progress review towards guidelines
- Convene stakeholder team regularly for integrated progress review. Stakeholder team to meet a minimum of once per phase.
- Convene General Contractor and Sub-contractors for pre-construction kick-off meeting to review the B3 Guidelines goals and objectives.
- Incorporate discussion about the progress toward project outcomes during every construction meeting.
- After occupancy, Facility Operations Manager, Human Resources Manager and others that offer cross disciplinary points of view on Facility Operations shall meet annually to review operation practices, complaints, and building maintenance issues.

Tools

IAQ Practices
- SMACNA, IAQ Guidelines for Occupied Buildings Under Construction, 1st Edition, 1995. www.smacna.org

Indoor Air Quality Operations, Measurement and Verification
- EPA's Building Air Quality can be found at http://www.epa.gov/iaq/largebldgs/baqtoc.html
- EPA's I-BEAM can be found at http://www.epa.gov/iaq/largebldgs/i-beam/

Related B3 Guidline Documents
- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- Appendix P-3a Integrated Design Process Supporting Information
- Appendix P-3b Integrated Design Process Matrix

Supplemental Resources
- Malin, Nadav, "Integrated Design," Environmental Building News, November 2004.
- Building Green in PA videos www.greenworks.tv/green_building/archives.htm
- The MPCA web site of Resources on Sustainability is an excellent source of information about community benefits from sustainable design. http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/sustainability/index.html

P.4 Design and Construction Commissioning

Intent

Verify that the building is constructed and calibrated to meet the design intent as represented in contract documents (which includes meeting performance criteria of the Agency, including B3 Guidelines as represented in the contract documents.)

Required Performance Criteria

A. Develop and refine a commissioning scope and project budget in programming and schematic design. The project budget should include sufficient dedicated funds to cover commissioning activities not already in other agency or departmental budgets. For Renovations Path projects, the team shall determine the commissioning budget adequate to fulfill the B3 Guidelines commissioning requirements for the scope of the renovations work.

B. Review and comment on the compatibility of the design with the Operations Commissioning Plan. (See Guideline P.5 Operations Commissioning.)

C. Develop and implement a commissioning process for the project. At a minimum, the commissioning process used must include the elements listed in Appendix P-4a Design and Construction Commissioning Supporting Information and Appendix P-4b Design and Construction Commissioning Matrix.

D. Scope of items to be commissioned
    1. Systems Commissioning: Mechanical HVAC system including testing, adjusting and balance, energy (including renewable) systems, power and electrical systems, including lighting and daylighting controls; indoor air quality elements and systems. See Appendix P-4a for more details on requirements under Design and Construction Commissioning Plan.

Recommended Performance Criteria

E. Additional scope of Commissioning:
    1. Plumbing Systems
    2. Interior materials (specification, installation)
    3. Envelope integrity
    4. Physical measurement of vibrations/acoustics/noise

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- Appendix P-0b Guideline Management Supporting Information
- Appendix P-4a Design and Construction Commissioning Supporting Information
- Appendix P-4b Design and Construction Commissioning Matrix
- Appendix P-4c Design and Construction Commissioning Plan Template

Supplemental Resources

- ASHRAE Guideline 1-1996, The HVAC Commissioning Process www.ashrae.org. See website for new guidelines for building commissioning
- Designing Tools for Schools: Commissioning www.epa.gov/iaq/schooldesign/commissioning.html

- Federal Energy Management Program Building Commissioning Guide http://www1.eere.energy.gov/femp/
- LEED 3.0 Green Building Reference Guide™, United States Green Building Council
- The Cost-Effectiveness of Commercial-Buildings Commissioning: a series of reports from the Lawrence Berkeley National Laboratory http://cx.lbl.gov/cost-benefit.html

P.5 Operations Commissioning

Intent

Ensure (verify) the building is operated to meet the design intent as represented in contract documents (which includes meeting performance criteria of the Agency, including B3 Guidelines.)

Required Performance Criteria

A. Develop and implement an Operations Management Plan for the project. At a minimum, the Operations Management Plan must include the elements listed in Appendix P-5a Operations Commissioning Supporting Information and Appendix P-5b Operations Commissioning Matrix.
B. Implement Operations and Maintenance Practices and annual evaluation according to the component of the Operations Management Plan.
C. Conduct at least two post-occupancy evaluations of the project. It is recommended that these occur at 9 and 18 months post-occupancy.
   - "Scan" level post-occupancy evaluations are required for available space types, this process supported by the B3 Post-Occupancy Evaluation (B3 POE) process.
   - Buildings with no supported space types at 6 months post-occupancy (3 months prior to the first POE) are exempt from this requirement. Projects may also be exempt if they do not meet the minimum required number of occupants or residents; more details are available at the B3 POE website.

Recommended Performance Criteria

D. Incorporate the following issues into the Operations Management Plan for the following additional areas of building performance over time.
   - Vibrations, acoustics, and noise verification
   - Access to daylight
   - View space and window access evaluation
   - Personal control of IEQ conditions and impacts
   - Opportunities and encouragement for healthful physical activity
   - Materials measurement and verification
   - Additional User Comfort and Satisfaction Assessment surveys as an indicator of ongoing IEQ performance (after those required as part of P.5.C.)
E. Perform Systems Recommissioning: At least annually or in response to events or triggers at the discretion of owner.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- B3 Post –Occupancy Evaluation Program: http://www.b3.umn.edu/poe/
- Appendix P-5a Operations Commissioning Supporting Information
- Appendix P-5b Operations Commissioning Matrix

Tools

Measurement and Verification

- Efficiency Valuation Organization : www.evo-world.org (Formerly US DOE's International Performance Measurement and Verification Protocol)

- Volume I - Concepts and Options for Determining Savings
- Volume II -Concepts and Practices for Improving Indoor Environmental Quality Volume III - Applications

Indoor Air Quality Operations, Measurement and Verification

- EPA's Building Air Quality can be found at www.epa.gov/iaq/largebldgs/baqtoc.html
- EPA's I-BEAM can be found at www.epa.gov/iaq/largebldgs/i-beam/index.html

Supplemental Resources

- LEED for Existing Buildings, United States Green Building Council, new.usgbc.org/leed/rating-systems/existing-buildings
- ASHRAE Guideline 4-2008, Preparation of Operating and Maintenance Documentation for Building Systems, www.ashrae.org.

P.6 Lowest Life Cycle Cost

Intent
Determine the lowest life cycle cost when comparing design alternatives.

Recommended Performance Criteria
A. Perform and document a life cycle cost analysis of energy use scenarios.

NOTE on related requirement: If Project is subject to guideline E.1A, it will be required, under the documentation for that guideline, to perform a life cycle cost analysis on the energy strategies impact on the Project Construction Area based on three energy use scenarios generated in Guideline E.1A using the life cycle cost calculation embedded in the B3 Guidelines Tracking Tool. The Project Construction Area for New Buildings Path shall be the whole building, for Major Renovations Path, the Project Construction Area shall be the area that is renovated.

B. Include more extensive life cycle cost analysis of any design alternatives at the assembly, system or component scale.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- Appendix P-6 Life Cycle Cost Supporting Information

Tools
Compliance with sub-guideline P.6A is earned with an uploaded file documenting the life cycle cost analysis. If a project is subject to guideline E.1A this must be supplemented by completing documentation for Guideline E.1A in the B3 Guidelines Tracking Tool (msbgtracking.com). For any life cycle cost analysis, a discounted cash flow analysis of each project alternative under review is recommended. These analyses can be accomplished through use of a custom designed discounted cash flow model or through use of the NIST's BLCC computer model. In either case, refer to description of other considerations outside the model under the definition of Life Cycle Cost Formula above. (See Appendix P-6 Life Cycle Cost Supporting Information.)

Custom Designed Model

- It is very likely that any entity proposing a significant state funded project will have the resources needed to prepare a discounted cash flow analysis of the project. Such an analysis, typically prepared using spreadsheet software like Excel, will detail all of the initial costs of design and construction and then project future annual operating and maintenance costs, utility costs, replacement costs, and the residual value of the building and equipment. If these future costs are presented in current dollars in each year (showing the impact of inflation), they are then discounted back to the present using a nominal discount rate (a discount rate that recognizes inflation.) If future costs are expressed in constant dollars (not adjusted for inflation), then they are discounted back to the present using a real discount rate. (For example, FEMP discount and inflation rates, valid for energy and water conservation and renewable energy analyses conducted between 4/1/2004 and 3/31/2005 are: 3% Real Discount Rate, 4.8% Nominal Discount Rate, and a 1.75% Inflation Rate.) The initial costs and the discounted future costs are the summed to provide the discounted present value (discounted cost) of the proposed project over its life cycle. By completing a life cycle cost

analysis of different options under consideration and then comparing the discounted present value of each, it is possible to work towards identifying the building option that has the lowest possible lifetime cost.

The BLCC Model

- The National Institute of Standards and Technology (NIST) Office of Applied Economics has produced, and annually updates, a Building Life-Cycle Cost (BLCC) computer model that is available at no charge from NIST and that can also be downloaded from their web site. The annual update of the BLCC is released each April and contains the federal government's latest estimates for inflation, energy price escalation by state, and federal discount rates (Nominal and Real.) This model is designed specifically to help the user identify building options that result in the lowest life cycle cost with particular attention paid to energy use and water consumption. The user of this model is expected to enter a base case (typically for a code-compliant basic building), one or more alternative designs, and then compare the results. While the BLCC model is focused on energy and water, with a little imagination it can be used to complete a comprehensive analysis of a project. The model allows the user to add new categories for initial capital expenditures, on going recurring charges, one time future charges, etc., so it is possible to build a comprehensive model of the life cycle costs of a proposed building. Numerous different building configurations can then be defined and evaluated and predefined reports can be used for easy comparisons of alternatives. The BLCC model has a module that compares the base case project to the alternative under review and calculates energy savings and emission reductions (CO2, SO2, NOx) achieved by the alternative.

Supplemental Resources

- Life-Cycle Costing Manual for the Federal Energy Management Program published by National Institute of Standards and Technology (NIST Handbook 135) (222 pages) A comprehensive manual containing a thorough discussion of both the concepts and underlying math of life cycle costing with numerous examples demonstrating the value of this approach. This publication can be ordered at no cost from NIST (301-975-6478) or the EERE Info Center (1-800-363-3732.) It can also be downloaded from the EERE web site: www.eere.energy.gov/femp/program/lifecycle.html
- Guidance on Life-Cycle Cost Analysis Required by Executive Order 13123, January 8, 2003 (27 pages) A brief but solid discussion of Life Cycle Cost Analysis concepts and definitions with some examples. Published by FEMP and available through the EERE web site: www.eere.energy.gov/femp/program/lifecycle.html
- 2005 Facilities Standards (P100), Section 1.8 Life Cycle Costing (5 pages) This section of the GSA's Facility Standards manual discusses Life Cycle Costing and contains a table summarizing key LCC formulas and their use. Available through GSA: http://www.gsa.gov/portal/content/104188 (see section 1.8 "General Requirements; Life Cycle Costing") Note that later versions of P100 do not include this reference.
- OMB Circular A-94 - Guidelines for Benefit-Cost Analysis of Federal Programs Presents guidance for the analysis of projects other than those that are primarily energy related. Broadens the discussion beyond just costs and cost-avoidance to include benefits. Available for download at: www.whitehouse.gov/omb/circulars/a094/a094.html
- Whole Building Design Guide is a web based resource containing extensive background information, research reports and references relating to the design, analysis, and construction of "Whole Buildings". Includes information on life cycle analysis, productivity, energy conservation and other topics pertinent to sustainable design. www.wbdg.org

Site and Water Guidelines

B3 Guidelines Compliance Path Table for Site and Water Guidelines

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	SITE AND WATER		
S.1	Identification and Avoidance of Critical Sites	Required	Documentation Required
S.2	Stormwater Management	Required	Required for Minimum Site Scope (See Guideline)
S.3	Soil Management	Required	Required for Minimum Site Scope (See Guideline)
S.4	Sustainable Vegetation Design	Required	Required for Minimum Site Scope (See Guideline)
S.5	Light Pollution Reduction	Required	Required for Exterior Lighting Scope
S.6	Erosion and Sedimentation Control during Construction	Required	Required for Any Site Scope
S.7	Landscape Water Efficiency	Required	Required for Minimum Site Scope (See Guideline)
S.8	Building Water Efficiency	Required	Required if Plumbing Scope (See Guideline)
S.9	Appropriate Location and Development Pattern	Recommended	Not Applicable
S.10	Brownfield Redevelopment	Recommended	Not Applicable
S.11	Heat Island Reduction	Recommended	Reccommended if Roof or Site Scope
S.12	Transportation Impacts Reduction	Recommended	Recommended
S.13	Wastewater Management	Recommended	Recommended if Plumbing or Site Scope
S.14	Bird Safe Building	Required	Required if glazing in scope

Related Documentation

B3 Guidelines Tracking Tool at www.msbgtracking.com

Worksheets and Appendices

Appendix S-0	Suggested Implementation for All Site and Water Guidelines
Appendix S-2a	Storm Water Quality Table
Appendix S-7	Irrigation Water Consumption
Appendix S-8	Building Water Calculator
Appendix S-14a	Bird-Safe Calculator
Appendix S-14b	Bird Monitoring Worksheets
Appendix S-14c	Bird-Safe Building Narrative

Overview

Building construction transforms land that provides valuable ecological services. Society has only recently begun to understand that these services have a quantifiable economic value. For example, the City of Minneapolis has recently developed a stormwater management fee that better reflects the true costs of stormwater runoff and that provides more economic incentive for improved stormwater performance. Site selection and design affect transportation and energy use which leads to ground-level ozone, acid rain, smog, and global climate change. Current development practices on the land can lead to uncontrolled stormwater runoff, degraded water and soil quality, depletion of water, soil, and valuable vegetated areas, and destruction of habitat. The State of Minnesota Sustainable Building Guidelines (B3 Guidelines) seeks to restore and improve site water and soil quality, and to reduce negative impacts associated with site selection and design.

Goal

To design and maintain sites which have soil and water quality capable of supporting healthy, bio-diverse plant, animal, and human communities, which reduce water and energy consumption, improve

the rate, quantity and quality of stormwater runoff, and which minimize pollutant contributions related to transportation requirements.

Objectives

- Maintain and improve the ability of the soil to maintain its structure against adverse impacts.
- Restore/improve the hydrologic cycle of water on the site to avoid adverse impacts on the site and downstream of the site.
- Reduce consumption of potable water.
- Improve the biodiversity of the site by introducing flora/fauna which will help contribute to the sustainability of the site over time.
- Reduce energy consumption and pollution contributions to air and water related to site location and associated transportation requirements.
- Restore/improve the outdoor environmental quality (OEQ) of the site to enhance occupant productivity, building performance, and community benefits.

S.1 Identification and Avoidance of Critical Sites

Intent
Avoid selecting sites, or identify if project is on a site and minimize the development footprint on portions of sites whose natural features and functions are particularly valuable to the larger community. Avoid selection of and development on sites where soil, water, and flora/fauna indicators are in a fragile condition because of surrounding development or the natural state of the site. Knowledge of critical site conditions will help determine actions to be taken under S.4 Sustainable Vegetation Design.

Required Performance Criteria
For New Buildings Path: Avoid selecting sites that meets any one of the following Critical Site Criteria:

For New Buildings Path with a variance for site selection that meets S.1: Identify if project is on a site, and if building is allowed, minimize the development footprint on portions of sites that meets any one of the following Critical Site Criteria:

For Major Renovations Path: Identify if project is on a site that meets any one of the following Critical Site Criteria:

Critical Site Criteria:

A. Land of national, state, regional, or local natural resource and biological/ecological significance as identified in national, state, regional, or local natural resources inventories, assessments and biological surveys and land within 150 ft of this type of these areas which functions as a buffer zone.
B. Prime farmland and farmed wetland as defined by state statute rules and identified in County Soil Surveys and/or County/regional farmland and natural areas conservation/preservation programs.
C. Land whose elevation is lower than 5 feet above the elevation of the 100-year flood (as defined by the local Watershed District, Watershed Management Organization, or Joint Powers organization) and land within 50 ft of these areas which functions as a buffer zone.
D. Land which provides habitat for any animal or plant species on the Federal or State threatened or endangered list. If rare, threatened, or endangered species occur on maps of subject site, then contact the County Biological Survey (CBS) for exact coordinates of the said species. AND/OR if the site provides habitat for any rare animal or plant species using County Biological Survey (CBS,) and land which is within 300 ft of these areas which functions as a buffer zone.
E. Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (Park Authority projects are exempt.)
F. Land which is under a conservation easement.

Note: If the site does not completely avoid the conditions in S.1A, S.1C, or S.1D, there are site management implications documented in S.4D, S.4E, and S.4F respectively.

Compliance Tools and Resources

- Public Land Survey Plat Maps
- For S.1A Through S.1F Public Land Survey Notes (University of Minnesota, Twin Cities Campus, Wilson Library – must have range, township, and section information on the subject site to obtain notes.)
- For S.1A Marshner's Land Cover Map of Minnesota (www.dnr.state.mn.us/)
- For S.1A Comprehensive County "Critical Natural Resources" map and assessments such as County Biological Surveys, DNR Natural Resources Inventory and Assessment (NRI/A) (in 7 county Metro Area), local NRI/A's
- For S.1A National Wetland Inventory (www.fws.gov/nwi/)
- For S.1B See www.farmlandinfo.org/minnesota) as a starting point to help identify prime farmland and to identify other resources for this information.
- For S.1C The Minnesota Board of Water and Soil Resource (BWSR) can direct you to the source for most current local flood information.
- For S.1D National, state, or county databases and maps identifying habitat with identified or potential threatened or endangered flora/fauna
- For S.1E Comprehensive Plan
- For S.1F Minnesota Land Trust, Conservation Easement Holdings

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Minnesota Rules; Board of Soil and Water Resources, Chapters 8400-8420
- Soil and Water Conservation Society www.swcs.org
- ALTA Survey (American Land Title Association/ American Congress of Surveying and Mapping).

S.2 Stormwater Management

Intent
Minimize the negative impacts of the project, both on and off site, by maintaining a more natural hydrologic cycle through infiltration, evapotranspiration, and reuse.

Notes:
All governing rules and regulations for stormwater management apply to work covered by this section. The more stringent regulation shall take precedent.

Methods to achieve credits in this section shall be consistent with those found in the most current edition of the Minnesota Pollution Control Agency's "Minnesota Stormwater Manual".

Required Performance Criteria

A. Runoff Rate and Volume:
1. Control the rate of runoff from the post-development site to match the runoff rates for the native soil and vegetation conditions for the 2-year and 10-year, 24- hour design storms.
2. Prohibit discharge from the site for 1.1 inches of runoff from all new or redeveloped impervious (non-vegetated) areas.

B. Runoff Quality:
1. Provide treatment systems designed to remove 80% of the post-development Total Suspended Solids (TSS).
2. Provide treatment systems designed to remove 60% of the post-development Total Phosphorus (TP).

C. Operations and Maintenance Manual
All stormwater BMPs must have an Operations and Maintenance manual created which outlines maintenance requirements and schedules for completion. Operations and Maintenance manuals shall be recorded with the County Registrar.

Compliance Tools and Resources
“Minnesota Stormwater Manual" (Minnesota Pollution Control Agency)
- Standard Curve Numbers
- Stormwater Treatment BMPs and related information

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Local Government Unit
- Environmental Protection Agency: www.epa.gov
- “Best management practices for Stormwater Management”
- Metropolitan Council Urban Small Sites BMP Manual Low-Impact Development Guidelines: http://www.metrocouncil.org/environment/water/bmp/manual.htm
- Minnesota Association of Watershed Districts: www.mnwatershed.org
- Minnesota Pollution Control Agency: www.pca.state.mn.us
- "Protecting Water Quality in Urban Areas"
- Center for Watershed Protection: www.cwp.org
- Minnesota Association of Watershed Districts: www.mnwatershed.org
- Board of Water Quality and Soil Resources: www.bwsr.state.mn.us
- International Stormwater Database: www.bmpdatabase.org
- Minnesota Erosion Control Association: www.mnerosion.org
- Stormwater Manager's Resource Center: www.stormwatercenter.net

S.3 Soil Management

Intent
Maintain the permeable structure of the soil in order to optimize water infiltration/filtration capabilities and maintain the biological functions of the soil in order to optimize plant health and species richness.

Required Performance Criteria

A. Create Soil Management and Erosion Control Plans to protect the soil profile of the site during and after construction.
B. The bulk density of all unpaved pervious surfaces intended for seeding and planting shall have the following maximum bulk densities. Soils in these areas that exceed the stated bulk densities shall be decompacted to 18 inches prior to planting or seeding by air spading, ripping, adding organic matter (see S.3 F), or other decompaction method.
   - Clay and Silt: less than 1.25 g/cm3.
   - Loam: Less than 1.35 g/cm3
   - Sand: Less than 1.55 g/cm3
C. Limit Soil Disturbance
   1. Limit soil disturbance (defined as grading, compacting, piling, tilling, scraping, storing, and removal of soil) to 40 feet beyond the building perimeter, 15 feet beyond primary roadway curbs, main utility branch trenches, pervious areas and stormwater management features, and 5 feet beyond walkways.
   2. Soil disturbance shall be no closer than 5 feet from tree driplines and/or the perimeter of site areas/features identified for protection. Trees shall be protected as individuals or as groups (canopies < 10' apart) with tree protection fence located 5’ beyond the drip line, prior to site activities.
D. Maintain, establish, or enhance a 75-foot vegetated buffer for delineated wetland boundaries.
E. Do not sell or export any top soil from project site. Stockpile and protect existing site topsoil or import topsoil for a respread of 12” in all proposed planting and seeding areas.
F. Build the site’s natural mycorrhyzae and microbial population and enhance the health of the soil by raising or maintaining the percentage of organic material content in the existing or imported site soil. Soil must have a minimum of 3% organic material by weight. Test the soil in planting and seeding areas and amend with organic material as needed to meet this requirement.
G. Where trees are surrounded by hard surfaces (e.g. sidewalks, patios, driveways, car parks, plazas, parking islands) use suspended pavement techniques, structural soils or other comparable methods such as larger tree openings to provide adequate rootable soil volumes. Minimum volume of rootable soil volume per tree shall be:
   - Small trees (e.g. serviceberry): 400 cubic feet (c.f.)
   - Medium trees (e.g. ironwood): 800 c.f.
   - Large trees (e.g. hackberry): 1,200 c.f.

   Note: if using structural soils, total soil volumes above need to be multiplied by 5 to obtain equivalent volume of soil useable by the tree.
   If above soil volumes cannot be met it is recommended that trees requiring smaller soil volumes be selected. Where applicable, utilize suspended pavement or comparable methods to allow tree roots to gain access under hard surfaces to adjacent open space.

Compliance Tools and Resources

- University of Minnesota Extension: www.extension.umn.edu

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Philip J. Craul. Urban Soils: Applications and Practices. New York: John Wiley & Sons, 1999.
- Urban, James. Up By Roots: Healthy Soils and trees in the Built Environment. Illinois: International Society of Arboriculture, 2008.

S.4 Sustainable Vegetation Design

Intent

Conserve existing site features during planning and construction to promote biodiversity and both net and viable species populations and richness on the site and to restore natural areas damaged by construction so the site can sustain its water, soil, and plant cover functions.

Required Performance Criteria

For all of the following:
New Buildings Path: Vegetation Design Criteria apply for all sites
Major Renovations Path: Vegetation Design Criteria apply for renovations including Area of site disturbance > 3,000 s.f. or Area of imperviousness (footprint of building plus site impervious area) renovated > 2000 s.f.

A. On previously developed sites: maintain or improve natural site functions and biodiversity for 50% of site area (excluding building footprint) in accordance with existing conditions and surrounding site context.
B. On all sites: A minimum of 75% of total vegetated area on the site shall be native to the local area. In addition, a minimum of 75% of all trees and shrubs, by quantity, are to be native material. Native is defined as within 200 mile radius of the site. Cultivars may be used if they do not appear on the Minnesota Native Plant Society or University of Minnesota Extension Service "Invasive" or "Species of Concern" lists. Exception: do not remove existing, non-invasive vegetation solely in order to achieve this threshold.
C. Maintain or supplement tree trunk area of site so that there is no net loss of tree trunk area (square inches) at dbh (diameter at breast height=4.5 ft.) (Reference: International Society of Arboriculture (ISA) measurement tree area ratio for translating dbh to caliper.) Pre-project tree trunk area may disregard existing trees less than 6 inches in diameter. Replaced tree trunk area may include trees of any diameter.
D. If the site selected did not completely avoid (per guideline S.1A) land of national, state, regional, or local natural resource and biological/ecological significance as identified in national, state, regional, or local natural resources inventories, assessments and biological surveys and an associated 150 ft buffer zone, then for the portions of this site that include this type of land, create and implement a protection and maintenance plan that follows County Biological Survey (CBS) guidelines and with CBS staff input before any site work is done.
E. If the site selected did not completely avoid (per guideline S.1C) Land whose elevation is lower than 5 feet above the elevation of the 100-year flood the local Watershed District, Watershed Management Organization, or Joint Powers organization)) and an associated 50 ft buffer zone, then for the portions of this site that include this type of land, create and implement a protection and maintenance plan that follows BWSR guidelines and with BWSR staff input before any site work is done.
F. If the site selected did not completely avoid (per guideline S.1D) land (including a 300ft buffer zone) which provides habitat for any animal or plant species on the Federal or State threatened or endangered list, and/or if the site provides habitat for any rare animal or plant species, using County Biological Survey (CBS,) then, create and implement a protection and maintenance plan that follows CBS guidelines and with CBS staff input before any site work is done.

G. Determine if the vegetation on site includes invasive species using the Invasive Species County Weed Guideline. If the site does contain invasive species, create or implement a mitigation and maintenance plan as defined by the Minnesota Department of Agriculture.

Recommended Performance Criteria

Advanced Vegetation Design Criteria
New Buildings Path: Advanced Vegetation Design Criteria apply for all sites
Major Renovations Path: Advanced Vegetation Design Criteria apply for all sites renovations including disturbed site areas totaling 1 acre or more or as deemed applicable:

H. On previously developed sites: maintain or improve natural site functions and biodiversity for 90% of site area in accordance with existing conditions and surrounding site context.

Compliance Tools and Resources

- www.nh.nrcs.usda.gov/technical/ This will lead to a page that has a link to the Electronic Field office Technical Guide (eFOTG)
- Seeding Manual - Latest Edition, Mn/DOT Office of Environmental Services, Turf Establishment & Erosion Control Unit
- The Minnesota County Biological Survey: www.dnr.stste.mn.us/ecological_services/mcbs/index,htmlFor Item F. While not needed for compliance, these resources may help in creating the required plan: BWSR's 2006 publication: "Restoring and Managing Native Wetland and Upland Vegetation" and MPCA's 2005 publication: "Minnesota Stormwater Manual"

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Municipal tree and natural resource inventory
- Geotechnical soils analysis
- www.epa.gov/owow/wetlands/restore
- United States Dept. of Agriculture, Natural Resources Conservation Service, Engineering Field Handbook
- Minnesota Department of Agriculture, Invasive Species
- International Society of Arboriculture www.isa-arbor.com/publications/tree-ord/ordprt3d.aspx
- Board of Water and Soil Resources website: www.bwsr.state.mn.us/index.html

S.5 Light Pollution Reduction

Intent
Eliminate light trespass from the site, improve night sky access, and reduce development impact on nocturnal environments.

Required and Recommended Performance Criteria apply to all projects in the New Buildings Path and for all new exterior lighting scope within Major Renovations projects.

Required Performance Criteria
All S.5 Required Performance Criteria apply to all projects in the New Buildings Path and for all new exterior lighting scope within Major Renovations projects.

Light Trespass:

A. Do not exceed the following night-time (sunset to sunrise) vertical illuminance values for each of the four exterior lighting zone types defined below. The illuminance measurement shall be at 5ft above ground level, along the site property line and facing into the site, perpendicular to the site property line. Vertical illuminance solely from site lighting fixtures may be used; light reflectance off of site surfaces may be ignored in meeting this criteria.

Table for S.5A Light Trespass Limitations

Environmental Lighting Zone	Description	Maximum Vertical Illuminance Levels [fc] at Property Line
E1: Intrinsically Dark	Parks and residential areas where controlling light pollution is a high priority	0.1
E2: Low Ambient Brightness	Outer urban and rural residential areas	0.1
E3: Medium Ambient Brightness	Urban residential areas	0.2
E4: High Ambient Brightness	Urban areas having both residential and commercial use and experiencing high levels of nighttime activity	0.6

Note: This Table was adapted from IESNA RP-33-99, using "post curfew" recommendations for all values to ensure that light trespass is minimized for each environmental zone. In situations where the property line is very close to the area of development (commonly referred to as "zero property line"), and where lighting is required for emergency egress purposes, it may not be possible to meet these recommendations and an exception may be made for lighting within 10 feet of these areas. Carefully explain and document these conditions.

Recommended Performance Criteria

All S.5 Recommended Performance Criteria apply to all projects in the New Buildings Path and for all new exterior lighting scope within Major Renovations projects.

Light Pollution or Sky Glow:

B. Reduce Upward Emissions:

For Parking Lot and Security Lighting areas:

For the same environmental lighting zones as defined above for light trespass, achieve the following light distribution characteristics:

- Zone E1: Use Luminaires with light distribution that meets IESNA's "Full Cutoff Fixtures"
- Zone E2: Use Luminaires with light distribution that meets IESNA's "Cutoff Fixtures"
- Zone E3: Use Luminaires with light distribution that meets IESNA's "Semi-Cutoff Fixtures"
- Zone E4: Use Luminaires with light distribution that meets IESNA's "Cutoff Fixtures

For façade, display, sculptural and sign lighting:

- For luminaires of 3500 or more lumens, light objects from above
- For luminaires of less than 3500 lumens, objects may be lit from below. Make an effort to minimize non-target light (maximize the percentage of uplight that falls on the target)

C. Create lighting control zones and provide lighting control devices for parking lot, security, and decorative and façade lighting so that each type of lighting can be controlled independently and can be turned off or reduced in response to reduced lighting needs during low use or non-use periods.

Note: The principles for sky glow criteria S.5 B-C are adapted from principles outlined in IESNA RP33-99, Lighting for Exterior Environments.

Light Quality:

D. Use lamps with a minimum CRI of 65 in areas of safety/security (i.e. main walking routes through large parking lots, isolated areas), at building entrances, and locations where identification of objects or individuals is essential.

Compliance Tools and Resources

- Illuminating Engineering Society of North America (IESNA) Recommended Practice (RP-33-99) Lighting for Exterior Environments.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Illuminating Engineering Society of North America (IESNA) Technical Memorandum TM-10-00, Addressing Obtrusive Light (Urban Sky Glow and Light Trespass) In Conjunction with Roadway Lighting.
- Illuminating Engineering Society of North America (IESNA) Technical Memorandum TM-11-00, Light Trespass: Research, Results and Recommendations.
- International Dark-Sky Association, www.darksky.org

S.6 Erosion and Sedimentation Control During Construction

Intent

Reduce erosion and sedimentation during construction.

Required Performance Criteria

New Buildings Path, Major Renovations Path: For all sites

Plan for and implement Erosion Control Management during construction (per NPDES site permit), until final punchlist that includes:

A. Leave no soil open for more than 48 hours (for example: use blankets, fences, slope interceptions)
B. Inspect, repair and cover erosion-damaged areas within 6 hours of every 24 hour storm event that is greater than or equal to 0.75 inches.
C. Create a Storm Water Pollution Prevention Plan (SWPPP) and submit it to MPCA and local watershed authority 4 days prior to any and all site disturbance.
D. Enact a fine structure (with a $1,000 minimum) for all erosion control infractions, to be set and enforced on Contractors by the Owner or Owner's representative.
E. Identify and protect all downstream (TMDL) impaired waters from identified impacts. (Examples: mercury, lead, calcium, chromium, copper, chloride, Total Suspended Solids (TSS), phosphorus, biota).
F. Limit sediment discharge to the most stringent of the following scenarios: a) 5 tons per acre per year using the RUSLE method or other generally accepted soil runoff calculation. or b) where applicable meet the sediment discharge requirements of the watershed district, watershed maintenance organization, joint powers association, or other local governing unit.
G. Maintain Temporary Erosion Control until the site is vegetated and stormwater infrastructure is fully functional.

Compliance Tools and Resources

- Best management practices for erosion and sedimentation control by the Environmental Protection Agency (EPA), Minnesota Pollution Control Agency (MPCA), MetCouncil, or Local Governing Unit (LGU), whichever is most stringent.
- MetCouncil Small Sites BMP Manual
- RUSLE Method (NRCS) http://www.ars.usda.gov/Research/docs.htm?docid=5971
- Minnesota Pollution Control Agency SWPPP Guidelines
- Minnesota Pollution Control Agency Publication: Minnesota's Impaired Waters

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Stormwater Best Management Practices Manual http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/stormwater-best-management-practices-manual.html
- Erosion Control & Stormwater Management http://www.dot.state.mn.us/environment/erosion/index.html

S.7 Landscape Water Efficiency

Intent

Limit, or eliminate demand for municipal potable water or harvested groundwater (well water) used for maintaining plants and lawn areas.

New Buildings Path: For all sites

Major Renovations Path: For Area of site disturbance > 3,000 s.f. OR Area of imperviousness (footprint of building plus site impervious area) renovated > 2000 s.f.

Required Performance Criteria

A. Design and maintain landscape so that after a 2 year establishment period, the landscape uses 50% less municipal potable water or harvested ground water for irrigation than a base case landscape design. (Exception: annuals are exempt.) Any amount of site-harvested rainwater, storm water, or gray or waste water treated on site to tertiary standards may be used. The criteria may be met by any combination of: selection of native or low water use plants, use of alternatively sourced irrigation water as described, use of high efficiency irrigation systems, or other strategies.

Recommended Performance Criteria

B. Design and maintain landscape so that after 1-2 year establishment period, the landscape uses no (100% less) municipal potable water or harvested ground water than a base case landscape design. (Exception: annuals are exempt.) Any amount of site- harvested rainwater, storm water, or gray or waste water treated on site to tertiary standards may be used. The criteria may be met by any combination of: selection of native or low water use plants, use of alternatively sourced irrigation water as described, use of high efficiency irrigation systems, no irrigation systems, or other strategies.

Compliance Tools and Resources

- Typical Irrigation Water Use: See Appendix S-7 Irrigation Water Consumption
- Custom calculation or manufacturer worksheets such as Rainbird or Toro Irrigation Worksheet

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines
Appendix S-7 Irrigation Water Consumption

Supplemental Resources

- University of Minnesota Extension http://www.extension.umn.edu

S.8 Building Water Efficiency

Intent

Minimize municipal potable water or harvested groundwater (well water) use in buildings to conserve water resources and minimize water and wastewater treatment infrastructure impacts and cost.

Required Performance Criteria

A. Reduce municipal potable water or harvested groundwater use in building by 30% compared to code (1992 Energy Policy Act requirements) for any fixture types referenced by those requirements. The criteria may be met by any combination of: selection of low or no flow fixtures, use of alternatively sourced water, or other strategies. Major Renovation Path projects, may limit performance criteria application to the number of fixtures included in the renovation scope, however, even if no fixture replacement was planned in renovations scope, for any plumbing fixtures within the renovated area: faucets in the renovated area shall be upgraded with low-flow faucet aerators, and showerheads shall be upgraded with low-flow showerheads.

Recommended Performance Criteria

B. Reduce municipal potable water or harvested groundwater use in building by 50% compared to code (1992 Energy Policy Act requirements) for any fixture types referenced by those requirements. The criteria may be met by any combination of: selection of low or no flow fixtures, use of alternatively sourced water, or other strategies. Major Renovation Path projects, may limit performance criteria application to the number of fixtures included in the renovation scope.

Compliance Tools and Resources

- Use Worksheet S-2 Building Water Calculator to calculate building water use for base and design. This also shows EPA required flow and flush fixture rates, and example fixture performance values.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines
Appendix S-8 Building Water Calculator

S.9 Appropriate Location and Development Pattern

Intent

Direct development, where appropriate, to existing urban, suburban, or rural areas with in-place infrastructure to reduce development pressure on undeveloped land or greenfield sites; to conserve natural resources, reduce energy use and pollution contributions related to transportation requirements; and to promote a sense of increased community interaction. Develop the site to support existing patterns and goals for local density, open space, and land use.

Recommended Performance Criteria

Site Selection:

A. Select a site, considering the associated building concept, which presents the most comprehensively positive impact for environmental, economic, community, and human benefits.
   - Urban and suburban locations: Select sites which reuse existing urban/suburban and industrial sites; are located near mass transit and public amenities to encourage walking to services instead of driving; and can utilize existing infrastructure such as utilities, roadways, services, etc. Select sites that support regional development strategies and local comprehensive plans. Favor sites on which the project will disrupt the least amount of ecologically preferable land uses.
   - Rural locations: Avoid greenfield sites which might not meet the threshold for a potentially critical site under guideline S.1 , but which negatively impact green space and soil and water conditions. Favor sites on which the project will disrupt the least amount of ecologically preferable land uses.

Context and Planning Compatible Development

B. Land Use Maintain or improve upon site land use type and condition from pre-project to post project.
C. Density: Urban and suburban locations: Maintain or increase localized density to conform to existing or desired density goals as listed in Minnesota's Community-Based Planning Act.
D. Open Space: Maintain or increase open space compared to local or prevailing standards for the site.
E. Green Corridors: Maintain or increase Green Corridors compared to local or prevailing standards for the site.

Compliance Tools and Resources

- Form P-3 Site and Water Documentation
- Minnesota Regional Development Organizations: www.mrdo.org/ (Regional Development Strategies)
- Minnesota Community Based Planning Act web addresses for:
- Local Planning Laws in Mn: http://www.lpa.state.mn.us/laws/index.html
- Resource Materials, Planning Guides, “Under Construction, Tools and Techniques for Local Planning:” http://server.admin.state.mn.us/resource.html?Id=2910
- Green Corridors: Minnesota DNR Natural Resource Planning, which includes green corridors, webpage: http://www.dnr.state.mn.us/nrplanning/index.html

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- The Minnesota Stormwater Manual http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/minnesotas-stormwater-manual.html
- Open Space: National Recreation and Park Association webpage: www.nrpa.org/
- National Recreation and Park Association publication "Park, Recreation, Open Space and Greenway Guidelines." NRPA, 1995

S.10 Brownfield Redevelopment

Intent

Redevelop damaged or contaminated sites to reduce development pressure on undeveloped land and utilize existing investments in infrastructure, conserve natural resources, and promote a new sense of community renewal, identity, and revitalization.

Recommended Performance Criteria

A. Redevelop Brownfield sites to support Minnesota's Community-Based Planning Act.
B. Provide remediation as required for EPA's Sustainable Redevelopment of Brownfields Program and enroll site in the Minnesota Pollution Control Agency's Voluntary Investigation and Cleanup Program.
C. Develop a site classified as a Brownfield into a Greenspace (B2-G), for park or open space connected to building development.

Compliance Tools and Resources

- County Brownfield map listing contamination source and degree of contamination
- Minnesota Community Based Planning Act web addresses for:
- Local Planning Laws in Mn: http://www.lpa.state.mn.us/laws/index.html
- Resource Materials, Planning Guides, "Under Construction, Tools and Techniques for Local Planning:" http://server.admin.state.mn.us/resource.html?Id=2910
- EPA Sustainable Redevelopment of Brownfields http://www.epa.gov/brownfields/sustain.htm
- Minnesota Pollution Control Agency's Voluntary Investigation and Cleanup Program http://www.pca.state.mn.us/cleanup/vic.html

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Brownfields www.pca.state.mn.us/cleanup/brownfields.html
- County comprehensive development plan
- Municipal land use plan

S.11 Heat Island Reduction

Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

Recommended Performance Criteria

A. Non-roof site surfaces:

Provide at any combination of the following characteristics for 50% of the site hardscape:

- Surface is light colored/high albedo (reflectance is .30 or greater.)
- Surface composed of an open-grid pavement system (less than 50% impervious)
- 50% of non-parking surfaces will be shaded within 5 years.
- 50% of parking surfaces will be shaded within 10 years.
- OR 100% of non-circulation parking surface will be shaded within 10 years.

OR

- Place a minimum of 50% of parking spaces underground or in a structured parking facility.

B. Roof Surfaces:

- Use ENERGY STAR Roof-compliant, high-reflectance AND high emissivity roofing (initial reflectance of at least 0.65 and three-year-aged reflectance of at least 0.5 when tested in accordance with ASTM #903 and emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surface.

OR

- Install a "green" (vegetated) roof for at least 50% of the roof area.

OR

- The two options can be combined by the following formula: (high albedo roof Area/.75) + (green roof area/.5) is greater than or equal to total roof area.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Public Technology, Inc., U.S. Green Building Council, U.S. DOE, U.S EPA. Sustainable Building Technical Manual, Part 3 (Part 3 deals with Site issues, all issues under S.11), Chapters 5, 6,7 and 8. Available from www.usgbc.org.
- Green Roofs for Healthy Cities website: www.greenroofs.org

S.12 Transportation Impacts Reduction

Intent

Reduce negative land development impacts on energy, and pollution caused by transportation. Reduce dependence on the automobile, reduce the amount of pavement impacting natural systems, and allow for more ecologically responsive approaches to the site.

Recommended Performance Criteria

Site selection and Design:

A. Locate the building within 1/4 mile of one or more bus lines OR a light rail/bus station, AND within 1/4 mile of retail and public services.
B. Locate project within 1/4 mile of restaurants and service facilities.
C. Provide means for securing bicycles, with convenient changing/shower facilities for use by cyclists, for 5% or more of building full time equivalent (FTE) occupants OR according to local bicycle parking guidelines OR zoning requirements, whichever is more stringent.
D. Install alternative-fuel refueling or plug-in electric vehicle charging station(s) for 3% of the total vehicle parking capacity of the site.
E. Limit parking area by sizing parking capacity not to exceed minimum local zoning requirements, encouraging shared parking with adjacent uses, and adding no new parking for rehabilitation projects
F. Provide preferred parking for hybrid vehicle owners, carpools or van pools capable of serving 5% of the building occupants.
G. Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances, with markings clearly designating these areas.

Operations Policies

H. Offer work pattern alternatives such as telecommuting, and teleconferencing facilities that reduce vehicle and air travel time.
I. Set a company policy to buy carbon emission offsets for business air travel.
J. Support mass transit riders by offering free or discounted bus or train passes for those that commit to not driving in at least 3 days per week. Make company cars (preferably alternatively fueled) readily available for daytime business travel for those who do not drive in.
K. Manage transportation impacts: Track commuting and business travel contributions to pollution impacts and include in annual environmental reporting. Evaluate the effectiveness of transportation policies and facilities and set goals for continual improvement in travel emissions performance.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- For more information on Light Rail Transit see Metropolitan Council. http://metrocouncil.org
- Sprawl Watch Clearinghouse www.sprawlwatch.org
- Calthorpe, Peter. The Next American Metropolis. Princeton Architectural Press, 1993.

S.13 Wastewater Reduction and Management

Intent

Reduce wastewater generated for conventional treatment.

Recommended Performance Criteria

A. Reduce the volume of the subject sites' wastewater flow entering the municipal wastewater system or an on-site conventional septic system by 50%. Alternatives that can contribute to this guideline include, but are not limited to: peat moss drain fields, constructed wetlands, aerobic treatment systems, solar aquatic waste systems (or living machines), and composting or ecologically-based toilets or urinals. Reduction of building water and sewer discharge also contributes to reduced waste water generated without negatively impacting adjacent municipal water well heads. Reduction of building water consumption also contributes to reduced waste water generated.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix S-0 Suggested Implementation for All Site and Water Guidelines

Supplemental Resources

- Integrated Water Strategies www.waterrecycling.com
- National Sustainable Agriculture Information Service www.attra.ncat.org
- Wetlands http://water.epa.gov/type/wetlands/

S.14 Bird-Safe Building

Intent

Sustainable design can create environments that are attractive to birds which benefits both occupants and wildlife. Any built environment, but especially those attractive to birds, can pose a risk for bird-building collisions, which kill hundreds of millions of birds per year. The intent of this guideline is to limit the risk of built environments to birds, with special attention to the highest risk conditions. Some other B3 Guidelines guidelines also affect bird-safe building such as S.1 Avoidance of Critical Sites, S.4 Sustainable Vegetation Design, and S.5 Light Pollution Reduction recommended criteria S.5B and S.5C

Definitions:

TF Threat Factor, a property of a building material related to likelihood of bird collision, found in the Threat Factor Table (See Appendix S-14a)

Required Performance Criteria

For New Construction and Major Renovations with new or replacement glazing scope, all required criteria apply. For Major Renovations without new or replacement glazing scope, only S.14E (Follow "Lights Out" light management program) is required

A. Traps (Highest Risk Surfaces) shall be less than **TF 25**

Any material in the following conditions must have a Threat Factor less than or equal to **TF 25**

- Glass/Plexiglas (transparent) railings (all surfaces exposed to exterior)
- Glass/Plexiglas-sided walkways (eg. sky ways, covered walks with glass on two sides)
- Any glazed surface that offers a see-through situation that is 20ft or less across, such as a small atrium, or glass corners

B. High Risk Surfaces are limited to 15% of surface area with **TF 75** or more

No more than 15% of the area of a "High Risk Surface' shall have a threat factor less than or equal to TF 75. A High Risk Surface is defined as:

- A surface within fifty feet or less of attractants such as trees, shrubs, prairie, grassland or open water (including green roofs with this type of vegetation)
- A surface in a see through situation greater than 20 feet across (such as atriums, gathering spaces/lobbies, etc.)

C. Whole Building Threat Factor (WBTF) shall be less than or equal to WBTF 45; or WBTF 15 for Critical Sites

Use the B3 Guidelines Bird-safe Design Calculator (Appendix S-14a) to determine WBTF. The calculator will also document and help to meet requirements for S.14A , S.14B, and S.14D. Use Guideline S.1 criteria to determine if the project is on a "critical site" to determine the appropriate WBTF threshold.

D. Non-Enclosure Threat Factor (NETF) shall be less than or equal to NETF 45

Use the B3 Guidelines Bird-safe Design Calculator to determine NETF for non-enclosure surfaces.

E. Follow "Lights Out" light management program

Follow "Lights Out" light management program which addresses operation of lights at night for specified times and dates of bird migrations. In addition to the B3 Guidelines requirement, note that this is also required by law for state owned and managed buildings. (https://www.revisor.leg.state.mn.us/laws/?id=101&doctype=Chapter&year=2009&type=0)

- Dates: Between March 15 and May 31 and between August 15 and October 31 each year
- Times: Between midnight and dawn
- Lighting: Turn off building lighting including but not limited to: architectural lighting at top of building; up-lighting; interior lighting, especially on upper floors; and lobby or atrium lighting. Exception: where lights are documented to be needed between midnight and dawn for normal use of the building, they may be operated.

F. First Year Building Monitoring

For one year after construction/occupancy, walk the perimeter of the building(s) and all accessible set-backs and roof areas at least two times per week. Document survey activity and findings as required in Appendix S-14b Bird Safe Monitoring Worksheets.

Recommended Guidelines:

G. Meet Whole Building Threat Factor (WBTF) of less than or equal to 15

Use the B3 Guidelines Bird-safe Design Calculator (Appendix S-14a) to determine WBTF

H. Enhanced Bird Safe Building Monitoring

In addition to S.14 F (First Year Building Monitoring) above:

- Continue First Year Monitoring Format for one or more additional years (shifting to a January-December Calendar year basis in ongoing operations phases of the tracking tool)
- AND/OR Conduct more surveys per week for first or more years
- AND/OR Work with an organization such as Audubon Minnesota to collect and catalog birds found.

I. Bird Safe Building Narrative

Complete a Bird-Safe Case Study Narrative Report to document and share your bird-safe efforts. Use Appendix S-14c Bird Safe Building Narrative Template or include a write up with similar content.

J. Bird Safe Lighting Design

Comply with recommended lighting guidelines S.5B and S.5C and Document Bird Safe Features of lighting including for S.5C; identify how control zones relate to Lights Out program

Compliance Tools and Resources

- Appendix S-14a Bird Safe Calculator and Threat Factor Table
- Appendix S-14b Bird Safe Monitoring Worksheets
- Appendix S-14c Bird Safe Building Narrative Template
- Audubon Minnesota Lights Out Program : http://mn.audubon.org/lights-out-program

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix S-0 Suggested Implementation for All Site and Water Guidelines
- Appendix S-14a Bird Safe Calculator and Threat Factor Table
- Appendix S-14b Bird Safe Monitoring Worksheets
- Appendix S-14c Bird Safe Building Narrative Template

References:

- Bird Safe Building Guidelines by Audubon Minnesota http://mn.audubon.org/sites/default/files/documents/05-05-10_bird-safe-building-guidelines.pdf
- USGBC LEED Pilot Credit 55: SS - Bird Collision Deterrence http://www.usgbc.org/ShowFile.aspx?DocumentID=10402
- Sheppard, C. 2011. Bird-Friendly Building Design. American Bird Conservancy, The Plains, VA collisions.abcbirds.org

Energy and Atmosphere Guidelines

B3 Guidelines Compliance Path Table for Energy and Atmosphere Guidelines

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	ENERGY AND ATMOSPHERE		
E.1	Energy Efficiency	Required	Required
E.2	Renewable Energy	Required	Recommended
E.3	Efficient Equipment and Appliances	Required	Required
E.4	Atmospheric Protection	Recommended	Recommended

Related Documentation

B3 Guidelines Tracking Tool at www.msbgtracking.com

Worksheets and Appendices

Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines
Appendix E-1a Compliance and Reporting Instructions (for SB2030 projects)
Appendix E-1b Building Performance Evaluation Guide
Appendix E-1c Building Strategy Checklist
Appendix E-1d Meter Plan Guidelines
Appendix E-1e Alternate Path Application Process for Adjusted SB2030 Standard
Appendix E-1f Small Building Methodology for pre-SB2030 projects
Appendix E-4 Refrigerant Properties

Overview

Energy consumption for building operations represents approximately one third of the total energy use in the State of Minnesota. This section of the B3 Guidelines provides guidance on mitigating both the cost of energy and associated ecological impacts which affect the state's economy. For each building, there are multiple paths to conservation. To further reduce impacts on the environment and to promote community economic development, this guide requires a minimal baseline of on-site wind or solar renewable energy and recommends the investigation of renewable and distributed forms of power generation using wind, solar and biomass technologies as well as other cleaner forms of hydrogen or hydrocarbon-based power generators. Combined Heat and Power (CHP) systems may be an appropriate solution for individual buildings or groups of State facilities.

Goal

To provide energy efficient buildings and renovations that reduce the State's expenditures on imported fuel and power and have the lowest reasonable environmental impacts resulting from energy generation and the use of refrigerants harmful to the atmosphere. A parallel goal is to support and enhance the State's building benchmarking activities for ongoing operations performance.

Objectives

- Design Pre-MN2030 New Buildings and Major Renovations to use 30% less energy than code and encourage higher performance
- For buildings subject to MN2030, design New Buildings and Major Renovations to meet the custom energy benchmarks of the MN2030 program.
- Provide building performance data for benchmarking activities

- Reduce plug loads and process energy through energy-smart purchasing practices
- Design New Buildings and Major Renovations to source at least 2% of their MN2030 target or better final energy use from on-site renewable sources.
- Encourage the consideration of additional power usage from renewable energy and cleaner generation systems whether generated on-site or purchased from off-site, "green power" generated in Minnesota.
- Encourage the installation of on-site renewable energy systems to provide 2% of total building energy use, in accordance with Minnesota legislation
- Encourage the balanced consideration of Global Warming Potential, Ozone Depletion Potential and Atmospheric Lifetime in selecting refrigerants
- Help assure that long-term operations meet or exceed original design operating parameters

E.1 Energy Efficiency

Intent

For pre-MN2030 Buildings, ensure annual energy costs are reduced by at least 30% as required by the Minnesota Legislature. This can be achieved by using either guideline E.1A or E.1B (E.1B is only for applicable pre-SB2030 buildings under 30,000sf)

For Buildings subject to MN 2030, the project must meet custom energy targets as determined by the MN2030 program.

Criteria E.1A and E.1B are not available pathways to compliance for B3 Guidelines for projects beginning Schematic Design phase on or after August 1, 2009. Projects beginning the Schematic Design Phase on or after August 1, 2009 are required to complete both E.1C and E.1D, and not E.1A and not E.1B. The small buildings methodology in the SB2030 program is different than the one listed below (in E.1b).

Required Performance Criteria

A. 30% Reduction from Energy Analysis (over 30,000 sf, **pre-SB2030 projects only**)
If the project was in the schematic design phase before August 1, 2009: For all New Buildings and Major Renovations over 30,000 square feet that are heated, perform a comparative analysis to reduce design energy costs compared to the energy cost budget by at least 30% for regulated energy components as described in the Minnesota State Energy Code in effect as of 15 January 2003. Enter results in the B3 Guidelines Tracking Tool
A whole building, (or for Major Renovations the whole renovated space and all its systems) comparative analysis methodology must be used before the Construction Document phase of the design process to determine the energy conservation solution with the lowest lifetime cost. Programs with the following simulation engines can be used: DOE2.1e, DOE2.2, Energy Plus, Energy-10 and TRNSYS. Compliance with the Performance Criteria are only valid under the following conditions:
    - Only one building geometry may be used for a given project analysis.
    - Only one set of plug and process loads may be used for a given project analysis.
    - Only one mechanical system type may be used for a given project analysis.
    - Design teams must first use the Indoor Environmental Quality section I.4 of this guide to establish base operation parameters for outside air requirements.

OR Meet E1.C “Meet MN SB2030 Energy Standards instead of Using E.1A.

B. B. 30% Reduction from Small Building Method (under 30,000 sf, **pre-SB2030 projects only**)
If the project was in the schematic design phase before August 1, 2009: For all New Buildings and Major Renovations under 30,000 Square Feet: Use one of the building envelope and system option sets in the Small Buildings Methodology found in B3 Guidelines Appendix E-1. OR follow E.1A above if preferred. Enter results in the B3 Guidelines Tracking Tool

OR Meet E1.C “Meet MN SB2030 Energy Standards instead of Using E.1B.

C. Meet MN SB2030 Energy Standards
If the project was NOT in the schematic design phase before August 1, 2009: For New Buildings and Major Renovations, meet MN SB2030 Energy Standards which can be found at www.mn2030.umn.edu. Results and compliance are tracked in the B3 Guidelines Tracking Tool

D. Document predicted and actual energy use by type
For all New Buildings and Major Renovations, document predicted and actual energy use by type in the B3 Guidelines Tracking Tool, including recording modeled plugloads and sub-metered actual plugloads separately from other electrical loads in the built project.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at at www.msbgtracking.com
- Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines
- Appendix E-1a Compliance and Reporting Instructions (for SB2030 projects)
- Appendix E-1b Building Performance Evaluation Guide (SB2030 document)
- Appendix E-1c Building Strategy Checklist (SB2030 document)
- Appendix E-1d Meter Plan Guidelines (SB2030 document)
- Appendix E-1b Small Building Methodology for pre-SB2030 Energy Standard projects

Supplemental Resources

- Minnesota Sustainable Building 2030 legislation and program. See www.mn2030.umn.edu.
- The MPCA web page on Financing for Energy Improvements is a resource for information on utility programs, performance contracting, the MSBA lease purchase program for schools, and more. http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/green-building/financing.html
- The MPCA web page on Design Guidelines, Specifications and Rating Systems provides links to the Energy Star online design tools, Portfolio Manager and Target Finder. Also links to ASHRAE standards, the U.S. Department of Energy's Buildings for the 21st Century program, and the MN Commerce Department Energy Office. http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/green-building/design-guidelines-specs-and-rating-systems.html

E.2 Renewable Energy

Intent

Require a minimal use of on-site renewable energy, and encourage the broader consideration and use of renewable energy sources and cleaner forms of hydrogen and hydrocarbon-based distributed generation systems to reduce atmospheric pollution. This can provide a stimulus to the State's economy through investments in local jobs and materials while reducing the State's expenditures on imported fuel and power. The language of this guideline is intended to align with Minnesota legislation that requires and economic analysis of onsite solar-and-wind-derived renewable energy systems sufficient to offset 2% of predicted energy demand (MN Statute §16B.32, Subd 1a https://www.revisor.mn.gov/statutes/?id=16B.32). This legislation requires the installation of such systems unless explicit reasons are provided that rule out installation.

Required Performance Criteria

A. Provide 2% of Energy Needs with On-Site Solar or Wind Renewable Sources:

This is required for new buildings, and recommended for Major Renovations.
Eligible Wind and Solar Renewable Sources may include:

- Photovoltaic solar panels which convert sunlight directly into electricity,
- Wind turbines capture wind to turn rotors, which turns a generator and creates electricity.
- Transpired solar collectors use sunlight to preheat air for heating purposes
- Solar thermal systems use the sun to heat water for heating or domestic hot water uses.

During Predesign, “a new building must consider meeting at least two percent of the energy needs of the building from renewable sources located on the building site. For purposes of this subdivision, "renewable sources" are limited to wind and the sun. The predesign must include an explicit cost and price analysis of complying with the two-percent requirement compared with the present and future costs of energy supplied by a public utility from a location away from the building site and the present and future costs of controlling carbon emissions. If the analysis concludes that the building should not meet at least two-percent of its energy needs from renewable sources located on the building site, the analysis must provide explicit reasons why not.“ Note that this text aligns with referenced legislation applying to state agencies, but is applied to all bonded projects subject to B3 here. Also see source legislation for more details

During the Schematic Design phase, analyze at least two scenarios that include the environmental and economic impacts of supplying two percent of the building's anticipated total energy use with on-site renewable generation systems. Enter results in the B3 Guidelines Tracking Tool and incorporate at least 2% renewable into the project planning. The evaluation is limited to “renewable sources” as defined by the legislation, which limits the definition to solar and wind power. Since renewable percent is to be calculated on final compliant energy use, not baseline use, make use of 2030 benchmarks for building to set 2% renewable benchmarks accordingly early in project.

During the Design Development phase, update and complete the analysis of the two scenarios in the B3 Guidelines Tracking Tool and refine the inclusion of at least 2% renewable into the project planning documents.

Pursuant to Minnesota Statute §16B.323, the project may, after the completion of a cost-benefit analysis, include installation of “Made in Minnesota” solar energy systems of 40 kilowatts capacity

on, adjacent, or in proximity to the state funded building. The capacity of a solar system must be less than 40 kilowatts to the extent necessary to match the electrical load of the building or to the extent necessary to keep the costs for the installation below five percent of the appropriations from the bond proceeds fund for the construction or renovation of the state building. Purchase and installation of a solar thermal system may account for no more than 25 percent of the cost of a solar system installation. See the full legislation for complete requirements.

Pursuant to Minnesota Statute §16B.326, when practicable, geothermal and solar thermal heating and cooling systems must be considered when designing, planning, or letting bids for necessary replacement or initial installation of cooling or heating systems in new or existing buildings that are constructed or maintained with state funds. The predesign review must include a written plan for compliance with this section from a project proposer. For the purposes of this section, "solar thermal" means a flat plate or evacuated tube with a fixed orientation that collects the sun's radiant energy and transfers it to a storage medium for distribution as energy for heating and cooling. See the full legislation for complete requirements.

Recommended Performance Criteria

B. Provide 10% of Energy Needs with renewable and cleaner distributed generation systems
Consider the inclusion of all renewable and cleaner distributed generation approaches to meet 10% or more of the buildings energy needs. This goal may be achieved through the construction budget by paying for the design and installation of a renewable or cleaner distributed generation system or through the operating budget through a contract to purchase renewable or cleaner distributed generation.

C. Provide 100% or more of Energy Needs with renewable and cleaner distributed generation systems
Consider the inclusion of all renewable and cleaner distributed generation approaches to meet 100% or more of the buildings energy needs. This goal may be achieved through the construction budget by paying for the design and installation of a renewable or cleaner distributed generation system or through the operating budget through a contract to purchase renewable or cleaner distributed generation.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at at www.msbgtracking.com
- Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines

Supplemental Resources

- Minnesota renewable legislation: MN Statute §16B.32, Subd 1a: https://www.revisor.mn.gov/statutes/?id=16B.32
- Minnesota Legislation: Solar Energy in State Buildings: §16B.323 SOLAR ENERGY IN STATE BUILDINGS : https://www.revisor.mn.gov/statutes/?id=16B.323
- Minnesota Legislation: Geothermal Energy in State Buildings: §16B.326 HEATING AND COOLING SYSTEMS; STATE-FUNDED BUILDINGS https://www.revisor.mn.gov/statutes/?id=16B.326
- The Database of State Incentives for Renewable Energy (DSIRE) is a comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy. http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=MN

- RETScreen International: Clean Energy Decision Support Center (www.retscreen.net). RETScreen software that analyzes costs and benefits of renewables can be downloaded from this web site.

E.3 Efficient Equipment and Appliances

Intent

Reduce energy use associated with plug loads and process loads in buildings. These strategies may also contribute to meeting the SB2030 Energy Standard if using a performance approach (documenting design energy use with a simulation).

Required Performance Criteria

A. Select new equipment and appliances that meet Energy Star criteria.

Compliance Tools and Resources

For Item A above:

- DOE Energy Star Program: www.eren.doe.gov/buildings/energystar.html
- For Energy Star Products: www.energystar.gov

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at at www.msbgtracking.com
- Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines

• E.4 Atmospheric Protection

Intent

Encourage the investigation and evaluation of refrigerants to reduce environmental impacts harmful to the atmosphere. Energy conservation should be achieved with the lowest reasonable environmental impacts.

Recommended Performance Criteria

There are no required levels for atmospheric pollution from refrigerants at this time except for CFC reduction which is required in the MN State Building Code. It is recommended that the following three criteria be met for refrigerants.

A. Achieve an atmospheric Lifetime (AtL) < 33. Atmospheric Lifetime is a measure of the average persistence of the refrigerant if released. A longer lifetime has worse environmental effects.
B. Achieve an Ozone Depletion Potential (ODP) < 0.034. Ozone Depletion Potential is a normalized indicator based on the ability of a refrigerant to destroy atmospheric ozone, where CFC-11 = 1.00. A higher ODP has worse environmental effects.
C. Achieve a Global Warming Potential (GWP) < 3500. Global Warming Potential is an indicator of the potency of the refrigerant to warm the planet by action as a greenhouse gas. A higher GWP has worse environmental effects.
D. Design, maintain and operate the mechanical equipment to reduce refrigerant leakage over the life of the building.

Compliance Tools and Resources

For Items A, B and C above:

- Appendix E-4 Refrigerant Properties

Note: CFCs generally have high Ozone Depletion Potential and Global Warming Potential with long Atmospheric Lifetimes. CFCs are therefore not allowed by these guidelines and prohibited by State law. Halons have a higher Ozone Depletion Potential though a lower Global Warming Potential but a much longer Atmospheric Lifetime. Halons should not be used if possible. HCFCs such as R-123, which other guides put in the same class as Halons, can have an Ozone Depletion Potential, a Global Warming Potential and an Atmospheric Lifetime two orders of magnitude less than CFCs and Halons. HFCs offer near zero Ozone Depletion Potential, but some have high Global Warming Potential. For example, R-134 has an Ozone Depletion Potential of 0.0 but a Global Warming Potential and an Atmospheric Lifetime approximately 10 times greater than R-123, an HCFC alternative. Substituting an HFC, which tends to be less energy efficient than an HCFC, may result in the use of more energy, resulting in a further increase in global warming.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at at www.msbgtracking.com
- Appendix E-0 Suggested Implementation for all Energy and Atmosphere Guidelines
- Appendix E-4 Refrigerant Properties

Indoor Environmental Quality Guidelines

B3 Guidelines Compliance Path Table for Indoor Environmental Quality Guidelines

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	INDOOR ENVIRONMENTAL QUALITY		
I.1	Restrict Environmental Tobacco Smoke	Required	Required
I.2	Specify Low-emitting Materials	Required	Required for Newly Installed Materials
I.3	Moisture Control	Required	Required if Exterior Envelope is in Scope
I.4	Ventilation Design	Required	Required
I.5	Thermal Comfort	Required	Required
I.6	Quality Lighting	Required	Required if Lighting Replacement is in Scope
I.7	Effective Acoustics	Required	Required
I.8	Reduce Vibration in Buildings	Required	Recommended if Structural is in Scope
I.9	Daylight	Required	Required (Partial - See Guideline)
I.10	View Space and Window Access	Recommended	Recommended
I.11	Personal Control of IEQ Conditions & Impacts	Recommended	Recommended
I.12	Encourage Healthful Physical Activity	Recommended	Recommended

Related Documentation

B3 Guidelines Tracking Tool at www.msbgtracking.com

Worksheets and Appendices

Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines
Appendix I-4 Calculating CO2 Concentrations in a Zone
Appendix I-9 Daylighting Factor Calculator
Appendix I-10 View Space Diagrams and Tables for I.10

Overview

The provision of indoor environmental quality at levels that support productive human habitation both complements and supports the environmental and economic goals for sustainable building. Appropriate indoor environmental qualities of air, temperature, sound, light, visible and physical space and occupants' ability to personally control these are the building's contributions to the biological bases of occupant comfort, health and well-being. Harmful effects on occupants of poor indoor environmental quality are well documented in laboratory and field studies. Similarly, enhanced indoor environmental quality helps occupants feel and perform at their best, with subsequent health, well-being and productivity benefits for themselves and their work organizations. These indoor environmental quality guidelines are constructed to first and foremost help prevent harm coming to occupants, then to optimize environmental quality conditions to correspond with human physiological processes, and finally to fine tune environmental conditions to work activities in a way that further enhances personal and organizational productivity.

Goal

The goal of the guidelines in this section is to provide exemplary indoor air quality and other interior environmental conditions to promote occupant health, well-being and productivity. Here, "health" is more than the absence of disease and "well-being" includes provision of physical comfort and psychological satisfaction with the physical work environment.

Objectives

- Provide a clean building that will minimize pollutant sources in the structure and its occupants.
- Provide a dry building to minimize structural and health problems associated with water intrusion and accumulation.
- Provide a well-ventilated building to dilute pollutants and bioeffluents emitted by the building materials, the occupants and their activities.
- Provide for occupant thermal comfort.
- Provide daylight for general ambient illumination.
- Provide interior view space or views to the exterior.
- Provide lighting solutions of high quality for visual tasks and preferred interior rendering.
- Provide interior conditions that avoid harmful vibration and noise effects and produce a positive acoustic environment acceptable to occupants and appropriate to their tasks.
- Provide for local occupant control of localized indoor environmental conditions in order to quickly correct harmful conditions and to better support work performance.
- Provide an interior spatial arrangement that encourages healthy human interaction and movement

I.1 Restrict Environmental Tobacco Smoke

Intent
Reduce indoor pollutants by eliminating environmental tobacco smoke (ETS) from occupied areas of the building.

Required Performance Criteria
Owner/ Facilities Operations Manager

A. Establish a no smoking policy for the entire building.
B. Smoking policy will state where smoking outside of building can occur, such that design considerations will not introduce ETS into the building from outdoor sources.

Design Team:

C. Design documentation must state explicitly that the newly constructed portions of the building were designed assuming that smoking would not occur in the those portions.
D. Design documentation shall show the designated smoking areas and non-smoking areas outside of the building.

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool (www.msbgtracking.com)
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

I.2 Specify Low-emitting Materials

Intent

Reduce indoor chemical pollution in a building by choosing low-emitting materials and furnishings during construction, operations and maintenance. Since material emissions are a major factor in determining air quality, lower emitting materials will improve the air quality in the space.

Required Performance Criteria

A. Subject to exceptions 1 and 2 below,all newly installed interior materials and finishes (including but not limited to: flooring adhesives, sealants, and concrete sealers, carpets, resilient flooring, wood flooring, paints, thermal and acoustical insulation products, gypsum board, acoustical ceilings, acoustical wall panels, cabinetry, composite wood subflooring, and furnishings) shall be certified to comply with the most current Indoor Air Quality portion of California Section 01350 standard, or are listed in one of the approved databases below.

- Exception 1 to requirement: if, in the sum of all the approved databases below, there are less than two supplying companies for a product type that are certified as compliant as of the end of the Design Development phase of the project, that product type does not need to comply.
- Exception 2 to requirement: Paints containing a minimum of 20% recycled content, which might not comply with this guideline, may be used as a primer in spaces unoccupied for 72 hours after application and covered with final topcoat(s) that meet the requirements of this guideline.
- Approved databases of materials that are recognized as substantially compliant with the most current Indoor Air Quality portion of California Section 01350 standard:
    - California High Performance Schools (CHPS) Low Emitting Materials in the CHPS Database
    - Carpet and Rug Institute (CRI) Green Label Plus Certification (for Adhesives)
    - Carpet and Rug Institute (CRI) Green Label Plus Certification (for Carpet)
    - Scientific Certification Systems (SCS) Gold Indoor Advantage Certification
    - Scientific Certification Systems (SCS) FloorScore™ Certification
    - GREENGUARD Product Emission Standard For Children & Schools™

B. All newly installed modular office furnishings shall comply with the most current version of the State of California's Modular Office Furniture Specification. .Contract Documents shall state that manufacturers must send a sign letter affirming that the product to be provided have been tested to comply with this standard within a year of delivery to the project.

Compliance Tools and Resources

For Item A above:

As of B3 Guidelines Version 2.2, the most current version of the Indoor Air Quality portion of California Section 01350 standard is in a document called: "STANDARD METHOD FOR THE TESTING AND EVALUATION OF VOLATILE ORGANIC CHEMICAL EMISSIONS FROM INDOOR SOURCES USING ENVIRONMENTAL CHAMBERS VERSION 1.1" dated February 2010
http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350/default.htm

Links for Approved Databases for item A above as of B3 Guidelines Version 2.2

- California High Performance Schools (CHPS) Low Emitting Materials (LEM) Database http://www.chps.net/dev/Drupal/node/445
- Carpet and Rug Institute (CRI) Green Label Plus Certification (for Carpets and Adhesives) http://www.carpet-rug.org/commercial-customers/green-building-and-the-environment/green-label-plus/
- Scientific Certification Systems (SCS) Gold Indoor Advantage Certification http://www.scscertified.com/manufacturing/manufacture_certclients.html
- Scientific Certification Systems (SCS) FloorScore™ Certification http://www.scsglobalservices.com/floorscore
- GREENGUARD Product Emission Standard For Children & Schools™ http://www.greenguard.org (then click on the "find products" tab)

For Item B: Above:

- "Final Environmental Specifications to be Included in the Bid Documents for Office Furniture Systems REVISED: December 18, 2000" from http://www.calrecycle.ca.gov/greenbuilding/specs/Furniture/default.htmhttp://www.ciwmb.ca.gov/GreenBuilding/Specs/Furniture/DGSSpecs.pdf

Optionally, for reference for both A and B above:

- California Department of Public Health: Indoor Air Quality Program http://www.cal-iaq.org/

Related B3 Guidelines Documents

B3 GuidelinesTracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- GreenSpec, Environmental Building News, www.buildinggreen.com. For information on low-emitting products, search database for attribute "release minimal pollutants" (subscriber service)
- The MPCA web page on Building Products and Materials http://www.pca.state.mn.us/index.php/living-green/living-green-citizen/green-building/shelter/finding-green-building-products.html The MPCA web page on Design Guidelines, Specifications and Rating Systems http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/green-building/design-guidelines-specs-and-rating-systems.html

I.3 Moisture Control

Intent
Prevent exterior water intrusion, leakage from interior water sources, or other uncontrolled accumulation of water.

Required Performance Criteria

A. Design the building envelope to resist moisture penetration. Since all buildings have potential for moisture penetration, and since Minnesota is a heating dominated climate, provide drainage planes to the exterior.
B. During the coldest portion (99.5% cold temperature design value) of the heating season keep the indoor dew point below 35ºF(2ºC).
C. Specify maximum moisture content of materials used in construction to assure that subsurface layers are dry enough to prevent moisture trapping by surface finish materials (Consult: Lstiburek and Carmody, 1993, Harriman et al., 2001)

Note: Other related and critical items for moisture control are covered under other sections:

- I.5 Thermal Comfort which includes criteria for relative humidity
- P.4 Design and Construction Commissioning, Construction Air Quality Management Plan which includes requirements for air quality pre-assessment and correction of moisture and air quality problems in existing buildings that may affect New Building Additions or Major Renovations work.
- P.5 Operations Commissioning which includes practices for detection and management of unintended accumulation or intrusion of water.

Compliance Tools and Resources

- Lstiburek, J, and J Carmody (1993) Moisture Control Handbook, New York, Van Nostrand. (Can be purchase from a general on line bookstore such as Amazon.com)
- Harriman, L. I., G. Brundrett, et al. (2001.) Humidity Control Design Guide for Commercial & Institutional Buildings. Atlanta, ASHRAE. (can be purchased at ASHRAE online Bookstore)

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0a Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- For supplemental information for Item A consider Lstiburek and Carmody, 1993; Lstiburek, 2002, Lstiburek, 2006 listed below.
- For supplemental information for Item B consider Consult: Lstiburek (2002))listed below.
- ASHRAE 62.1-2007 requirements:
    - ASHRAE 62.1-2007 - §5.9 Filtration requirements for HVAC ductwork upstream of all cooling coils and other devices with wetted surfaces
    - ASHRAE 62.1-2007 - §5.11-5.14 Condensate management and maintenance of moisture conditions in ductwork.
    - ASHRAE 62.1-2007 - §5.5 Requirements that ductwork be resistant to mold growth.
    - ASHRAE 62.1-2007 - §5.10 & 5.15 Humidity control and pressure control in spaces that are mechanically cooled
    - ASHRAE 62.1-2007 – Addendum a. §5.10 Dehumidification Systems.

- ASHRAE (2005). 62.1 User's Manual, ANSI/ ASHRAE 62.1-2007 Ventilation for Acceptable Indoor Air Quality. Atlanta, GA, ASHRAE.
- Lstiburek, J, and J Carmody (1993) Moisture Control Handbook, New York, Van Nostrand.
- Lstiburek, J. (2002.) "Moisture Control for Buildings." ASHRAE Journal 44(2): 36-41.
- Lstiburek, J. (2006) “Understanding Drainage Planes” ASHRAE Journal 48(2) 30-35
- Harriman, L. I., G. Brundrett, et al. (2001.) Humidity Control Design Guide for Commercial & Institutional Buildings. Atlanta, ASHRAE.
- California Occupational Safety and Health Standards Board, Title 8, Chapter 4, Article 9, Section 3362(g) "Uncontrolled accumulation of water" (2002.)
- Horner, W. E., P. R. Morey, et al. (2001.) "How quickly must gypsum board and ceiling tile be dried to preclude mold growth after a water accident". Moisture, Microbes, and Health Effects: Indoor Air Quality and Moisture in Buildings, San Francisco, CA, IAQ 2001.
- Kosar, D. (2006). "Dehumidification system enhancements." ASHRAE Journal 48(2): 48-58.
- Wyon, D., L. Fang, et al. (2002.) "Limiting Criteria for Human Exposure to Low Humidity Indoors". Indoor Air 2002, Monterey, CA, Vol. 4, pp. 400-405.

I.4 Ventilation Design

Intent

Promote good indoor air quality by requiring a ventilation baseline based on the general procedures and information contained in the latest approved version of ASHRAE Standard 62.1. Encourage better indoor air quality by recommending that, in addition, ventilation design intent be demonstrated on a regular basis to building owners and operators. Encourage best indoor air quality by further recommending adjusting ventilation requirements upward from the baseline based on setting target CO_2 concentration maxima.

Required Performance Criteria

A. Radon is best controlled using source prevention techniques rather than ventilation. For New Buildings Path, if construction is to occur in one of the 68 Minnesota counties considered "Zone 1" by the US EPA, guidance contained in the EPA document, "Radon Prevention in the Design and Construction of Schools and other Large Buildings", must be followed. Major Renovations located in these 68 counties whose exterior envelopes have more than 40% of their surface areas in contact with the ground must follow the same EPA guidance.

B. Ventilation Baseline: meet current ASHRAE ventilation standard 62.1 for commercial and institutional buildings (as of the writing of this guideline ASHRAE 62.1-2010 Updates are scheduled to be issued every three years thereafter.)

Recommended Performance Criteria

C. Ventilation Performance Validation: in addition to required ventilation baseline criteria above, design the ventilation system so that CO_2 concentrations can be monitored continuously in all continuously occupied spaces. Continuously occupied spaces are those intended for human occupancy excluding spaces intended for other purposes such as storage rooms or equipment rooms. Compare the expected values of CO_2 concentrations found in high-occupancy spaces* in the building with those expected from the building design using ASHRAE 62.1. This should be done at three-month intervals during the initial year of occupancy and annually thereafter.

D. Carbon Dioxide Limits on Ventilation: in addition to required and recommended criteria within this guideline above design the ventilation system so that they CO_2 concentration in continuously occupied breathing zones (defined as the volume between 3 and 72 inches above the floor and 2 feet or greater distance from walls) shall not exceed 450 ppm above outdoor concentrations. Compare the expected values of CO_2 concentrations found in high-occupancy spaces* in the building with those expected from the building design using ASHRAE 62.1 supplemented by the more rigorous CO_2 concentration limit of this guideline (I.4D). Do this at three-month intervals during the initial year of occupancy and annually thereafter.

Note: For this guideline, “high-occupancy spaces” are defined as spaces in the building with normal occupancy densities higher than the average density for the entire building.

Compliance Tools and Resources

- For Item A: US EPA, Radon zone map: www.epa.gov/iaq/radon/zonemap.html
- For Item A: US EPA, "Radon Prevention in the Design and Construction of Schools and other Large Buildings", EPA document 625-R-92-016, June 1994. www.epa.gov/iaq/radon.pubs/index.html

- For Items B, C, D: Reference Standard: ASHRAE (2007). ANSI/ASHRAE Standard 62.1-2007: Ventilation for acceptable indoor air quality. Atlanta, GA, USA, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
- For Items B, C, D: ASHRAE (2005). 62.1 User's Manual, ANSI/ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. Atlanta, GA, ASHRAE.
- For Item D: B3 Guidelines Appendix I-4 Calculating CO2 Concentrations in a Zone

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines
Appendix I-4 Calculating CO2 Concentrations in a Zone

Supplemental Resources

For I.4C and D:

There is a robust literature examining the technique of monitoring CO_2 concentrations in a space and using that information to extract information about the ventilation delivered to the space. The literature comparing design and performance of ventilation systems in commercial buildings, on the other hand, is modest. Readers should consult the 2006 paper by Persily listed below for further perspectives. This paper is based on an invited plenary presentation he made at the ***Indoor Air 05*** conference in Beijing, China in Sept 2005.

- Persily, A. (1997.) "Evaluating building IAQ and ventilation with indoor carbon dioxide." *ASHRAE Transactions* 103(2.)
- Schell, M. B., S. C. Turner, et al. (1998.) "Application of CO_2-based demand-controlled ventilation using ASHRAE Standard 62: Optimizing energy use and ventilation." *ASHRAE Transactions* 104(2): Paper TO-98-21-1.
- Persily, A. (2006). "What we think we know about ventilation." *Ventilation*: submitted for publication.

For I.4D:

The choices about CO_2 concentrations come from many sources. Primary are the studies that relate CO_2 concentrations to ventilation rates and to occupant complaints. A representative collection of references are:

- Apte, M. G., W. Fisk, et al. (2000.) "Associations between indoor CO_2 concentrations and sick building syndrome symptoms in US office buildings: An analysis of the 1994-96 BASE study." *Indoor Air 10*: 246-257.
- Engvall, K., P. Wickman, et al. (2005). "Sick building syndrome and perceived indoor environment in relation to energy saving by reduced ventilation flow during heating season: 1 year intervention study in dwellings." *Indoor Air* **15**(2): 120-126.
- Mumma, S (2004.) Transient occupancy ventilation by monitoring CO_2, *IAQ Applications,* 5(1): pgs. 21-23.
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- Wargocki, P., J. Sundell, et al. (2002.) "Ventilation and health in non-industrial indoor environments: Report from a European Multidisciplinary Scientific Consensus Meeting (EUROVEN.)" *Indoor Air-International Journal of Indoor Air Quality and Climate* 12(2): 113-28

I.5 Thermal Comfort

Intent
Provide for occupant thermal comfort through control of ambient temperature, and operative temperature which includes wet bulb, dry bulb and globe temperatures, relative humidity (RH), mean radiant temperature (MRT), and air velocity.

Required Performance Criteria

A. Maintain continuous indoor exposure to ambient temperature in continuously occupied spaces less than 80°F and greater than 64°F. For transition spaces (entries, hallways, exterior walls) temperatures may fall outside the limits for continuously occupied spaces to save energy.

B. In continuously occupied spaces where MRT asymmetry could be a problem (for example: spaces such as glass atria, rooms adjacent to boiler rooms, and areas under an exposed roof structure), maintain the wall, floor, and ceiling surface temperatures within 20 °F when taken from all continuously occupied positions OR Maintain no continuous indoor exposure to greater than 0.30 asymmetry in MRT across three body plane hemispheres (front-back, side-side, top-bottom)

C. Maintain air velocity greater than or equal to 10 fpm for continuously occupied spaces. Exception: Spaces with natural ventilation or mixed mode ventilation are exempt from I.5C during the times that they are operating in a natural or mixed mode ventilation mode.

D. Maintain interior relative humidity (RH) greater than 20% and less than 50% in continuously occupied spaces. Exception: Spaces with natural ventilation or mixed mode ventilation are exempt from I.5D during the times that they are operating in a natural or mixed mode ventilation mode.

Recommended Performance Criteria

E. Full compliance in keeping thermal variables within ASHRAE 55-2004 winter and summer comfort zones

F. Vary dry bulb temperature (DBT) via building control system so as to avoid thermal boredom. Produce ramped drifts of up to + 2.0°F/hr in peak-to-peak variation around neutral temperature. Note: Operative Temperature (OT) is also known as Wet Bulb Globe Temperature, (OT or WBGT = 0.7 Natural Wet Bulb Temperature + 0.3 Globe Temperature)

Compliance Tools and Resources

- ASHRAE 55-2010.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.
- Calculate or simulate thermal comfort using guideline performance criteria and other appropriate thermal comfort indices. Operative Temperature is determined by dry bulb temperature, relative humidity and mean radiant temperature (DBT, RH, MRT), and air velocity. Calculation can also include the effects of Clo value (the insulation value of clothing), physical activity and time. See especially ASHRAE Standard 55-2010 and the Human Factors Design Handbook for explanation of conditions and measures to provide for thermal comfort. See other references, particularly Engineering Data Compendium and NASA MSIS for handling special condition problems. See Handbook of Environmental Psychology for discussion of thermal issues for particular settings (e.g. offices, industrial environments) and for perceived control of thermal variables.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Salvendy, Gavriel (Ed.) (1987) Handbook of Human Factors. John Wiley & Sons, NY.
- Stokols, Daniel, & Alt man, Irwin (Eds.) (1991) Handbook of Environmental Psychology. Krieger Publishing Co. NY.

I.6 Quality Lighting

Intent

Electric lighting should be designed to supplement and support the use of daylight as the primary source of light for visual tasks. This is vitally important to achieving environmental, health and economic goals. The integrated design of artificial and natural light must also maintain these lighting quality characteristics and effects: tolerable glare, natural color rendering, and attractive illumination of people for social exchanges. Quality lighting enhances and contributes to creating the perception of a 'bright and cheery' workplace through volumetric brightness by illuminating upper wall areas and ceiling planes.

Required Performance Criteria

A. Newly installed electric lighting must be operable in multiple modes responsive to both daylight zones and differentiated uses within a given space such as separating controls for media projection areas from general task areas within a space.

Recommended Performance Criteria

B. For general illumination in most space types, attain an average electrical illumination at the work plane of 35 to 50 foot-candles. A minimum of 25 foot-candles is recommended at any point 3 ft or more from a wall.

C. Consult the current version of the IESNA handbook for other recommended light levels. You may design closer to the minimum recommended values to reduce the connected load and conserve energy, but in this case note that the contrast ratios in item D below become even more important to maintain, and the overall volumetric rendering should be bright.

D. Keep contrast ratios in the field of view within the space as seen from the task areas to no greater than 10:1

E. Achieve a Color Rendering Index (CRI) for each space type based on recommendations in the current version of the IESNA handbook.

Methods:

F. At a minimum, conduct a point-by-point analysis of horizontal illumination levels at the work plane in each lighting mode for each space.

G. Preferably, use a computer program to determine the performance characteristics of the electric lighting system in each primary space type. Computer models should be used to analyze illumination levels on vertical planes when they have been defined as a task or work area.

Compliance Tools and Resources

- Rea, M. S., ed. IESNA Lighting Handbook, Ninth Edition. New York: Illuminating Engineering Society of North America, 2000.
- Lighting design tables, luminaire specification sheets.
- Lighting design software including Lumen Micro 2000, Lumen Designer, AGI32, Radiance, Desktop Radiance, LightPro and Luxicon

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

I.7 Effective Acoustics

Intent

Provide interior conditions that avoid harmful noise effects and produce a basis for a positive soundscape acceptable to occupants and appropriate to their tasks. The benefits are avoiding exposure to: unhealthy noise levels, the elevated stress which accompanies higher background noise levels and noise distraction impacts on mental work. Effective acoustics enable effective speech communications at normal speaking voice while providing for local speech privacy.

Required Performance Criteria

Prevent Harmful Acoustic Conditions

A. Recurrent background noise from external and internal sources shall not exceed 70 dBA.

B. All continuously occupied office space shall meet a NC (Noise Curve) of no greater than NC-50. (See recommended levels below.)

C. All classroom space shall meet an NC of no greater than NC-45.(See recommended levels below.)

D. Reverberation time for all continuously occupied space shall be no less than 0.2 sec and no greater than 0.8 sec. Reverberation time shall be based on the 500 Hz octave band, and shall be appropriate to the uses of the space. (See recommended levels below.) Note that this requirement would not apply to concert halls or other music performance auditoria.

Recommended Performance Criteria

E. Articulation Index shall be less than 0.20 for open offices, where a low level of speech intelligibility is required (speech privacy is desired), and greater than 0.70 for enclosed offices where a high level of speech intelligibility is required.

Promote Positive Acoustics Appropriate to Tasks:

F. Reduce NC criterion to NC 45 or lower for continuously occupied spaces.

G. NC shall be no greater than NC 40 for intermittently occupied meeting spaces like conference rooms and classrooms. (Note that this is less stringent than the ANSI S12.60 standard for classrooms.)

H. Provide Reverberation Times optimal for space use based on professional acoustic judgment. General Guidelines are as follows:
   - Open Office: 0.2-0.5 seconds
   - Enclosed offices: 0.2-0.4 seconds
   - Classrooms 0.2-0.7 seconds
   - For other space types, such as gymnasiums and auditoriums, use acoustic professional judgment and advice.

Compliance Tools and Resources

- Professional acoustical advice and consulting
- Acoustics modeling and analysis software programs.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- There are several US University programs focused on architectural acoustics and many sources of room acoustics modeling software that are commercially available. There are also free acoustics modeling and analysis software programs available from some universities and companies. These programs provide calculated estimates of quantities like reverberation time and sound pressure levels given certain parameters that account for room size, shape, surface absorption and activity types.
- Very informative introductions to room acoustics modeling are given by Lokki & Jarvelainen, (2001) and Rindel, (2000.) A very helpful, illustrated, online PowerPoint presentation that includes room acoustics modeling is given by Lokki & Savioja (2002.) The University of California at Berkeley, The Rensselaer Technical Institute, and McGill University all have extensive online resources available on architectural acoustics.

Helpful Internet resources include:

- The Engineering Toolbox http://www.engineeringtoolbox.com/room-accoustics-d_521.html references a calculator for architectural acoustics calculations.
- IRCAM (a French research project with many useful publications and free software) http://www.ircam.fr/recherche.html?&L=1
- ODEON (distributes room acoustics modeling software) www.odeon.dk
- SARA (a Spatial Audio & Room Acoustics Project from the Academy of Finland) www.acoustics.hut.fi/~vpv/projects/sara.htm

Other Supplemental Resources

- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- Harris, C. M. (1979) Handbook of Noise Control. McGraw-Hill, New York.
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- Lokki, T. & Jarvelainen Hanna, (2001) Proceedings of the 2001 International Conference on Auditory Display, July 29-August 1, 2001. Pgs. 26-31 Espoo, Finland. (Available online.)
- Lokki, T. & Savioja, L. (2002) VR Research at HUT and Real-Time Auralization. Future Workplaces, Stuttgart, 10-11 October 2002. (Available online.)
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Rindel, J.H. (2000) The use of computer modeling in room acoustics. Journal of Vibroengineering. No. 3(4) Index 41-72. (Available online)
- Salvendy, Gavriel (Ed.) (1987) Handbook of Human Factors. John Wiley & Sons, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Wise, James. The Human Nature of Noise and Vibration. Eco-Integrations, Inc.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

I.8 Reduce Vibration in Buildings

Intent

Provide interior conditions that avoid harmful vibration effects produced by wind sway, transmitted outdoor sources, indoor machinery (especially HVAC) and foot traffic. This will avoid prolonged exposure to unhealthy vibration levels, and enable prolonged comfortable work at a workstation. It will also diminish anxiety and stress due to wind sway on upper floors as well as maintain the value of the building.

Required Performance Criteria

A. For steel structures, control vibrations in accordance with AISC Design Guide 11

B. For Steel Joists, control vibrations in accordance with SJI Technical Digest #5: Vibration of Steel Joist-Concrete Slab Floors

C. For Wood or Concrete Construction, control deflection as follows:
Live Load Deflection: L/480
Total Deflection: L/360

Recommended Performance Criteria

D. To better control vibration, do not construct floors using bar joists

The following recommendations for improved vibration control come from Human Factors Research on the effects of vibration on health and well-being of occupants:

E. Return period of greater than 0.5% g horizontal acceleration in top third of a high rise (7 stories or greater) building shall not be less than 6 years.

F. Floor vibration shall be kept above Splittgerber Minimum Complaint Level (approximately 0.001 A rms,g across 4-8 hz resonant with human body components) or 8 hr reduced comfort level (approximately 0.15m/sec2 across 4-8 hz resonant with human body components) for all continuously occupied spaces, restrooms and meeting rooms.

G. Go beyond Item F to extend floor vibration criterion to all intermittently occupied spaces except storage areas.

Compliance Tools and Resources

- For Item A: The American Institute of Steel Construction Inc. (AISC) AISC Design Guide 11 can be purchased from AISC Bookstore at http://www.aisc.org/store/
- For Item B: Steel Joist Institute (SJI) SJI Technical Digest #5: Vibration of Steel Joist-Concrete Slab Floors can be purchased from SJI at http://www.steeljoist.org/publications/
- For Items E through G: Vibration control practices. Lookup tables. Calculation. See NASA MSIS, Chapter 10 of the Engineering Data Compendium, the Human Factors Design Handbook, and the ISO 2631 (Guide for the Evaluation of Human Exposure to Whole-Body Vibration), all referenced below.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- International Organization for Standardization (ISO) (1982.) Guide for the Evaluation of Human Exposure to Whole-Body Vibration. (ISO 2631-1978/AI 1982) Geneva: ISO.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Salvendy, Gavriel (Ed.) (1987) Handbook of Human Factors. John Wiley & Sons, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

I.9 Daylight

Intent

Provide daylight for ambient illumination at levels and conditions known to produce physiological and psychological benefits. Daylight contributes to a perception of a 'bright and cheery' workplace through provision of volumetric brightness (also called "room-surface brightness".) The important qualities of daylight are its inherent variation, power spectrum (color), and the predominantly horizontal component of its illumination vector (direction of illumination.) Some studies have also shown a correlation between daylighting and improved productivity and test scores.

Required Performance Criteria

A. In New Buildings, at least 75% of the floor area of continuously occupied spaces in the building shall have a minimum daylight factor of 1% when measured without furniture and at 2'6" above the floor. This may be demonstrated using the Daylight Factor Calculator provided in the guidelines, through daylight simulation, or physical daylight modeling. (This is recommended for Major Renovations where applicable.)

B. In New Buildings, in every continuously occupied space with daylight, not more than 15% of the floor area shall exceed a uniformity ratio of 10:1 when measured without furniture and at 2'6" above the floor. (This is recommended for Major Renovations where applicable.)

C. To be considered a good daylighting design, direct solar penetration must be controlled with fixed or operable shading devices and kept from falling on the work plane beyond 4 ft from the exterior walls during most operating hours.

For new lighting scope, automatic controls should be employed to turn off or dim the electric lights when daylighting is available. Note: For spaces with daylight the Window to Floor Area Ratio (WFAR) should not need to exceed 25% in order to meet daylighting criteria listed here. Note that exceeding this WFAR may introduce excess energy use and possibly glare.

Compliance Tools and Resources

- Daylighting Factor Calculator See Appendix I-9.
- For more advanced and refined analysis, using physical models is one very effective way to analyze daylighting performance of a building. Even the simplest foam core models will inform the design team about how the behavior of daylight changes as building parameters are varied. Daylight apertures and reflectance values of material surfaces must be accurately modeled for valid results. Such daylighting models can then be tested on site or under artificial sky conditions in a daylighting laboratory to determine daylight factors. Sundials attached to the model base allow such models to be tested so as to simulate annual variation of direct sunlight.
- In addition, also for more advanced and refined analysis, computer analysis and simulation may be used to generate a daylighting solution. Some widely available programs are noted below. Usually, three-dimensional digital models are constructed using (CAD) computer-aided design software that is then imported into the lighting software. Such programs usually require the user to define location, sky conditions, and date and time and interior surface characteristics. Some programs produce lifelike renderings of the design but do not provide accurate quantitative results.

Related B3 Guidelines Documents

B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines
Appendix I-9 Daylighting Factor Calculator

Supplemental Resources

The US Department of Energy and its associated national laboratories and their outreach programs are rich sources of information and simulation and analysis programs for daylighting. Among these are

- ADELINE (Advanced Daylighting and Electric Lighting Integrated New Environment) at http://radsite.lbl.gov/adeline/intro.html, which "provides architects and engineers with accurate information about the behavior and the performance of indoor lighting systems. Both natural and electrical lighting problems can be solved, in simple rooms or the most complex spaces."
- Radiance. radsite.lbl.gov/radiance/, The primary advantage of Radiance over simpler lighting calculation and rendering tools is that there are no limitations on the geometry or the materials that may be simulated. Radiance is used by architects and engineers to predict illumination, visual quality and appearance of innovative design spaces, and by researchers to evaluate new lighting and daylighting technologies..
- DOE Buildings Program: Daylighting http://www.eere.energy.gov/basics/buildings/lighting_daylighting.html for everything you ever wanted to know about daylighting, and more.
- Efficient Windows Collaborative www.efficientwindows.org contains references, resources and simulation tools for window design and selection for daylighting.
- Windows for High Performance Commercial Buildings www.commercialwindows.org contains references, resources and simulation tools for window design and selection for daylighting.
- An entire course in daylighting is provided by the online available Vital Signs Curriculum Materials Project by Marc Schiller and Schweta A. Japee (both at the University of Southern California School of Architecture): "Interior Illuminance, Daylight Controls, and Occupant Response." It is "a complete range of exercises covering everything from an understanding of how your eye works to how to do image processing on a digitized video scan."

Other Supplemental Resources:

- Baker, Nick, & Steemers, Koen (2002) Daylight Design of Buildings: A Handbook for Architects and Engineers. James & James, Publishers.
- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Rea, Mark S. (Ed.) (1999) The IESNA Lighting Handbook: Reference & Application. Illuminating Engineering Society of North America, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.

I.10 View Space and Window Access

Intent
Provide interior view space or views to the exterior. The benefits of providing this visual access are the ability for focal rest to avoid eyestrain, and access to visual information about changing outside conditions. A view amenity also aids varying attention cycles and relieves the stress of mental work.

Recommended Performance Criteria
See "Appendix I-10 View Space Diagrams and Tables for I.10" for further illustrations of these criteria.

A. From every continuously occupied position in spaces there shall be visual access to an external window view that is at least 10 degrees in horizontal and vertical visual angle at no greater than the 50th percentile standing average eye height of 64 inches.

B. From every assigned and continuously occupied workstation position at seated eye height of 48 inches there shall be visual access to a view space that is at least 20 feet away. The view space shall be at least a continuous 20 degrees horizontal angle beginning at not more than 10 degrees from the centerline of sight. The view space shall also be at lease a continuous 15 degrees vertical view angle beginning at not more than 10 degrees from the horizontal centerline of sight and shall also be above that horizontal centerline. As an alternate to the 20 degree horizontal by 15 degree vertical dimensions of the line of sight, the table "View Space Aperture Approximately Corresponding to a 20 degree Horizontal by 15 degree Vertical View Angle" found in Appendix I-4 may be used.

C. Higher performance is achievable if views are provided to horizon lines, clouds, tree lines and clusters and natural waterscapes.

Compliance Tools and Resources

- Appendix I-10 View Space Diagrams and Tables for I.10
- Calculation from drawings or simulation via analytic software.

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines
Appendix I-10 View Space Diagrams and Tables for I.10

Supplemental Resources

- Software broadly incorporating view space calculations is embedded in the "Spatialist" program from the School of Architecture, Georgia Institute of Technology, Atlanta, GA.
- Baker, Nick, & Steemers, Koen (2002) Daylight Design of Buildings: A Handbook for Architects and Engineers. James & James, Publishers.
- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.

- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Rea, Mark S. (Ed.) (1999) The Iesna Lighting Handbook: Reference & Application. Illuminating Engineering Society of North America, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

I.11 Personal Control of IEQ Conditions and Impacts

Intent
Provide for local occupant control of interior conditions to better support work performance. Personal control will enable immediate improvement of intermittent discomfort and will help indicate personal availability or current work status. It will also allow workers to increase personal comfort in changing organizational contexts. However, occupants shall not be put in recurrent uncomfortable conditions, so that continuous adaptation is necessary to maintain comfort.

Recommended Performance Criteria

A. Provide adjustable task lighting to include 'on', 'off', and intermediate levels.

B. Provide means of alleviating direct solar gain at all continuously occupied and assigned positions.

C. Provide means of mitigating intermittent noise, drafts or low air circulation at all continuously occupied and assigned positions.

D. Provide means of alleviating building control system malfunctions at all continuously occupied and assigned positions.

E. Provide access to operable windows at all continuously occupied and assigned positions.

F. Neck extension for continuously viewing monitors at workstation shall not be greater than 0 degrees vertical. Head rotation for continuous viewing shall not be greater than 10 degrees horizontal.

G. At keyboard rest, there shall be no continuous deviation from an approximate 0 degree angle in elevation from elbows at sides at rest through wrists to fingertips on keyboard.

Higher performance is achievable with the following personal control criteria:

H. Increase flexibility of workspace through adoption of standards for ergonomically adjustable and movable furniture elements. (BIFMA Office Furniture Standard, European CEN Workplace Standard, NASA Man-System Integration Standards.)

I. Use tools to perform Spatial Syntax and other (e.g. Isovist) analyses that can be used to improve flexibility and habitability of workspace.

Compliance Tools and Resources

- BIFMA (Business and Institutional Furniture Manufacturers Association) (2002 version, updated version may become available) Ergonomics Guideline for VDT Furniture Used in Office Workspaces. BIFMA G1, Grand Rapids, MI.

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool at www.msbgtracking.com

Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- Human Factors Society (1988) American national standard for human factors engineering of visual display terminal workstations. (ANSI/HFS 100-1988.) Santa Monica, CA. Human Factors and Ergnomics Society.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Salvendy, Gavriel (Ed.) (1987) Handbook of Human Factors. John Wiley & Sons, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

I.12 Encourage Healthful Physical Activity

Intent
Provide spatial conditions conducive to incidental physical activity. Movement (like walking) between workplace destinations helps maintain cardiovascular fitness, mental alertness, and encourages synergistic staff interactions that improve morale and well-being.

Recommended Performance Criteria

A. Provide an 'open' or 'enhanced' stair design that is visible and/or easy to locate connecting the main (entry level) floor with at least the next two floors above it and the first floor beneath it. This encourages and enables building occupants to safely and conveniently use the stairs to travel between floors in their daily building circulation.

B. Encourage staff to walk to routinely used building service centers and interior destinations through design of circulation path and its amenities. Features that encourage physical activity include:
   - Separation of restrooms and service centers (like mailrooms and refreshment dispensers and break rooms) from work areas
   - Enhanced daylight and views along a circulation path
   - Different routes to popular interior destinations
   - Interior circulation paths that allow round trips without reversal of direction.

C. Interior circulation paths with adjoining meeting niches and nooks that encourage spontaneous staff interaction along the path lengths.

D. Amenities that encourage casual and continuous use of stairs include: position of stairs in floor plan, openness of stairway to surrounding interior views, provision of rest and incidental meeting nooks along stairway length, reversal or curving of stairway to facilitate expanded user view of stair traffic, proper stairway riser/tread ratios, surfacing, and grab handle meeting HFES (not minimum building code) design recommendations.

Related B3 Guidelines Documents
B3 Guidelines Tracking Tool at www.msbgtracking.com
Appendix I-0 Suggested Implementation for all Indoor Environmental Quality Guidelines

Supplemental Resources

- Bechtel, Robert B. & Churchman, Azra, (Eds.) (2002) Handbook of Environmental Psychology. John Wiley & Sons, NY.
- Boff, K. & Lincoln, J. (Eds.) (1988) Engineering Data Compendium: Human Perception and Performance. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright Patterson AFB, Ohio.
- Pauls, J. L. (1982) "Recommendations for Improving the safety of Stairs", Building Practice Note No. 35, June, Division of Building Research, National Research Council Canada, Ottawa.
- Pauls, J. "What Can We Do to Improve Stair Safety?" (1984) Building Standards, May-June, pp 9-12, 42-43; July-August, pp 13-16, p. 42.
- (1984) Southern Building, April-May, pp. 14-20; June-July 1984, pp. 22-28; (1984) The Building Official and Code Administrator. May-June, pp.30-36; July-August, pp. 10-15.

- Pauls, J. (1991) "Cost of Injuries in the United States and the Role of Building Safety." The Building Official and Code Administrator, Jan/Feb, pp. 19, 31-35;
- _____ (1991) Building Standards, July/Aug, pp. 18-22, 24;
- _____(1991) Southern Building, July/Aug, pp. 6, 8-10, 12, 51; etc
- Pauls, Jake. (1992) "What Should Inspectors Look for Regarding Safe Stair Construction?." Building Official and Code Administrator, July/August, pp. 32-39.
- NASA (1995) Man-System Integration Standards. Johnson Space Center, Houston, TX. msis.jsc.nasa.gov
- Salvendy, Gavriel (Ed.) (1987) Handbook of Human Factors. John Wiley & Sons, NY.
- Watson, Donald. Crosbie, Michael. Crosbie, Michael J. & Callender, Michael H. (1997.) Time-Saver Standards for Architectural Design Data. McGraw-Hill, NY.
- Woodson, W. E, Tillman, P. & Tillman, B. (1992) Human Factors Design Handbook, 2nd Edition. McGraw-Hill, NY.

MATERIALS AND WASTE GUIDELINES

B3 Guidelines Compliance Path Table for Materials and Waste Guidelines

No.	GUIDELINE	NEW BUILDINGS	MAJOR RENOVATIONS
	MATERIALS AND WASTE		
M.1	Life Cycle Assessment of Materials	Required	Required if Exterior Envelope is in Scope
M.2	Environmentally Preferable Materials	Required	Required
M.3	Waste Reduction and Management	Required	Required

Related Forms
B3-Guidelines Tracking Tool at www.msbgtracking.com

Appendices
Appendix M-0: Suggested Implementation for All Material and Waste Guidelines
Appendix M-3a: Example Specification for Construction Waste Management
Appendix M-3b: Construction Waste Recycling Economics Worksheet
Appendix M-3c: Packaging Waste Recycling Economics Worksheet

Overview
Selection and use of materials and resources for more sustainable building has been an evolving process since the first recycled content products hit the market in the early 1970s. Costs related to increased waste from construction, depletion of non-renewable resources, and air and water pollution from production and distribution are becoming increasing drains on the State's economy. Because the building industry consumes over three billion tons of raw materials annually—around 40 percent of the total material flow in the global economy—the need to reduce the effects of building material extraction, processing, delivery, use, and disposal has become imperative to improving the health of the economy and the environment. To this end, guidelines and rating systems have sought to guide practitioners toward choices that reduce waste and the negative environmental impacts associated with materials through prescriptive requirements for salvaged materials, recycled content, locally produced or assembled products, and renewable materials. The State of Minnesota Sustainable Building Guidelines (B3 Guidelines) are moving away from prescriptive requirements toward material selection based on Life Cycle Assessment (LCA) which will provide a better connection to real effects and costs. However, until there is more complete data available, the B3 Guidelines will also utilize some prescriptive strategies to effect change. This section focuses on the selection of building assemblies and materials as well as reduction of waste. Guideline P.2 Planning for Conservation addresses designing for reduced construction through shared use of spaces, building reuse, and design for flexibility and adaptability.

Goal
To produce projects with the lowest reasonable life cycle environmental impact at the lowest first cost based on material resource use and waste management.

Objectives
- Set a modest benchmark for building assemblies to optimize their total life cycle performance based on the *Athena Eco-Calculator.*

- Include some material alternatives to improve their total life cycle performance based on material properties such as: recycled, salvaged, renewable, bio-based, and durability-appropriate to service life. Additionally recommend consideration of locally/regionally produced, and ability to be reused, recycled, or biodegraded at the end of their life in the project.
- Reduce, recycle and manage wastes generated during the construction process and occupancy.

M.1 Life Cycle Assessment of Materials

Intent

To set a modest benchmark of performance and inform early building assembly material choices using life cycle assessment of alternatives. Building assembly choices significantly affect global warming, air pollution, water pollution, energy use, and waste.

Required Performance Criteria

A. Meet LCA Benchmark for Total Assemblies GWP (Global Warming Potential)
During schematic design, use the B3 Guidelines Tracking Tool to determine a custom benchmark for total assemblies global warming potential. Perform a material lifecycle analysis of project building assemblies using Athena EcoCalculator (a free download, see tracking tool) to arrive at a compliant selection of assembly materials that meets the custom benchmark determined in the tracking tool. Enter the compliant design solution and upload the EcoCalculator file to B3 Guidelines Tracking Tool. *Note that while the custom benchmark is derived from benchmark values for each assembly type, that compliance depends on the total of all assemblies, meaning that a better performing assembly in one area can make up for a worse performing assembly in another area*. Assemblies to be documented are foundations & footings, columns & beams, intermediate floors, exterior walls, windows, interior walls, and roof. Compliance is based on Global Warming Potential, but other important factors to consider in the output are: Energy Consumption, Material Resource Use, Acidification Potential, Human Health Respiratory Effect Potential, Aquatic Eutrophicatoin Potential, Ozone Depletion Potential, and Smog Potential. The analysis is calculated over a 60-year life cycle. Teams may alternately run the *Athena Environmental Impact Estimator* to model a design solution for a more customized approach.

Recommended Performance Criteria

B. Conduct LCA on Additional Materials
Use BEES or other tools to perform similar types of analysis for interior finish materials. This type of assessment usually occurs in the DD or CD phase.

Compliance Tools and Resources

For Item A above:

- *The Athena EcoCalculator for Assemblies for Minneapolis*—Free Download from the Athena Institute www.athenasmi.ca
- Alternately: *The Environmental Impact Estimator* — software from the Athena Institute www.athenasmi.ca

For Item B above:

- BEES (**B**uilding for **E**nvironmental and **E**conomic **S**ustainability) software http://www.nist.gov/el/economics/BEESSoftware.cfm

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix M-0: Suggested Implementation for All Material and Waste Guidelines

M.2 Environmentally Preferable Materials

Intent
To require and encourage the use of materials and products that have specific properties intended to improve life cycle performance.

Required Performance Criteria

A. Use recycled, salvaged or reused materials

Use a combination of recycled and salvaged or reused materials such that either:

- At least 5% of the total (by weight or value) of materials used in the project are reused or salvaged.

or

- At least 10% of the total (weight or value) of the materials used in the project are recycled content. Pro-rate cost or weight by each material's recycled content amount. Materials that contain a minimum weighted average of 20% post-consumer recycled content material, OR, a minimum weighted average of 50% pre-consumer (post-industrial) recycled content material are eligible.
    - Only half the cost or weight of pre-consumer (post-industrial) recycled content may be counted (i.e. - multiply pro-rated values for pre-consumer recycled weight or volume by 0.5 when calculating their contribution to the completion of this guideline).

It is possible to achieve compliance by partial completion of the above requirements if the following condtion is met:

$$100\%\left(\frac{\%\ salvaged\ or\ reuse\ material}{5\%}+\frac{\%\ recycled\ content\ material}{10\%}\right)\geq 100\%$$

B. Use renewable, bio-based materials

Use renewable, bio-based raw materials for 5% of the total (weight or value) of all products used in the project. Qualifying materials must be either: (a) residues from the processing of renewable, bio-based materials; OR (b) grown or harvested under a recognized sustainable management system. Programs that do not require third-party certification may be included. At a minimum, the management system must be subject to audit by the authority responsible for the system.

- For solid wood products, OSB, plywood and other engineered wood products, materials certified under one of the following systems can be fully counted by weight or value.
    - Forest Stewardship Council
    - Sustainable Forestry Initiative
    - Canadian Standards Association Sustainable Forestry Management
    - Property and Environment Research Center
- For bio-based content materials other than those listed above such as particleboard, cementitious panels or other material not rated by the above organizations, pro-rate the percentage contributing to satisfaction of this guideline by the recycled content listed by the manufacturer. Particleboard without manufacturer provided wood content percentages may be considered 75% bio-based content.

C. Use materials with appropriate durability
Use materials with appropriate durability for service life. In many cases, State buildings are intended to have a 50-100 year service life for the structure and envelope.

Recommended Performance Criteria

D. Use local materials
Use materials manufactured regionally within a radius of 250 miles of project site to specified qualifications, or are manufactured within the State of Minnesota and contain products from state-sponsored, approved, or acknowledged recycling programs.

E. Use reusable, recyclable, or biodegradable materials
Use materials that are reusable, recyclable, or biodegradable at the end of their use in the project. Composite materials or products should consider how their component parts can be separated for intended end of life reuse, recycling, or biodegradability.

Related B3 Guidelines Documents

- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix M-0: Suggested Implementation for All Material and Waste Guidelines

Supplemental Resources

- The MPCA web page on Building Products and Materials is an excellent resource for information on recycled-content products, including the OEA Recycled Products Directory, other directories, and informative fact sheets (including the Environmentally Preferable Purchasing Guide.) The page also provides links to standards and product lists from ASTM, EPA (Comprehensive Procurement Guidelines), Forest Stewardship Council for certified wood, Green Seal, and Scientific Certification Systems. Links to ATHENA, BEES 3.0, BuildingGreen (EBN), the OIKOS directory and more. http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/green-building/index.html

M.3 Waste Reduction and Management

Intent
Minimize use of resources and negative environmental impacts through careful reduction and management of wastes generated during the construction process and building occupancy.

Required Performance Criteria

A. Minimize construction waste through detailing and specifications
Minimize waste generated from construction, renovation and demolition of buildings through detailing and specifications.

B. Divert 75% construction and demolition waste from landfill
Divert at least 75% (by weight) construction, demolition, and land clearing debris from landfill disposal.

C. Design and Operate to reduce and recycle waste generated during building operation
Design to reduce operational waste and recycle at least 50% (by weight) of the waste generated during building operation. Provide dedicated recycling areas, processing and holding space, and reverse distribution space in the building.

Recommended Performance Criteria

D. Divert an additional 15% (90% total) construction waste
Reuse, recycle and/or salvage an additional 15% (90% total by weight) of the construction, demolition, and land clearing waste.

E. Reuse or return 50% of all packaging material
Reuse or return 50% of all packaging material (by weight) to suppliers or manufacturers. Reduce and recycle packaging waste associated with the construction process, and encourage manufacturers to ship their product using reusable, recyclable, returnable, or recycled content packaging.

Compliance Tools and Resources
For Item A, B and D above:
- Appendix M-3b Construction Waste Recycling Economics

For Item C and E above:
- Appendix M-3c Packaging Waste Recycling Economics

Related B3 Guidelines Documents
- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix M-0: Suggested Implementation for All Material and Waste Guidelines
- Appendix M-3a: Example Specification for Construction Waste Management
- Appendix M-3b Construction Waste Recycling Economics
- Appendix M-3c Packaging Waste Recycling Economics

Supplemental Resources
- The MPCA web page on C&D Waste is an excellent resource for information on reduction and management of construction and hazardous waste. Includes OEA's Recycling Markets Directory and

- MN Materials Exchange. Provides links to MPCA's hazardous waste rules and fact sheets for each special waste. Links to EPA's C&D Debris web site. http://mnexchange.org/

The MPCA web page on Efficient Transport Packaging Options is an excellent resource for reducing packaging waste. Includes a searchable directory on Reuseable Transport Packaging. http://www.pca.state.mn.us/index.php?option=com_k2&view=item&id=2110

- The Resourceful Waste Management Guide (RWM Guide) is produced by the Solid Waste Management Coordinating Board (SWMCB.) The SWMCB is a joint powers board of six metropolitan counties for the purpose of planning and coordinating solid waste management activities. The RWM Guide provides a list of Twin Cities material outlets which building owners, contractors, or design professionals can contact to recycle demolition waste and donate equipment, materials, and other items generated from a building demolition. The following sections of the RWM Guide relate to building demolition: Donation Opportunities; Appliances; Building Materials Reuse, Computers, Electronics, and Office Machines; Concrete and Bituminous Asphalt; Fluorescent Lamps, Landscaping and Tree Waste; Office Furniture and Equipment; Railroad Ties; Scrap Metal; Textiles; and Wood Waste. http://www.rethinkrecycling.com/businesses/recycling-disposal-info

Appendix P-0a: Suggested Implementation for All Performance Management Guidelines

This document is intended to offer some guidance on the issues to consider throughout the planning, design, construction and operation processes to help achieve and improve on the performance for each guideline. This document is intended as a guide and is not usable as a checklist to insure compliance. See the guidelines sections themselves to identify specific requirements and any time sensitive deadlines for those requirements.

Guideline P.0 Guideline Management

The Guideline Management Process is outlined in Appendix P-0b. Features of this process include:

- Project Work to meet the Guidelines: The Work Team is responsible for compliance shifts to correspond with the organization responsible for project work in a particular phase. For Example: during design phases, the design team (and their consultants) comprise the Work Team. During Ongoing Occupancy, the Work Team designation shifts to the facility operations group who are responsible for maintaining and operating the facility.
- Guideline reporting: compliance documentation is submitted for review at the end of each phase per the Compliance Review Process and only by using the B3 Guidelines Tracking Tool (www.msbgtracking.com).
- The Appropriated Agency Reviews the submittals in each phase that state the level of compliance and approves or rejects them. CSBR accesses these submittals for use in the B3 Guidelines Tracking Process.
- This document is not intended to outline the requirements of the Minnesota Sustainable Building 2030 Energy Standard Requirements (SB2030). SB2030 is the energy performance standard used by B3 Guidelines. Please see documentation available at www.mn2030.umn.edu on the phase-by-phase required submissions for verification of compliance with SB2030. Note that as SB2030 is separately legislated, it does not use the same variance process as the other guidelines in B3 Guidelines.

Agency Planning

- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process (See Appendix P-0b for more details).
- Create a project file in the B3 Guidelines tracking tool at www.msbgtracking.com.
- Educate the planning team so that Agency agrees to importance of:
    - A performance oriented planning, design and construction process.
    - An on-going evaluation of performance, implementation of preventive maintenance, and logging of occupant complaints and resolutions.
    - Evaluation and reporting tasks required by the Work Team
- Include the Guideline Management Process in budget plans. This includes long range implications for active management of performance during the Ongoing Occupancy phase.
- Education and Recognition: (Recommended) Plan ahead for ways to educate the public and the design and construction industry about the techniques and performance levels the facility will achieve. See Resources for samples of award recognition programs.[1] Variance

[1] Some recognition programs such as LEED™ take advance planning and specific steps throughout the design process, and so are best planned for early.

Review: Analyze guidelines to determine if any variances are appropriate, and apply for variances before the end of schematic design.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Predesign-Programming
- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall manage guideline tasks to perform in this phase and manage Work Team compliance with Guidelines and required Tracking Tool documentation.
- Variance Review: Analyze guidelines to determine if any variances are appropriate, and apply for variances before the end of schematic design.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Predesign-Site Selection
- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall manage guideline tasks to perform in this phase and manage Work Team compliance with Guidelines and required Tracking Tool documentation.
- Variance Review: Analyze guidelines to determine if any variances are appropriate, and apply for variances before the end of schematic design.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Schematic Design
- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall highlight guideline tasks to be performed in this phase, document details of performance goals and criteria as they develop and manage Work Team compliance with Guidelines and required Tracking Tool documentation.
- Variance Review: Analyze guidelines to determine if any variances are appropriate, and apply for variances before the end of schematic design.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Design Development
- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall highlight guideline tasks to be performed in this phase, document details of performance goals and criteria as they develop and manage Work Team compliance with Guidelines and required Tracking Tool documentation.
- Performance Check: Guideline Leader shall review design as documented to check that it supports the physical outcomes and operational performance desired.
- Variance Review: Analyze guidelines to determine if any variances are appropriate, and apply for variances before the end of schematic design.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Construction Documents

- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall highlight guideline tasks to be performed in this phase, document details of performance goals and criteria as they develop and manage Work Team compliance with Guidelines and required Tracking Tool documentation.
- Performance Check: Guideline Leader shall review design as documented to check that it supports the physical outcomes and operational performance desired.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Construction Administration

- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases.
- Guideline Leader shall identify guideline tasks to be performed by the design team in this phase. This may be the same Guideline Leader as previous phases.
- Performance Verification: Guideline Leader (with Design Team) shall verify performance that is not covered under the Commissioning Section. This includes reviewing submittal information to verify its compliance with performance criteria as incorporated in the construction documents.
- Construction Guideline Leader (with Construction Team) shall identify and document guideline Construction tasks (as represented in construction documents.)
- Contractor shall comply with guidelines to the extent these are incorporated in the construction documents.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Correction Period

- Identify the Guideline Leader appropriate to the phase to fulfill the role leading the Guideline Management Process. This may be the same Guideline Leader as previous phases, though some project teams may wish this role to shift to facilities management staff.
- Education and Recognition: Explore ways to educate the public and the design and construction industry about the performance levels achieved. See Resources section for samples of award recognition programs.
- Submit required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Ongoing Occupancy

- Identify the Guideline Leader for the ongoing occupancy phase. The Guideline Leader role during operations may be filled by the Facility Operations Manager, and is often not the Guideline Leader assigned to previous phases. Guideline Leader shall complete annual Compliance Summary and Outcome Documentation Forms (and optionally Guideline Report), demonstrating guideline compliance, and provide an executive summary of significant facility changes, actions taken to change performance level and measured or estimated results demonstrating performance level.
- Submit the required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com).
- Guideline Leader shall give written feedback to inform the guideline development process.

Next Use

- Guideline Leader (with Design Team) and Facility Operations Manager shall advise in facility planning process and review, and aid in transfer of planning, design, construction, and operations performance history as documented in the Project Archive.

Guideline P.1 General Project Data

All Phases

- Select a Work Team member to lead this guideline.
- Enter required and up-to-date building information into the B3 Guidelines tracking tool at www.msbgtracking.com

Guideline P.2 Planning for Conservation

Agency Planning

- Select a person from the agency to lead this guideline.
- Determine the required floor area based on typical industry data and first understanding of facility needs and operating parameters.
- Project organizational needs into the future. Create a document that states space, technology, and systems needs for the next 5-10 years at the beginning of a new project's inception.
- Evaluate the existing building's space utilization, opportunities, and limitations. Agency planning shall consider whether or not their needs can be met without building anything new.
- Determine if all spaces are being used to their capacity during facility use times. The measurement of success of this process will be based on whether or not the perceived facility need was resolved without new construction.
- Review space-sharing options with other state agencies or within the community. As needs are assessed, look to neighboring facilities to determine if spaces could be shared.

Predesign-Programming & Predesign-Site Selection

- Project organizational needs into the future. Review the Agency Planning document that projects Agency space needs for the next 5-10 years. The programming information created in the Agency Planning phase shall be considered the Planning Baseline.
- Evaluate Agency requirements through thorough use of surveys, interviews, questionnaires, and specific system analyses; compile information using tools available in a supplementary publication.
- Analyze Program Utilization
    - Every square foot of new construction has significant economic and environmental impacts, and so to achieve the most sustainable design, it is important to do a careful program analysis in order to build no more than is needed or will be well utilized.
    - Analyze space utilization by comparing recognized standards, existing facility, and proposed program spaces (SF/person-hour)

    - The design team and agency shall work together to create a program that focuses on overall space utilization. This is measured against standard space use standards.
    - Look for opportunities to reduce the number of duplicate spaces (i.e. consider a manager's office as a conference room if that person is out of the office more than 50% of the time.)
    - Develop a space program data sheet.
- Analyze potential future uses and building lifespan. Create multiple planning schemes for projected agency needs and building's next use
- Create a new program document incorporating changes to the space needs based on the analysis outlined above. Include square footage for spaces that may be located outside the facility as a separate subtotal.
- Enter the reductions in square footage from the predesign/programming phase in the B3 Guidelines Tracking Tool www.msbgtracking.com.

Schematic Design

- Analyze spatial utilization for program area.
  Determine net program to gross area and net program to gross volume. Excerpt from source of accepted space standards showing recommended SF/program unit ranges. Create a proposed SF/program unit and if the proposed exceeds minimum recommended, then provide an explanation.
- Analyze spatial utilization based on time.
    - For a given building area the justification for the environmental and economic demands, has most meaning when it is a well-utilized space. In a sense, all the embodied cost, and operating costs of a space is wasted for every hour it is not used for its intended purpose. This measure serves to increase awareness for all involved of the amount of "program benefit" achieved for an investment in a space. It is also a way to highlight opportunities for shared spaces between functions that have different scheduling. This can highlight under-utilized spaces that could be borrowed from adjacent facilities. It can also be a way to make more use of tax dollars to construct a building, by identifying underutilized spaces that might be shared with the community to add amenity and create interaction within the community. Each space as well as the whole facility should be analyzed for proposed annual percent utilization based on current program needs. If additional space is being rationalized by future needs the projected percent utilization should also be shown for the time frame scenario being considered.
    - In columns next to each programmed space, identify its annual % utilization based on current program needs. Add columns as needed if it is seasonally based, or if there are areas with low utilization to be examined in more detail for opportunities for space sharing.
    - Tally the total % utilization for all annual hours of all the net program area (not halls, toilets, janitor's closets, etc.)
    - Tally the % utilization for just the primary operating hours as a benchmark.
    - Report the total utilization, the operation hours to total hours, and the utilization within the operating hours.
- Analyze spatial utilization based on volume.
    - Two-dimensional spatial efficiency is a result of the layout of a building and grouping of functions which can affect the overall net to gross area ratio, which affects the environmental and economic impacts of building. Three-dimensional

spatial efficiency for a given square foot area, aims at building as high and with as much plenum space as is needed. This is not to say that ample plenum space is not beneficial for future adaptability and maintenance, but that if the designer aims at minimizing wasted height, creative solutions can occur. Nor is it to say that tall spaces whether for daylight access or for design objectives are not important, but they should be compared to the impact of added cubic feet and vertical feet of envelope to put the costs and the benefits in perspective.

- Consider impact of design configuration and system selection on projected building lifecycle scenarios.
    - Evaluate design against needs for adaptability, flexibility and disassembly.
    - Confirm life expectancy for building design and design systems accordingly.
- Enter the reductions in square footage from schematic design phase in the B3 Guidelines Tracking Tool at www.msbgtracking.com.

Correction Period

- Communicate intent and benefits of planning for conservation strategies to owner/operator to enhance operation

Ongoing Occupancy

- Analyze ongoing program and schedule optimization
- Review maintenance and operation of facility in relation to planning for conservation goals.
- Make improvements to optimize use of existing space before adding new space.

Next Use

- Refer to documentation of prior scenario planning and actions taken to make use of opportunities designed into the facility

P.3 Integrated Design Process

The Suggested Implementation schedule of is presented in the form of the Integrated Design Process Supporting Information (Appendix P-3a) and the related Integrated Design Process Matrix (Appendix P-3b).

P.4 Design and Construction Commissioning

Suggested Implementation

The Suggested Implementation is presented in the the Integrated Design Process Supporting Information (Appendix P-4a) and the Design and Construction Commissioning matrix (Appendix P-4b). Roles and responsibilities for each Commissioning Team member are flexible and need to be defined as part of the project-specific Commissioning Plan. However, some team members are prohibited from performing some of the activities due to inherent conflicts of interest. These unacceptable assignments of responsibility are blacked out in the matrix.

P.5 Operations Commissioning

Suggested Implementation

The Suggested Implementation is presented in Operations Commissioning Supporting Information (Appendix P-5a) and the Operations Commissioning matrix (Appendix P-5b). Roles and responsibilities for each Commissioning Team member are flexible and need to be defined as part of the project-specific Commissioning Plan. Additional members of the Operations Commissioning Team can also be named, as deemed appropriate for each project.

P.6 Lowest Life Cycle Cost

Agency Planning & Schematic Design

- Evaluate at least three alternatives at least once before the end of the schematic design phase. Submit a file in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Design Development & Construction Documents

- Evaluate at least three alternatives at least once more before the end of the Construction Documents phase. Submit a file in the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Ongoing Occupancy

- It is recommended a comparison to the final project model be run at least every 5 years to capture experiences during construction and operations and compare them with assumptions made in the final project model.

Appendix P-0b: Guideline Management Supporting Information

Overview of the Guideline Management Process

- At the start of each phase (or year of operation), the Guideline Leader reviews the B3 Guidelines and associated Outcome Documentation Forms, plans the tasks to be done for that phase to keep on track for meeting the guidelines, and communicates this with the work team.
- If exceptions to the B3 Guidelines are sought, the Guideline Leader (whether from the agency/owner in early phases or from the design team in later design phases) shall request the variance to the Appropriated Agency (via the B3 Guidelines Tracking Tool at www.msbgtracking.com) for Variance Review before the completion of the schematic design phase. For each guideline for which variance is requested, the request for variance shall include the following:
    - The name of the guideline or portion of the guideline (eg. S.3 F which is the 6th criteria under guideline S.3)
    - Supporting Documentation: In the request, the team shall:
        - First try to identify a modified performance level and/or compliance method that comes as close to meeting the guideline as written as possible and explain why the modifications are needed for the particular project. (For example, if a thorough search and proactive conversation with local waste management services in a rural Minnesota town yields no options for the required 75% construction waste recycling identify from the research what is the maximum waste recycling available in the region and support that modified performance threshold figure in the variance request.)
        - Second, if the first option with modified performance level and/or compliance method is not possible or applicable, The team shall explain why that is, and list what strategies they will use to best meet the intent of the guideline.
        - Third, if the first and second approaches are not possible or applicable, for example if a team feels the intent and objectives of a guideline simply do not apply to the building type, they shall explain the reasons why the first or second approaches are not possible and the reasons claimed for the non-applicability of the guideline.
    - Note that variances are not required for recommended guidelines.
- The Work Team for the responsible organization (planning team, design team, construction team, or operations team depending on phase) works towards the B3 Guidelines requirements. At the end of the phase, the Work Team completes the Outcome Documentation Forms and Compliance Summary Form and gives them to the Guideline Leader.
- The Guideline Leader collects the Compliance Summary Form and Outcome Documentation Forms for each topic area at the end of each phase (or annually during facility operation.)
- The Guideline Leader submits the required documentation to the Appropriated Agency for Compliance Review using the B3 Guidelines Tracking Tool (www.msbgtracking.com), and archives relevant documentation for future reference.

Variance Review Process

The Variance Review Process defines the steps for reviewing a request to not adhere to a portion of the guideline as written. This is intended to be used very sparingly, for issues such as non-applicability to a building type, location or scale. The Variance Review Process is led by the Appropriated Agency and consists of the following key steps:

- The Appropriated Agency receives the variance request from The Work Team consisting of the elements described in the Guideline Management Process above.
- After review, the Appropriated Agency either accepts or rejects the request for variance, or may specify a compromise equivalency or conditions for the variance.
- The Appropriated Agency documents variance approval or rejection using the B3 Guidelines Tracking Tool (www.msbgtracking.com).

Compliance Review Process

The Compliance Review Process is designed to provide checkpoints for regularly reviewing compliance with the guidelines over time from initial phases through ongoing occupancy. The Appropriated Agency leads the Compliance Review Process which consists of the following key components:

- The Appropriated Agency receives the end-of-phase Phase Summary Report from the Guideline Leader, submitted electronically using the B3 Guidelines Tracking Tool (www.msbgtracking.com).
- The Appropriated Agency reviews the extent and nature of compliance as documented by the Guideline Leader and decides if the extent of compliance is acceptable. (The Appropriated Agency is not responsible for determining compliance, but may question if compliance is achieved if in doubt.)
- The Appropriated Agency then either approves the extent of compliance for that phase, or directs the Guideline Leader to revisit compliance measures with the work team.
- After successful completion of the correction period or the first year of operation, whichever is longer, the Appropriated Agency may end its role in Compliance Review. In any case, the annual reporting will continue to be sent to CSBR throughout the life of the project's operation. (See B3 Guidelines Tracking Process.)

B3 Guidelines Tracking Process

This consists primarily of updating and maintaining the project information. Related activities may include posting data from the project on an informational B3 Guidelines web site, using project information to improve the usability and effectiveness of the B3 Guidelines, and translating reported building performance into economic, human, and environmental outcomes for use by the State of Minnesota. This process consists of the following elements:

- Agency completes required approval process for each phase using the B3 Guidelines Tracking Tool (www.msbgtracking.com). Depending on the phase, Outcome Documentation may also call for Commissioning or other reports to be attached. These attachments will be included in the online submission.
- CSBR receives Compliance and Outcome information from the Agency, via the Tracking Tool.
- CSBR uses the information received to update and maintain project information.
- CSBR uses project information at the direction of the State of Minnesota.

Guideline Management Roles

Work Team: The Work Team is responsible for the facility performance progress in a particular phase. Depending on the phase, this may be the planning team, predesign team, design team, construction team, or operations team. This team works towards the guideline performance criteria appropriate to their phase, and completes required documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com) at the end of each phase (or annually during Ongoing Occupancy.)

Guideline Leader: The Guideline Leader is the person who coordinates the completion, and documentation of tasks to comply with the sustainable guidelines. They shall work within the organization contractually responsible for a phase (or be a consultant hired by that organization), thus the role may be filled by different people for each phase. They are the contact person for guideline compliance. Some Agency processes, may have a different name for this role, or not designate this role, leaving it up to a representative from the Work Team to coordinate the tasks of the Guideline Leader. The person and organization mostly likely to play the role of the Guideline Leader in each phase is as follows:

Phase:	**Recommended Guideline Leader**:
Agency Planning	Facility Project Manager
Predesign-Programming	Facility Project Manager or Predesign Consultant
Predesign-Site Selection	Facility Project Manager or Predesign Consultant
Schematic Design	Design Team Project Manager or Sustainable Consultant
Design Development	Design Team Project Manager or Sustainable Consultant
Construction Documents	Design Team Project Manager or Sustainable Consultant
Construction Administration	Design Team Project Manager or Sustainable Consultant
Construction	Construction Supervisor
Correction Period	Commissioning Team Leader/ Coordinator
Ongoing Occupancy	Facility Operations Manager
Next Use	Facility Project Manager for Next Use

The Guideline Leader's duties include:

- Coordinate and Support the Guideline Management Process
- Maintain continuity as Guideline leader position transfers across phases and responsible organizations
- Support an interdisciplinary, participatory team approach. (See Guideline P-3 Integrated Design and Construction Process for details.)

The Guideline Leader should possess the following qualities:

- Familiar with B3 Guidelines and generally with sustainable practices
- Good facilitation and communications skills (verbal and written)

Appropriated Agency: The Appropriated Agency is the agency that received funding from the capital bond proceeds on behalf of the project and is responsible for compliance review. The role includes the following:

- The appropriated agency is responsible for reviewing, (but not necessarily determining), compliance with the guidelines according to the Compliance Review Process based on the extent of compliance represented and documented in the B3 Guidelines Tracking Tool.
- The Appropriated Agency also reviews and decides whether to accept applications for variance from the guidelines according to the Variance Review Process.
- The Appropriated Agency may choose to cease involvement in project compliance monitoring after successful completion of the correction period or 1 year of operation, whichever is longer.

CSBR: The Center for Sustainable Building Research (CSBR) at the University of Minnesota acts as the B3 Guidelines tracking team. CSBR leads the B3 Guidelines Tracking Process, updates and maintains project information with required forms and optional Guideline Reports from each phase of project development and each year of operational data. This data may be posted on an B3 Guidelines informational web site. It may also be used for selected audits, to improve the usability and effectiveness of the B3 Guidelines, and to translate building performance in to state economic, human, and environmental outcomes. CSBR tracks the B3 Guidelines on direction of the State.

Guideline Management Reporting

B3 Guidelines Tracking Tool

All B3 Guideline tracking activities are completed online at www.msbgtracking.com.

Appendix P-3a: Integrated Design Process Supporting Information

Introduction

The integrated design process refers to the bringing of the Work Team members together early in the design process and to the creation and execution of plans in order to effectively manage the design and construction process.

Elements included in P.3 (previously contained in guideline P.4 under version 2.1 of the B3 Guidelines) are related to the creation and execution of an IEQ Safety Risk Assessment of indoor air quality issues, Construction Air Quality Management Plan, Correction Period Air Quality Management Plan, and the Construction Waste Management Plan. The elements of these plans are outlined below.

The creation and execution of the following plans are required as part of Guideline P.3B

- The Design Intent Document (DID), which shall quantify functional performance expectations and parameters for each system to be commissioned.
- The Basis of Design (BOD) document, a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria
- Construction Air Quality Management Plan (including safety risk assessment of existing conditions, and protection of occupants in spaces adjacent to construction work.)
- Correction Period Air Quality Management Plan
- Construction Waste Management Plan

The following is a description of how the Integrated Design Process shall evolve over the course of the project.

Agency Planning

- Create and distribute to all stakeholders a communication plan and a team roster with all contact information included.
- Hold comprehensive Business Planning Workshop.
- The Guideline Leader (with Design Team) for the Agency is responsible for introducing the B3 Guidelines to the agency at the initial discussion of a new project. The early planning of the project generally includes a group discussion about the needs of the agency and requirements for a project. The B3 Guidelines shall be incorporated into the Comprehensive Business Plan and Strategic Plan for each Agency.

Pre-Design/Programming & Pre-Design/Site Selection

- Complete safety risk assessment of existing indoor air quality problems if work is to be attached to or renovated within an existing building.
- Create or update and distribute to all stakeholders a communication plan and a team roster with all contact information included.
- Hold Programming Workshop.
- The programming workshop is to be expanded to include discussion about the B3 Guidelines Guidelines. The workshop will include B3 Guidelines education for the design team and the stakeholders. The intent is to incorporate the B3 Guidelines into the programming discussion. An example of a format for this workshop can be found under tools: "Visioning Work Meeting/Client Awareness", provided in a supplementary publication.

Schematic Design

- Create Design Intent Document
- Create Basis of Design Document
- Create or update and distribute to all stakeholders a communication plan and a team roster with all contact information included.
- Assemble appropriate stakeholder team.
  Include representation from every discipline that will be involved in the project, Owner's decision making designate, user, occupant, operations and maintenance representatives, at least one representative from the community, and at least one agency "client" or visitor representative. Also include owner representative and commissioning agent if applicable. Choose members who can make a commitment through post-occupancy review phase.
- Hold Facility Performance Workshop.
  Schedule a Workshop within the first 2-3 weeks of the project. Include the stakeholder team. If some cannot attend a common date, include a representative on their behalf. Review programming document from Pre-Design and update as required. Review B3 Guidelines and revise project goals as required. Provide B3 Guidelines education for the team as required during this workshop.
- Convene multi-disciplinary team regularly for integrated progress review.
- Convene stakeholder team at least once during this phase for integrated progress review

Design Development

- Refine Design Intent Document
- Refine Basis of Design Document
- Create or update and distribute to all stakeholders a communication plan and a team roster with all contact information included.
- Convene multi-disciplinary team regularly for integrated progress review
- Convene stakeholder team at least once during this phase for integrated progress review

Construction Documents

- Complete Design Intent Document
- Complete Basis of Design Document
- Create the Following: (some templates available)
  - Construction Phase Air Quality Management Plan
  - Correction Period Air Quality Management Plan
  - Construction Waste Management Plan
  - Correction Period User Comfort & Satisfaction Assessment Plan

Construction Administration

- Create or update and distribute to all stakeholders a communication plan and a team roster with all contact information included.
- Convene multi-disciplinary team regularly for integrated progress review
- Convene stakeholder team at least once during this phase for integrated progress review
- Convene general contractor and subcontractors for pre-construction kick-off meeting to review the B3 Guidelines goals and objectives.
- Incorporate discussion about the progress toward project outcomes during every construction meeting. Use of the construction period related plans created or updated in

the Construction Documents phase, updated to reflect any system modifications or additions approved during Construction. Sections that may need to be changed include:
  - Updated Construction Phase Air Quality Management Plan
  - Updated Correction Period Air Quality Management Plan
  - Updated Construction Waste Management Plan

Correction Period

- Using the plans created during the Construction Documents phase, update the following to reflect any system modifications or additions approved during Construction. Sections that may need to be changed include:
  - Updated Correction Period Air Quality Management Plan

The following are narrative descriptions of the activities (rows) in Appendix P-3d Design and Construction Commissioning Matrix.

1. GENERAL INTEGRATED DESIGN PROCESS TASKS

1.01 Conduct an organization/kick-off meeting including the team

Engaging an integrated project team early in the design process and creating strategies can facilitate the creation of a high-performance building.

1.02 Review Site Alternatives

Review Site Alternatives for their impact on the ability of the systems being commissioned to achieve their Design Intent criteria.

1.03 Engage Commissioning Team

The Commissioning Team assists in planning, reviewing and coordination of commissioning activities with all disciplines involved in the building project. The Commissioning Team shall include the following members at a minimum. Contractors will not join the team until they are selected through the normal procurement process.

- Commissioning Leader
- Facility Operations Manager (FOM)
- Project Manager
- Designers
- Contractors
- Energy Modeler (if energy modeling is part of the project)
- Guideline Leader

The Commissioning Leader facilitates and coordinates the efforts of the commissioning team. For Design and Construction Commissioning, the commissioning leader shall have a distinct role from the design team but may be employed within a firm providing design services.

The Facility Operations Manager is accountable for facility performance during ongoing occupancy and will manage or perform ongoing operations and maintenance following construction. This person is available to participate throughout the design and construction process for continuity into final operation.

1.04 Design Intent Document (as coordinated with Design and Construction Commissioning Plan, see Appendix P-4a and P-4b)

The Design Intent Document (DID) shall quantify functional performance expectations and parameters for each system to be commissioned. The DID provides the common understanding that focuses design, construction, and commissioning activities on the desired outcome. The DID shall be written in objective and measurable terms. Quantify parameters such as space temperatures, humidity levels, lighting levels, sound levels, and ventilation rates when applied to the conditioned building spaces. The DID should also include the project Energy Standard (kBtu/SF/Yr), energy modeling expectations, other related performance Guidelines: E-1, E-4, E-5, and E-8, and the Carbon Footprint value requirement.

- The DID shall be updated every time the owner accepts an alternate performance criteria –due to owner desires, schedule, or budget. This might occur through normal design evolution, value engineering, change orders, or other supplemental instructions during construction.
- During the Correction Period and On-Going Operations, the DID helps the owner/operators understand the original design intent. It also provides the benchmark for maintenance, repair, and replacement decisions.
- The DID shall include an updated SB2030 Energy and Carbon Standard for the project related to guidelines E-1, E-4, E-5 and E-8.
- If energy modeling is part of the project, the Energy Modeler provides the energy model's inputs and outputs to the Commissioning Leader. The Commissioning Leader reviews the energy model's inputs and outputs and confirms that the energy model matches the performance expectations and parameters documented in the DID (e.g., percentage improvements in the proposed building performance rating compared to the baseline building).

1.05 Basis of Design (as coordinated with Design and Construction Commissioning Plan, see Appendix P-4a and P-4b)

- The Basis of Design (BOD) is a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria
- If energy modeling is part of the project, the Energy Modeler provides the energy model's inputs and outputs to the Designers and uploads the inputs and outputs to the on-line B3 Guidelines Tracking Tool. The Designers and the Sustainable Building 2030 reviewers review the energy model's inputs and outputs in parallel to confirm that the energy model parameters match the system configurations outlined in the BOD.
- In addition, the Energy Modeler shall estimate the annual building energy consumption by energy-type which becomes part of the Systems Operations Manual. The Energy Modeler shall upload the annual energy consumption estimate to the on-line B3 Guidelines Tracking Tool. Refer to Section 6: Systems Operations Manual in Appendix P-5a: Operations Commissioning Supporting Information for more details on the initial allocation of building energy diagrams.

2. CONSTRUCTION AIR QUALITY MANAGEMENT PLAN

2.01 Construction Air Quality Management Plan

The Construction Air Quality Management Plan shall cover practices to prevent introduction of air quality problems as a result of the construction process.

Meet construction air quality requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction. Requirements include elements for IAQ protection during construction (From CHPS section 01350, 1.6).

Indicate in the bid documents that compliance with the Construction Air Quality Management Plan is required.

2.02 Protect Stored Materials
Protect stored on-site or installed absorptive materials from moisture damage.

2.03 Replace Filtration Media
Replace all filtration media immediately prior to occupancy.

2.04 Temporary Construction Ventilation
Maintain sufficient temporary ventilation. Maintain ventilation continuously during installation, and until emissions dissipate after installation. If continuous ventilation is not possible via building's HVAC system(s) then ventilation shall be supplied via open windows and temporary fans, sufficient to provide no less than three air changes per hour. Air quality testing may be performed to demonstrate and maintain total VOC levels under 500 micrograms per cubic meter.

- Period after installation shall be sufficient to dissipate odors and elevated concentrations of VOCs. Where no specific period is stated in the Specifications or when air testing is performed, a time period of 72 hours may be used.
- Ventilate areas directly to outside. Ventilation to other enclosed areas is not acceptable.
- High VOC-products not pre-conditioned offsite may require a longer period of ventilation to achieve required VOC levels (see 2.06).

2.05 Protect HVAC System
During dust-producing activities (e.g., drywall installation and finishing), turn ventilation system off and protect openings in supply and return HVAC system from dust infiltration. Provide temporary ventilation as required.

Seal ducts during transportation, delivery, and construction to prevent accumulation of construction dust and construction debris inside ducts.

2.06 Offsite Product Preconditioning
All products which have odors and significant VOC emissions shall be preconditioned off-site prior to delivery to the project site, OR air quality testing shall be performed and additional ventilation provided to ensure compliant VOC levels (see below). Allow products to off-gas in a dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions.

- Condition products without containers and packaging to maximize off-gassing of VOCs
- Condition products in ventilated warehouse or other building. Comply with substitution requirements for consideration of other locations.
- Products subject to off-site preconditioning include (but are not limited to) flooring system components, composite wood and agrifiber products, furniture and furnishings, and ceiling and wall systems.

Flooring Systems Products:
Flooring system products include hard surface flooring (e.g., vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring, wall base, etc.), carpet, and carpet cushions. The 14 calendar day preconditioning is not required if:

- The carpet is Green Label Plus certified,
- The carpet cushion is Green Label Plus certified, or
- The flooring products are FloorScore certified.

Composite Wood and Agrifiber Products:
Composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), plywood, whiteboard, strawboard, panel substrates, and door cores. If the composite wood and agrifiber products do not contain added urea-formaldehyde resins, the 14 calendar day preconditioning is not required.

Furniture and Furnishings
All desks, tables, and seats that were manufactured, refurbished, or refinished shall be preconditioned off-site for 14 calendar days prior to delivery to the Project site as described above.

Ceiling and Wall Systems
All gypsum board, insulation, acoustical ceiling systems and wall coverings installed in the interior spaces shall be preconditioned off-site for 14 calendar days prior to delivery to the Project site.

Offsite product preconditioning is not required for adhesives and sealants or paints and coatings. Offsite product preconditioning is also not necessary for materials compliant with one of the low-VOC requirements of Guideline I.2.

If air quality testing is performed it is sufficient to monitor areas with high-VOC materials for the 14-day period and provide adequate ventilation to maintain VOC levels under 500 micrograms per cubic meter during occupied hours of while construction workers are present.

2.07 Remove Moisture Damaged Materials
Moisture sensitive materials (including but not limited to wood, other plant-based products and gypsum board) with evidence of moisture damage are not acceptable. Stains may be evidence of moisture damage and should be evaluated. This includes both stored and installed materials. Immediately remove all such materials from the site and properly dispose.
Take special care to prevent accumulation of moisture on installed materials and within packaging during delivery, storage, and handling to prevent development of molds and mildew on packaging and on products.

- Immediately remove from site and properly dispose of moisture-sensitive materials showing signs of mold and/or signs of mildew, including materials with moisture stains.
- Replace moldy materials with new, undamaged materials.

2.08 Protect Porous Materials
Where odorous and/or high VOC emitting products are applied on-site, apply prior to installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.

2.09 Building Flush-out Period

Comply with a pre-occupancy building flush-out as described in LEED NC Version 3.0 which states, "After construction ends, prior to occupancy and with all interior finishes installed, install new filtration media and perform a building flush-out by supplying a total air volume of 14,000 cubic feet of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60 degrees F and a relative humidity no higher than 60%." Note: schedule the completion of interior finish materials and occupancy accordingly to accommodate the flush out period.
If air testing is performed, demonstration of contaminant loads under the following levels is acceptable in lieu of the flush out period (note that these align with the relevant LEED 3.0 levels, to facilitate projects that are seeking dual compliance):

- Carbon Monoxide 9 ppm
- Particulates (PM10) 50 micrograms per cubic meter
- Total VOC 500 micrograms per cubic meter
- Formaldehyde 27 parts per billion

2.10 Pre-assessment of Existing Building Indoor Air Quality Problems

For New Buildings that are additions, or for Major Renovations, either A) ensure that ventilation flows between new or renovated areas and existing or non-renovated areas are decoupled or B) perform a pre-assessment of indoor air quality problems in the existing non-renovated portion, and the additions or to-be-renovated portions of the building. This pre-assessment should be done in the predesign phase, but no later than the schematic design phase by the design team. For path B, if there are problems in the non-renovated portion of the building that will be carried into the renovated zone by air movement common to the two zones of the building, these must be corrected prior to completion of the entire project. Also for path B, if there are problems in the to-be-renovated portion of the building, these must be corrected prior to completion of the entire project. The types of problems that must be addressed include, but are not limited to: air intakes in the older portion of the building that are now near major outdoor pollution sources, e.g.,trucks idling, trash, or garbage areas; cleaning and/or disposal of moldy surfaces or asbestos in the renovated space following code requirements.

2.11 Protect Occupants in Adjacent Building Areas During Construction

Protect occupants in adjacent parts of the building from hazards associated with New Building additions or Major Renovations during construction.(1) Perform a safety risk assessment for potential hazards that may affect occupied zones in areas adjacent to the addition or major renovation. Potential hazards to consider include, but are not limited to: asbestos, mold, and chemicals involved in demolition or new construction in the addition or renovated areas.(2) The new construction zone and the adjacent non-renovated zone shall have either separate HVAC systems or be capped off from the renovated area using metal duct caps during construction. (3) The new construction zone shall be separated from the non-renovated portion of the building using a secure barrier that separates the atmosphere of the non-renovated portion from the renovated portion of the building. Fire resistive barriers that are caulked and taped to the existing structure are considered to be an example of such a barrier. Based on the risk assessment, air flow should be monitored.

3. CORRECTION PERIOD AIR QUALITY MANAGEMENT PLAN

3.01 Correction Period Air Quality Management Plan

The Correction Period Air Quality Management Plan shall involve periodic indoor air quality testing.

- Evaluate building air quality three months, six months, and ten months after occupancy with testing that verifies ventilation system is better than or within design guidelines.

- Consider (recommended, not required), monitoring three months, six months, and ten months after occupancy of other pollutants on I.4 guideline list which are not the pollutants that determine the ventilation rate. Concentrations should be in guideline range and below action value for each pollutant. Sample pollutant action levels are given in Appendix I-1
- Indicate in the bid documents that compliance with the Correction Period Air Quality Management Plan is required.

3.02 Three Month Building Air Quality Evaluation & Modifications

- Three months into the Correction Period measure the key factor that determines ventilation rate for building (major pollutant and/or CO_2) in all building occupied zones. "Occupied zones" shall be, at a minimum, one per air handling system. No single "occupied zone" shall be greater than 5,000 square feet. The testing plan shall take into account high occupancy spaces and the locations of specific pollutant sources and shall not necessarily depend on combined/average return air concentrations at each air handler. Record CO_2 concentrations in each zone. If using ventilation strategy B or C, compare to expected value for this zone.
- If CO_2 levels are above expected values, additional ventilation must be provided until concentrations fall below these levels.

3.03 Six Month Building Air Quality Evaluation & Modifications

Six months into the Correction Period repeat the Indoor Air Quality testing performed at three months and make any necessary correction until concentrations fall below action levels.

3.04 Ten Month Building Air Quality Evaluation & Modifications

Ten months into the Correction Period repeat the Indoor Air Quality testing performed at three and six months and make any necessary correction until concentrations fall below expected levels.

4. CONSTRUCTION WASTE MANAGEMENT PLAN

4.01 Construction Waste Management Specification

Specify the required activities and performance metrics for construction phase waste management in the bid documents. See Guideline M.3 Waste Reduction and Management for criteria.

4.02 Construction Waste Management Plan

Prepare a Construction Waste Management Plan. See Guideline M.3 Waste Reduction and Management for criteria. Consult your waste management provider as to whether on site sorting will be necessary to achieve the required waste diversion amount.

4.03 Debris Diversion

Divert construction, demolition, and land cleaning debris away from landfills.

4.04 Recycle Packaging

Recycle materials and equipment packaging.

4.05 Hazardous Waste

Reduce and properly handle hazardous waste.

Appendix P-3b: Integrated Design Process Matrix

B3 State of Minnesota Sustainable Building Version 2.2

		PROJECT PHASE									TEAM MEMBERS RESPONSIBILITIES "R" represents Responsible Party "x" represents Participating Party						
	ACTIVITIES	Agency Planning	Pre-Design - Programming	Pre-Design - Site Selection	Schematic Design	Design Development	Construction Documents	Construction	Correction Period	On-Going Operations	Cx Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Energy Modeler	Guideline Leader
1. GENERAL INTEGRATED DESIGN PROCESS TASKS																	
1.01	Conduct Organization/Kick Off Meeting				x						R	x	x				x
1.02	Review Site Alternatives			x							R			x			
1.03	Engage Commissioning Team				x						R	x	x	x		x	x
1.04	Design Intent Document		x	x	x	x	x				x	x	R			x	
1.05	Basis of Design		x	x	x	x	x				x		x	R		x	
2. CONSTRUCTION PHASE AIR QUALITY MANAGEMENT																	
2.01x	Construction Air Quality Management Plan						x	x						x	R		
2.02	Protect Stored Materials							x							R		
2.03	Protect Filtration Materials							x							R		
2.04	Temporary Construction Ventilation							x							R		
2.05	Protect HVAC System							x							R		
2.06	Offsite Product Preconditioning							x							R		
2.07	Remove Moisture Damaged Materials							x							R		
2.08	Protect Porous Materials							x							R		
2.09	Building Flush-out Period							x							R		
2.10	Pre-assessment of Existing Building Indoor Air Quality Problems		x					x				x	x	x	R		
2.11	Protect Occupants in Adjacent Building Areas During Construction							x				x			R		
3. CORRECTION PERIOD AIR QUALITY MANAGEMENT																	
3.01	Correction Period Air Quality Management Plan						x								R		
3.02	3 Month Building Air Quality Evaluation & Modifications								x						R		
3.03	6 Month Building Air Quality Evaluation & Modifications								x						R		
3.04	10 Month Building Air Quality Evaluation & Modifications								x						R		
4. CONSTRUCTION WASTE MANAGEMENT																	
4.01	Construction Waste Management Specification						x	x						x	R		
4.02	Construction Waste Management Plan							x							R		

Appendix P-3b: Integrated Design Process Matrix

B3 State of Minnesota Sustainable Building Version 2.2

		PROJECT PHASE									TEAM MEMBERS RESPONSIBILITIES "R" represents Responsible Party "x" represents Participating Party						
	ACTIVITIES	Agency Planning	Pre-Design - Programming	Pre-Design - Site Selection	Schematic Design	Design Development	Construction Documents	Construction	Correction Period	On-Going Operations	Cx Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Energy Modeler	Guideline Leader
4.03	Debris Diversion														R		
4.04	Recyclable Packaging														R		
4.05	Hazardous Waste														R		

DESIGN & CONSTRUCTION PHASE
CONSTRUCTION AIR QUALITY MANAGEMENT PLAN TEMPLATE

Based upon B3 Minnesota Sustainable Building Guidelines—VERSION 2.2

Notes to the reader have been added to this document within numerous "text boxes" such as this. These "text boxes" contain references to supporting documentation, suggestions, and/or instructions pertaining to the Construction Air Quality Management Plan. ***They are intended to be deleted once the template is customized for a particular project.***

TABLE OF CONTENTS

1 Introduction

The Construction Air Quality Management Plan's intent is to define practices to prevent the introduction of air quality problems as a result of the construction process. A Construction Air Quality specification and the Construction Air Quality Management Plan should outline:

1) *Protecting Stored Absorptive Materials*
2) *Replacing Filtration Media*
3) *Temporary Construction Ventilation*
4) *Protecting HVAC System*
5) *Offsite Product Preconditioning*
6) *Removing Moisture Damaged Materials*
7) *Protecting Porous Materials*
8) *Building Flush-out Period*

The Construction Air Quality Management Plan should be developed during design, and the resulting bid documents should comply with the Construction Air Quality Management Plan.

The construction air quality requirements must meet the SMACNA IAQ Guideline for Occupied Buildings under Construction. Requirements include elements for IAQ protection during construction (From CHPS section 01350, 1.6).

Please refer to the Integrated Design Process Matrix- Activities & Responsibilities (refer to part 10 Appendix). This matrix outlines when the Construction Air Quality Management tasks should occur.

The following sections should be included in the Construction Air Quality Management Plan. It is recommended that these headings be used. As part of implementing the Construction Air Quality Management Plan, the requirements defined in the Plan need to be incorporated into the construction specifications in order to contractually obligate all contractors and subcontractors to participate in the Plan.

The number designations in parentheses (e.g. 3.01, 3.02, 3.03, etc.) are references to other MSGB documents. For example in Appendix 4.1, the Construction Air Quality Management tasks are referenced by these number designations.

Insert project customized introduction.

2 Protect Stored Absorptive Materials (2.02)

2.1 Processes and Procedures

Protect stored on-site or installed absorptive materials from moisture damage.

Provide a detailed narrative describing the project's means of protecting stored absorptive materials from moisture damage. Use Table 1 – Absorptive Materials to provide an inventory of all absorptive materials planned for use in the project and the intended pre-installation storage and post-installation protection of those materials.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of Absorptive Materials	Pre-Installation Storage	Plan for Preventing Moisture Damage after Installation
1			
2			
3			
4			
5			

Table 1 –Absorptive Materials

2.2 End of Project Summary

At the end of construction, include a brief summary of the project's means of protecting stored absorptive materials, include captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

3 Replace Filtration Media (2.03)

3.1 Processes and Procedures

Replace all filtration media immediately prior to occupancy.

If the air handling units are utilized during construction, all the air filtration media should be replaced. If the air handling units are not used during construction, clean filters meeting the contract specifications should be installed prior to startup, testing, and balancing.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Filter Manufacturer	Filter Identification (Model Number)	Filter MERV Rating	Location of Installed Filter	Date of Final Filter Installation	Indication that the Filter Replaced Prior to Occupancy[1] (Days)
1						
2						
3						
4						
5						

1 - Record how many days prior to official Owner occupancy?

Table 2 – Filtration Media Replacement

3.2 End of Project Summary

At the end of construction, submit documentation of the project's replacement of all filter media in tabular format (refer to Table 2 – Filtration Media Replacement).

Insert your End of Project Summary here.

4 Temporary Construction Ventilation (2.04)

4.1 Processes and Procedures

Provide a detailed narrative describing the project's temporary construction ventilation.

Considering temporary construction ventilation, refer to the following items that should be included in the specifications and Construction Air Quality Management Plan:

1) *Maintain sufficient temporary ventilation of areas where materials are being used that emit VOCs.*
2) *Maintain ventilation continuously during installation, and until emissions dissipate after installation. If continuous ventilation is not possible via building's HVAC system(s) then ventilation shall be supplied via open windows and temporary fans, sufficient to provide no less than three air changes per hour.*
3) *Period after installation shall be sufficient to dissipate odors and elevated concentrations of VOCs. Where no specific period is stated in the Specifications, a time period of 72 hours shall be used.*
4) *Ventilate areas directly to outside. Ventilation to other enclosed areas is not acceptable.*

Using Table 3 – Temporary Construction Ventilation, provide required details for all VOC emitting materials intended to be used during construction.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of VOC-Emitting Materials	Location of VOC-Emitting Materials	Capacity of Temporary Ventilation System (ACH)	Duration of Temporary Ventilation
1				
2				
3				
4				
5				

Table 3 – Temporary Construction Ventilation

4.2 End of Project Summary

At the end of construction, include a brief summary of the project's temporary construction ventilation, include captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

5 Protect HVAC System (2.05)

5.1 Processes and Procedures

Provide a detailed narrative describing the mechanisms by which HVAC system equipment and distribution systems (ducts and pipes) will be protected from accumulating dirt and debris during construction. This applies to all HVAC systems which are put into service during construction.

Considering how to protect the HVAC system, refer to the following items that should be included in the specifications and Construction Air Quality Management Plan:

1) *During dust-producing activities (e.g., drywall installation and finishing), turn ventilation system off and protect openings in supply and return HVAC system from dust infiltration.*
2) *Provide temporary ventilation as required.*
3) *Seal ducts during transportation, delivery, and construction to prevent accumulation of construction dust and construction debris inside ducts.*

Provide a detailed narrative describing the mechanisms by which HVAC system equipment and distribution systems (ducts and pipes) will be protected from accumulating dirt and debris during construction. This applies to all HVAC systems, not just HVAC system which is put into service during construction. In addition, document the temporary construction ventilation with Table 3 below.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

5.2 End of Project Summary

At the end of construction, include a brief summary of the project's means of protecting the HVAC system, include captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

6 Offsite Product Preconditioning (2.06)

6.1 Processes and Procedures

Provide a detailed narrative describing the project's means of offsite product preconditioning, including a description of the offsite ventilation systems (e.g., type, air changes per hour, temperature control, etc.).

Considering offsite product preconditioning, refer to the following items that should be included in the specifications and Construction Air Quality Management Plan:

1) *All products which have odors and significant VOC emissions shall be preconditioned off-site prior to delivery to the Project site. Allow products to off-gas in a dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions.*
2) *Condition products without containers and packaging to maximize off-gassing of VOCs*
3) *Condition products in ventilated warehouse or other building. Comply with substitution requirements for consideration of other locations.*

Using Table 4 – Offsite Product Preconditioning, document the pre-conditioning details for all products with significant VOC emission and other odor off-gassing properties to be installed during construction.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of Significant VOC Emitting & Other Odor Off-Gassing Products	Estimated Date of Shipment from Manufacturer	Location to which each Product will be Shipped for Preconditioning	Space Requirements[1]	Provisions for Unpacking for Preconditioning	Duration of Preconditioning Period	Provisions for Re-packing for Delivery to Project Site
1							
2							
3							
4							
5							

1 – For example, the floor space, volume, etc. required for preconditioning

Table 4– Offsite Product Preconditioning

6.2 End of Project Summary

At the end of construction, include a brief summary of the project's offsite product preconditioning; include descriptions of offsite products, means of preconditioning and locations, captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

7 Remove Moisture Damaged Materials (2.07)

7.1 Processes and Procedures

Provide a detailed narrative describing the project's process for identifying (regular inspections), removing, and disposing of moisture damaged materials and replacement procedures. Narrative should include the name of the responsible party for this activity. Considering the removal of moisture damaged materials, refer to the following items that should be included in the specifications and Construction Air Quality Management Plan:

1) *Materials with evidence of moisture damage, including stains, are not acceptable. This includes both stored and installed materials. Immediately remove all such materials from the site and properly dispose.*
2) *Take special care to prevent accumulation of moisture on installed materials and within packaging during delivery, storage, and handling to prevent development of molds and mildew on packaging and on products.*
3) *Immediately remove from site and properly dispose of materials showing signs of mold and/or signs of mildew, including materials with moisture stains.*
4) *Replace moldy materials with new, undamaged materials.*

Provide a detailed narrative describing the project's process for identifying (regular inspections), removing, and disposing of moisture damaged materials and replacement procedures. Narrative should include the name of the responsible party for this activity.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

7.2 End of Project Summary

At the end of construction, using Table 5– Moisture Damaged Materials, include a brief summary of the project's moisture damaged materials, replacement occurrences, preventive and corrective procedures, include captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

#	Description of Moisture Damaged Materials[1]	Date of Identification	Cause of Moisture Damage	Date of Removal	Description of Disposal Method[2]	Actions taken to Prevent Similar Moisture Damage in the Future
1						
2						
3						
4						
5						

1 – Include photos
2 – For example, recycling landfill, etc.

Table 5– Moisture Damaged Materials

8 Protect Porous Materials (2.08)

8.1 Processes and Procedures

Provide a detailed narrative describing the project's means to protect porous materials.

Where odorous and/or high VOC emitting products are applied on-site, apply prior to installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.

Provide a detailed narrative describing the project's means to protect porous materials. Using Table 6 – Porous Material document the following information:

1) *Inventory of all VOC-emitting or odor-emitting materials and where they are to be used*
2) *Inventory of all porous and fibrous materials and where they are to be used*
3) *Highlight locations where both categories of materials are to be used in the same location*
4) *Describe means of preventing the absorption of VOCs and/or odors by the porous and fibrous materials in each of these locations.*

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

8.2 End of Project Summary

At the end of construction, include a brief summary of the project's means of protecting porous materials, include captioned photos to highlight the Construction Air Quality Management Plan practices, and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

Location	VOC-Emitting or Odor-Emitting Materials	Porous & Fibrous Materials	Description of Absorption Prevention[1]
Room 100	1)	1)	
	2)	2)	
	3)	3)	
Room 101	1)	1)	
	2)	2)	
	3)	3)	
Room 102	1)	1)	
	2)	2)	
	3)	3)	

1 - Description of means to prevent absorption of VOC and/or odors by porous & fibrous materials in each of these locations.

Table 6– Porous Materials

9 Building Flush-out Period (2.09)

9.1 Processes and Procedures

Provide a detailed narrative describing the project's pre-occupancy flush-out procedures.

Comply with a pre-occupancy building flush-out as described in LEED NC Version 2.2 which states, "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 square feet of floor area while maintaining an internal temperature of at least 60°F and relative humidity no higher than 60%."

(Source: LEED NC Version 2.2, October 2005, Credit EQ 3.2 First part of Option 1, page 323.) Note: Schedule the completion of interior finish materials and occupancy accordingly to accommodate the flush out period.

Provide a detailed narrative describing the project's pre-occupancy flush-out procedures.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

9.2 End of Project Summary

At the end of construction, include a brief summary of the building flush-out period, include data regarding temperature, airflow, and duration of flush-out and provide information regarding special considerations, notes, or additional comments.

Insert your End of Project Summary here.

10 Appendix

10.1 Appendix P-3b Integrated Design Process Matrix– Activities & Responsibilities

Insert B3 Guidelines v.2.2 Appendix P-3b - Integrated Design Process Matrix along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

DESIGN & CONSTRUCTION PHASE CONSTRUCTION WASTE MANAGEMENT PLAN TEMPLATE

Based upon B3 Minnesota Sustainable Building Guidelines—VERSION 2.2

Notes to the reader have been added to this document within numerous "text boxes" such as this. These "text boxes" contain references to supporting documentation, suggestions, and/or instructions pertaining to the Construction Waste Management Plan. ***They are intended to be deleted once the template is customized for a particular project.***

TABLE OF CONTENTS

1 Introduction

The intent of the Construction Waste Management Plan is to minimize use of resources and negative environmental impacts through carful reduction and management of wastes generated during the construction process and building occupancy.

The Construction Waste Management Plan outlines:

1) *Construction Waste Management Specification*
2) *Construction Waste Management Plan*
3) *Debris Packaging*
4) *Recycle Packaging*

Please note that portions of this template are adapted from LEED Version 2.0.

The number designations in parentheses (e.g. 4.01, 4.02, 4.03, etc.) are references to other B3 Guideline documents. For example in Appendix P-3b, the Construction Waste Management tasks are referenced by these number designations.

Insert project customized introduction.

2 Construction Waste Management Specification (4.01)

2.1 Processes and Procedures

Provide a detailed specification describing the required activities and performance metrics for construction phase waste management in the bid documents. The specification should include the required performance criteria:

1) *Construction Waste: Minimize waste generated from construction, renovation and demolition of buildings through detailing and specifications.*
2) *Construction Waste: Divert at least 75% (by weight) construction, demolition, and land clearing debris from landfill disposal.*
3) *Operations Waste: Reduce and recycle at least 50% of the waste generated during building operation. Provide dedicated recycling areas, processing and holding space, and reverse distribution space in the building.*

If applicable, the specification should include the recommended performance criteria:

4) *Construction Waste: Reuse, recycle and/or salvage an additional 15% (90% total by weight) of the construction, demolition, and land clearing waste.*
5) *Packaging Waste: Reduce and recycle packaging waste associated with the construction process, and encourage manufacturers to ship their product using reusable, recyclable, returnable, or recycled content packaging. Reuse or return 50% of all packaging material, by weight, to suppliers or manufacturers.*
6) *Packaging Waste: Return an additional 25% (75% total by weight) of all packaging material to suppliers or manufacturers*

For additional details, please refer to Guideline M.3 Waste Reduction and Management (http://www.msbg.umn.edu/m_3.html) and Appendix M-1 Suggested Implementation of All Material and Waste Guidelines (http://www.msbg.umn.edu/downloads_v2_0/6Materials_App-M-1.pdf).

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

3 Debris Diversion (4.03)

3.1 Processes and Procedures

The goal of debris diversion is to divert construction, demolition, and land cleaning debris away from landfills.

The construction, demolition, and land clearing debris should be documented using Worksheet M-2 Construction Waste Recycling Economics (see Appendix 5.2). Worksheet M-2 Construction Waste Recycling Economics documents the following:

1) *A description of diverted / recycled materials,*
2) *Where these materials were diverted or recycled,*
3) *The quantity of diverted / recycled materials (in tons or cubic yards),*
4) *A description of landfill material,*
5) *The landfill hauler or the landfill location,*
6) *The quantity of the landfill waste.*

Please refer to Guideline M.3 Waste Reduction and Management. Guideline M.3 Waste Reduction and Management includes a link to Worksheet M-2 Construction Waste Recycling Economics (Appendix 5.2) which applies to Construction Waste.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

3.2 End of Project Summary

The M-2 worksheet should be started during demolition and continuously updated throughout the construction process. At the end of construction, the M-2 worksheet represents a project history of the construction, demolition, and land clearing debris. This project history demonstrates that the required and recommended performance criteria are satisfied at the end of construction.

Insert your End of Project Summary here.

4 Recycle Packaging (4.04)

4.1 Processes and Procedures

The goal is to recycle materials and equipment packaging generated during construction.

The recycled materials and equipment should be documented using Worksheet M-3 Packaging Waste Recycling Economics (Appendix 5.3) The M-3 worksheet includes:

1) *A description of the packaging and operations waste diverted / recycled materials,*
2) *Where these materials were diverted or recycled,*
3) *The quantity of packaging and operations waste diverted / recycled materials (in tons or cubic yards)*
4) *A description of landfill material,*
5) *The landfill hauler or the landfill location,*
6) *The quantity of the landfill waste.*

Please refer to Guideline M.3 Waste Reduction and Management. Guideline M.3 Waste Reduction and Management includes a link to Worksheet M-3 Packaging Waste Recycling Economics (Appendix 5.3) which applies to Packaging and Operations Waste

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

4.2 End of Project Summary

The M-3 worksheet should be started during demolition and continuously updated throughout the construction process. At the end of construction, the M-3 worksheet represents a project history of the packing recycling. This project history demonstrates that the required and recommended performance criteria are satisfied at the end of construction.

Insert your End of Project Summary here

5 APPENDIX

5.1 Appendix P-3b - Integrated Design Process Matrix

5.2 M-2 Construction Waste Recycling Economics

5.3 Worksheet M-3 Packaging Waste Recycling Economics

DESIGN & CONSTRUCTION PHASE
CORRECTIVE PERIOD AIR QUALITY MANAGEMENT PLAN TEMPLATE

Based upon B3 Minnesota Sustainable Building Guidelines—VERSION 2.2

Notes to the reader have been added to this document within numerous "text boxes" such as this. These "text boxes" contain references to supporting documentation, suggestions, and/or instructions pertaining to the Correction Period Air Quality Plan. ***They are intended to be deleted once the template is customized for a particular project.***

TABLE OF CONTENTS

1 Introduction

The Correction Period Air Quality Management shall involve periodic indoor air quality testing. The intent of the Construction Air Quality Management Plan is to evaluate the building air quality three months, six months, and ten months after occupancy with testing that verifies that the ventilation system is better than or within design guidelines.

Please refer to the Integrated Design Process Matrix - Activities & Responsibilities (refer to Appendix 6.1). This matrix outlines when the Correction Period Air Quality Management tasks should occur.

The number designations in parentheses (e.g. 3.01, 3.02, 3.03, etc.) are references to other B3 Guideline documents. For example in Appendix 6.1, the Correction Period Air Quality Management tasks are referenced by these number designations.

Consider (recommended, not required), monitoring three months, six months, and ten months after occupancy of other pollutants on I.4 guideline list which are not pollutants that determine the ventilation rate. Concentrations should be in guideline range and below action value for each pollutant. Sample pollutant action levels are given in Appendix I-1.

Insert project customized introduction.

2 Correction Period Air Quality Management Specification (3.01)

2.1 Processes and Procedures

During the design phase, the team should determine which, if any, of the responsibilities associated with the Correction Period Air Quality Management Plan will be assigned to the bidding contractors. If the contractors will be responsible for any part of the correction period testing or modifications, the design team should prepare a Correction Period Air Quality Management Specification for the contract documents in order to obligate the contractors to follow the provisions of this Correction Period Air Quality Management Plan.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

3 Three Month Building Air Quality Evaluation & Modifications (3.02)

3.1 Processes and Procedures

Provide a detailed narrative describing the indoor air quality testing plan and strategies at an interval of three-months after occupancy. Outline specific occupied zones, document zone square footage, locations of specific pollutants, CO_2 concentrations at each zone, and concentration limits (refer to Table 1a - Three-Month Building Air Quality).

Three months into the Correction Period, measure the key factor that determines ventilation rate for building (major pollutant and/or CO_2) in <u>all</u> building occupied zones. "Occupied zones" shall be, at a minimum, one per air handling system. No single "occupied zone" shall be greater than 5,000 square feet. The testing plan shall take into account high occupancy spaces and the locations of specific pollutant sources and shall not necessarily depend on combined or average return air concentrations at each air handler.

- *Record CO_2 concentrations in each zone.*
- *If CO_2 levels are above expected values, additional ventilation must be provided until concentrations fall below these levels.*

Refer to LEED-NC Version 2.2 Reference Guide – Indoor Air Quality Credit 2 for greater detail.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of Occupied Zone	Zone Square Footage (ft^2)	Locations of Specific Pollutants	CO_2 Concentration Limits (PPM)	3-Month Evaluation	6-Month Evaluation	10-Month Evaluation
					CO_2 Concentration (PPM)		
1							
2							
3							
4							
5							

Table 1a – Three-Month Building Air Quality

3.2 Three-Month Summary

At the conclusion of the three-month evaluation, compose a brief summary of the testing results (Table 1a) and system modifications that were necessary to achieve satisfactory concentration levels.

Insert your summary here.

4 Six-Month Building Air Quality Evaluation & Modifications (3.03)

4.1 Processes and Procedures

Six months into the Correction Period, repeat the Indoor Air Quality testing performed at three months and record findings in Table 1b (i.e., add more data to Table 1a). Make any necessary corrections until concentrations fall below action levels.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of Occupied Zone	Zone Square Footage (ft^2)	Locations of Specific Pollutants	CO2 Concentration Limits (PPM)	3-Month Evaluation	6-Month Evaluation	10-Month Evaluation
					CO2 Concentration (PPM)		
1							
2							
3							
4							
5							

Table 1b – Six-Month Building Air Quality

4.2 Six-Month Summary

At the conclusion of the six-month evaluation, compose a brief summary of the testing results (Table 1b) and system modifications that were necessary to achieve satisfactory concentration levels.

Insert your summary here.

5 Ten-Month Building Air Quality Evaluation & Modifications (3.04)

5.1 Processes and Procedures

Ten months into the Correction Period, repeat the Indoor Air Quality testing performed at three months and record findings in Table 1c (i.e., add more data to Table 1b). Make any necessary corrections until concentrations fall below action levels.

Insert your Processes and Procedures along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

#	Description of Occupied Zone	Zone Square Footage (ft^2)	Locations of Specific Pollutants	CO2 Concentration Limits (PPM)	3-Month Evaluation	6-Month Evaluation	10-Month Evaluation
					CO2 Concentration (PPM)		
1							
2							
3							
4							
5							

Table 1c – Ten-Month Building Air Quality

5.2 Ten-Month Summary

At the conclusion of the ten-month evaluation, compose a brief summary of the testing results (Table 1c) and system modifications that were necessary to achieve satisfactory concentration levels.

Insert your summary here.

6 Appendix

6.1 Integrated Design Process Matrix – Activities & Responsibilities

Insert B3 Guidelines v.2.2 Appendix P-3b - Integrated Design Process Matrix along with assigned Roles and Responsibilities to ensure that these requirements will be achieved.

Appendix P-4a: Design and Construction Commissioning Supporting Information

Introduction

Design and Construction Commissioning refers to the process that shall begin in pre-design and conclude after the correction period or after completion of a full year of operation, whichever is later. The Design and Construction Commissioning process is the means to verify and document that the facility systems operate in accordance with their design intent and that the operations staff fully understands the system operational procedures and are prepared to continue operating the system per the design intent. This includes documenting system operational goals and design parameters, specifying verification and testing in the contract documents, confirming the successful completion of the verification process, documenting the system operational procedures and training the operations staff. The Design and Construction Commissioning Process is coordinated by the Commissioning Leader and executed by the Commissioning Team. The scope of the requirements of guideline P-4 is intended to align with the typical scope of Commissioning Agent.

The following are narrative descriptions of the activities (rows) in Appendix P-4d Design and Construction Commissioning Matrix.

1. GENERAL

1.01 Design & Construction Commissioning Plan

The Design & Construction Commissioning Plan consists of the following elements:

- Systems Commissioning Plan
  - List of required systems to be commissioned
    - Mechanical HVAC Comfort, Energy, and Renewable Energy Systems, Testing Adjusting and Balancing: And other elements related to performance of Guidelines : E.1, E.2, E.3, E.4, I.4, I.5
    - Electrical Systems, including Lighting and Daylighting Controls: And other elements related to performance of Guidelines : S.5, E.1, E.2, E.3, I.6, I.9
    - Indoor Air Quality Elements and Systems: And other elements related to performance of Guidelines : I.1, I.2, I.3, I.4, I.5
  - The following systems are recommended to be included in the commissioning process and in the Systems Commissioning Plan:
    - Plumbing Systems : In addition to required flow rate commissioning above as needed to support operational achievement of guidelines: S.7, S.8, S.13
    - Interior materials (specification, installation): As needed to support operational achievement of guidelines: I.2, M.1, M.
    - Envelope integrity: In addition to required water infiltration commissioning above as needed to support operational achievement of guidelines: I.3, M.1, M.2
    - IEQ: Vibrations/acoustics/noise: In addition to occupant surveys above, perform physical measurements as needed to support operational achievement of guidelines: I.7, I.8
    - Plumbing Systems: Flow Rate
    - Envelope Integrity: Test Building Envelope for Water Infiltration

- Design Intent Document for systems to be commissioned (as created by the design team, see appendix P-3a)
- Basis of Design for systems to be commissioned (as created by the design team, see appendix P-3a)Description of commissioning activities
- List of commissioning team members; by project role, not by name
- Assignment of roles and responsibilities of each team member
- Description of commissioning documentation requirements
- Customized system installation checklists and functional performance test procedures to be completed prior to system acceptance by the owner
- Correction Period User Comfort and Satisfaction Assessment Plan

The Design and Construction Commissioning Plan is a living document that grows in detail over time, as systems are specified and design details are refined. The following is a description of how the Commissioning Plan shall evolve over the course of the project.

- Agency Planning
  - Brief description of commissioning process for budgeting purposes.
- Pre-Design/Programming & Pre-Design/Site Selection
  - Brief description of commissioning process for budgeting purposes.
  - Systems to be commissioned
  - Inclusion of Design Intent Document and Basis of Design for those systems (as created by the design team)
  - Reference the Energy Standard and the estimated Carbon Footprint per the Sustainable Building 2030 program[1]
- Schematic Design Phase
  - Systems Commissioning Plan
    - General list of system types to be commissioned
    - Include Design Intent Document for those systems (as created by the design team)
    - Include Basis of Design Document for those systems (as created by the design team)
    - Review and comment for Energy Standard and Carbon Footprint updates for the Design Intent Document and Basis of Design Document. Review and comment as necessary. Review and comment upon the completion of the Building Strategy Checklist from Guideline E.1D.
    - Description of commissioning activities
    - List of commissioning team members; by project role, not by name
    - Assignment of roles and responsibilities of each team member
    - Description of commissioning documentation requirements
- Design Development
  - Systems Commissioning Plan
    - Detailed list of systems (using design document names/numbers) to be commissioned
    - Include updated Design Intent Document for those systems
    - Include updated Basis of Design Document for those systems

1 Refer to the Sustainable Building 2030 Compliance and Reporting Instructions: http://www.mn2030.umn.edu/download/Welcome_SB2030_Instructions.pdf

        - Review and comment as necessary on any Energy Standard and Carbon Footprint updates. Review and comment upon the completion of the Building Strategy Checklist from Guideline E.1D.
        - Description of commissioning activities
        - List of commissioning team members; by project role, not by name
        - Assignment of roles and responsibilities of each team member
        - Description of commissioning documentation requirements
- Construction Documents
    - Systems Commissioning Plan
        - Updated detailed list of systems (using design document names/numbers) to be commissioned
        - Review updated Design Intent Document for those systems
        - Review updated Basis of Design Document for those systems
        - Incorporate any Energy Standard and Carbon Footprint updates into the Design Intent Document and Basis of Design Document. Review and comment as necessary. Coordinate with the completion of the Building Strategy Checklist from Guideline E.1D.
        - Description of commissioning activities
        - List of commissioning team members; by project role, not by name
        - Assignment of roles and responsibilities of each team member
        - Description of commissioning documentation requirements
        - List of commissioning activities to be incorporated into the construction schedule, including recommended integration with typical contractor installation, startup, and turnover milestones
        - Customized system installation checklists and functional performance test procedures to be completed prior to system acceptance by the owner
- During Project Construction
    - Same as Construction Documents but updated to reflect any system modifications or additions approved during Construction. Sections that may need to be changed include:
        - Updated detailed list of systems (using design document names/numbers) to be commissioned
        - Updated Design Intent Document for those systems
        - Basis of Design for those systems
        - Provide suggested Energy Standard and Carbon Footprint updates for the Design Intent Document and Basis of Design Document. Review and comment as necessary. Coordinate with the completion of the Building Strategy Checklist from Guideline E.1D.Customized system installation checklists and test procedures to be completed prior to system acceptance by the owner
- Correction Period
    - Same as Construction but updated to reflect any system modifications or additions approved during at the time of systems turnover to the owner. This document is intended to include representation of the final approved and tested condition of the systems being commissioned. Sections that may need to be changed include:
        - Updated Design Intent Document
        - Review any Energy Standard to the Design Intent Document and Basis of Design Document
        - Customized system installation checklists and test procedures to be completed prior to system acceptance by the owner

1.02 Commissioning Reports
Commissioning Reports shall be prepared at the end of each phase of design and construction documenting progress in and compliance with the Commissioning Plan for that phase. Each report should include recommendations for adjustments in the Commissioning Plan for the next phase.

Starting with the Pre-Design Phase and going through the Construction Documents Phase, the Commissioning Reports should include design review comments documenting the Commissioning Team's evaluation of the ability of the facility, as defined or described at the Phase, to meet the Design Intent Document criteria.

The end-of-Correction Period Commissioning Report shall be the final deliverable of the Design and Construction Commissioning Process. The Report shall state that the Design and Construction Commissioning Plan has been completed and the Design Intent Document criteria have been achieved. If the owner accepts systems that do not meet the Design Intent Document criteria, the Report shall document which deviations were approved by the owner. The report shall also include, but not be limited to, the following:

- Design Intent Document
- Other System Requirements and Parameters
- Specifics of Equipment and Systems Operation
- Test Procedures
- Testing Record
- O&M Training Record
- Commissioning Team Participants

1.03 Compliance and Outcome Documentation
Review documentation submitted as required by the B3 Guidelines at the end of each phase of the design and construction process using the B3 Guidelines Tracking Tool (www.msbgtracking.com). This includes Sustainable Building 2030 documentation (i.e., Energy Standard, Carbon Footprint, energy usage predictions, Building Strategy Checklists, Meter Plan, Drawings & Schedules, Energy Model Verification Form, and annual energy use data). Refer to the Sustainable Building 2030 Compliance and Reporting Instructions for additional details.

2. SYSTEMS COMMISSIONING

2.01 Engage Commissioning Team (as coordinated with the Integrated Design Process, see Appendix P-3a and P-3b)

The Commissioning Team assists in planning, reviewing and coordination of commissioning activities with all disciplines involved in the building project. The Commissioning Team shall include the following members at a minimum. Contractors will not join the team until they are selected through the normal procurement process.

- Commissioning Leader
- Facility Operations Manager (FOM)
- Project Manager
- Designers

- Contractors
- Energy Modeler (if energy modeling is part of the project)
- Guideline Leader

The Commissioning Leader facilitates and coordinates the efforts of the commissioning team. For Design and Construction Commissioning, the commissioning leader shall have a distinct role from the design team but may be employed within a firm providing design services.
The Facility Operations Manager is accountable for facility performance during ongoing occupancy and will manage or perform ongoing operations and maintenance following construction. This person is available to participate throughout the design and construction process for continuity into final operation.

2.02 Coordination of Design Intent Document (as coordinated with the Integrated Design Process and as created by the design team, see Appendix P-3a and P-3b)

- The Design Intent Document (DID) shall quantify functional performance expectations and parameters for each system to be commissioned. The DID provides the common understanding that focuses design, construction, and commissioning activities on the desired outcome. The DID shall be written in objective and measurable terms. Quantify parameters such as space temperatures, humidity levels, lighting levels, sound levels, and ventilation rates when applied to the conditioned building spaces
- The DID shall be updated every time the owner accepts an alternate performance criteria –due to owner desires, schedule, or budget. This might occur through normal design evolution, value engineering, change orders, or other supplemental instructions during construction.
- The DID shall include an updated SB2030 Energy and Carbon Standard for the project related to Guidelines E-1, E-4, E-5 and E-8.
- During the Correction Period and On-Going Operations, the DID helps the owner/operators understand the original design intent. It also provides the benchmark for maintenance, repair, and replacement decisions.

2.03 Coordination with Basis of Design (as coordinated with the Integrated Design Process and as created by the design team, see Appendix P-3a and P-3b)

- The Basis of Design (BOD) is a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria
- If energy modeling is part of the project, the Energy Modeler provides the energy model's inputs and outputs to the Designers and uploads the inputs and outputs to the on-line B3 Guidelines Tracking Tool. The Designers and the Sustainable Building 2030 reviewers review the energy model's inputs and outputs in parallel to confirm that the energy model parameters match the system configurations outlined in the BOD.
- In addition, the Energy Modeler shall estimate the annual building energy consumption by energy-type which becomes part of the Systems Operations Manual. The Energy Modeler shall upload the annual energy consumption estimate to the on-line B3 Guidelines Tracking Tool. Refer to Section 5: Systems Operations Manual in Appendix P-5a: Operations Commissioning Supporting Information for more details on the initial allocation of building energy diagrams, refer to the SB2030 program for energy model requirements.

2.04 Commissioning Design Review

At least once during each of the Schematic Design, Design Development, and Construction Documents Phases, review the design progress against the goals of the Design Intent Document. Commissioning Design Review comments shall be documented in writing and responses prepared by the appropriate designers.

- Performance Check: Commissioning Team shall review design as documented to verify that it meets the physical outcomes and operational performance defined at that phase. Performance areas include, but are not limited to:
  - Design Intent acceptance criteria for all required and additional pursued Guidelines
  - Requirements for specific operational scenarios of the building
- Measurability/ Testability Check: Commissioning Team shall review design as documented to verify that it meets criteria for testing and verification of performance for Design and Construction Commissioning as well as Operations Commissioning monitoring during Ongoing Occupancy. Performance areas include, but are not limited to:
  - Measurements and testing required during all phases of Design and Construction Commissioning.
  - Measurement, monitoring, and control of energy, water, indoor environmental quality during Ongoing Occupancy.

2.05 Coordinate with Operations Commissioning Requirements (Appendices P-5a and P-5b)
Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning. Refer to Appendix P-6 Operations Commissioning Support Information and Appendix P-5b Operations Commissioning Matrix for an understanding of what these features might be.

2.06 List of I/O Data Points
Submit a list of input and output (I/O) data points or sequence of operations as part of outcome documentation before the end of 50% Construction Documents. These shall be submitted for all computer-based control systems, e.g., HVAC, lighting controls, etc.

2.07 Provide Cx Criteria & Scope for Construction Documents
Provide a commissioning specification section for Division 1 of the project manual. The commissioning specification shall define and elaborate on the contractor's responsibilities as defined in the Commissioning Plan. Incorporate the Commissioning Plan into the contract documents by reference in order to communicate the context of the commissioning specification and information regarding other team member responsibilities.

2.08 Review Contractors' Submittals
Review contractor submittals for commissioned equipment and other commissioned design elements.

2.09 Verify Installation
Complete customized system installation checklists, as included in the Commissioning Plan, prior to system acceptance by the owner.

2.10 Verify Functional Performance
Complete customized system functional performance test procedures, as included in the Commissioning Plan, prior to system acceptance by the owner.

2.11 Verify Operations & Maintenance (O&M) Documentation

Verify that the contractor creates and submits Operations & Maintenance manuals for the owner prior to construction completion and system acceptance by the owner.

2.12 Verify Operations & Maintenance (O&M) Training
Verify that the contractor presents Operations & Maintenance training to the owner prior to construction completion and system acceptance by the owner.

2.13 Systems Operations Manual
Prepare a Systems Operations Manual to be delivered to the Owner. Please refer to Appendix P-5a Operations Commissioning Supporting Information's Section 6 "Systems Operations Manual."

2.14 Deferred Verification
Some of the system functional performance test procedures will not be practical or meaningful to complete prior to the Correction Period. This may be due to construction phasing,climate or other constraints. Those test procedures shall be completed at the earliest appropriate time, and the results of the tests shall be reported to the Owner and Project team. It shall be expected that deficiencies identified as part of this deferred testing executed after the Correction Period will be resolved by the project team as if they had been identified prior to the end of the Correction Period.

2.15 Ten Month O&M Review
At 10 months into the correction period, review building operation with Operations and Maintenance staff, and create a plan for resolution of outstanding commissioning-related issues.

Appendix P-4b: Design and Construction Commissioning Matrix

B3 State of Minnesota Sustainable Building Version 2.2

		PROJECT PHASE									TEAM MEMBERS RESPONSIBILITIES "R" represents Responsible Party "x" represents Participating Party						
	ACTIVITIES	Agency Planning	Pre-Design - Programming	Pre-Design - Site Selection	Schematic Design	Design Development	Construction Documents	Construction	Correction Period	On-Going Operations	Cx Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Energy Modeler	Guideline Leader
1. GENERAL																	
1.01	Design & Construction Phase Commissioning Plan	x	x	x	x	x	x	x			R						
1.02	Commissioning Reports		x	x	x	x	x	x	x		R						
1.03	Review Compliance & Outcome Documentation for SB2030	x	x	x	x	x	x	x	x		R		x	x		x	
2. SYSTEMS COMMISSIONING																	
2.01	Engage Commissioning Team				x						R	x	x	x		x	x
2.02	Coordination of Design Intent Document		x	x	x	x	x				x	x	R			x	
2.03	Coordination of Basis of Design Document		x	x	x	x	x				x		x	R		x	
2.04	Commissioning Design Review				x	x	x				R			x			
2.05	Coordinate with Operations Commissioning Requirements (P.5)				x	x	x	x	x		R	x	x	x	x	x	
2.06	List of I/O Data Points						x							R			
2.07	Incorporate Cx Criteria & Scope into Construction Documents						x				x			R			
2.08	Review Contractors' Submittals							x			R			x	x		
2.09	Verify Installation							x			R				x		
2.10	Verify Functional Performance							x			R				x		
2.11	Verify O&M Documentation							x			R				x		
2.12	Verify O&M Training							x			R	x			x		
2.13	Systems Operations Manual							x			R			x	x	x	
2.14	Deferred Verification								x		R				x		
2.15	Ten Month O&M Review								x		R	x	x	x	x		

DESIGN & CONSTRUCTION PHASE COMMISSIONING PLAN TEMPLATE

Based upon B3 Guidelines—VERSION 2.2

Notes to the reader have been added to this document within numerous "text boxes" such as this. These "text boxes" contain references to supporting documentation, suggestions, and/or instructions pertaining to the Commissioning Plan Template.

Please delete these "text boxes" when they are no longer needed.

TABLE OF CONTENTS

1 INTRODUCTION

Design and Construction Commissioning refers to the process that shall begin in schematic design and conclude after the correction period or after completion of a full year of operation, whichever is later.

The Design and Construction Commissioning Process is the means to verify and document that the facility systems operate in accordance with their design intent and that the operations staff fully understands the system operational procedures and are prepared to continue operating the system per the design intent. This includes documenting system operational goals and design parameters, specifying verification and testing in the contract documents, confirming the successful completion of the verification process, documenting the system operational procedures and training the operations staff. The Design and Construction Commissioning Process is coordinated by the Commissioning Leader and executed by the Commissioning Team.

The goals of the Design and Construction Plan are to define the:

1) Systems-to-be-Commissioned
2) Commissioning activities and documentation
3) Scheduling parameters
4) Acceptance criteria
5) Roles and responsibilities of the Commissioning Team members

The Design and Construction Commissioning Plan is a living document that grows in detail over time, as systems are specified and design details are refined. The following is a description of how the Design and Construction Commissioning Plan shall evolve over the course of the project.

2 COMMISSIONING TEAM MEMBERS

Role	Company	Title	Name	Phone Number	E-mail Address
Commissioning Leader				(XXX) XXX-XXXX	
Facilities Operations Manager (FOM)				(XXX) XXX-XXXX	
Project Manager				(XXX) XXX-XXXX	
Designers				(XXX) XXX-XXXX	
				(XXX) XXX-XXXX	
				(XXX) XXX-XXXX	
Contractors				(XXX) XXX-XXXX	
				(XXX) XXX-XXXX	
				(XXX) XXX-XXXX	
Guideline Leader				(XXX) XXX-XXXX	

Please insert the project team contact information (e.g. Company, Title, Name, Phone Number, and E-mail).

3 SYSTEMS-TO-BE-COMMISSIONED

Please substitute the X's with all the relevant systems-to-be commissioned

3.1 Systems-to-be-Commissioned:

1) Mechanical HVAC System (including Testing, Adjusting, and Balancing)
   a) X
   b) X
   c) X
   d) …
2) Energy
   a) X
   b) X
   c) X
   d) …
3) Renewable Energy Systems
   a) X
   b) X
   c) X
   d) …

Other elements related to performance of Guidelines: E.1, E.2, E.3, E.4, I.4, and I.5.

4) Power and Electrical Systems
   a) X
   b) X
   c) X
   d) …

Other elements related to performance of Guidelines: S.5, E.1, E.2, E.3, I.6, and I.9.

5) Lighting and Daylighting Controls
   a) X
   b) X
   c) X
   d) …
6) Indoor Air Quality Elements and Systems
   a) X
   b) X
   c) X
   d) …

Other elements related to performance of Guidelines: I.1, I.2, I.3, I.4, and I.5.

7) See Appendix P-4a for more details on requirements under Design and Construction Commissioning Plan

Modify the Systems-to-be-Commissioned List to be project-specific. For example:

1) *Mechanical HVAC System*
   a) *Air Handling System*
   b) *Chilled Water System*
   c) *Heating Hot Water System*
   d) *Domestic Hot Water System*
   e) *…*
2) *Renewable Energy System*
   a) *Photovoltaic System*
   b) *…*
3) *Power and Electrical System*
   a) *Normal Power Distribution System*
   b) *Emergency Power System*
   c) *…*
4) *Lighting and Daylighting System*
   a) *Lighting Control System*
   b) *…*
5) *Indoor Air Quality Elements and System*
   a) *…*
6) *…*

This list of the systems-to-be-commissioned should be modified to accommodate the project-specific systems. Refer to Appendix P-4 for more details on requirements under Design and Construction Commissioning Plan.

RECOMMENDED SYSTEMS-TO-BE-COMMISSIOED:

2) *Plumbing Systems : In addition to required flow rate commissioning above as needed to support operational achievement of guidelines: S.7, S.8, S.13*
3) *Interior materials (specification, installation): As needed to support operational achievement of guidelines: I.2, M.1, M.2*
4) *Envelope integrity: In addition to required water infiltration commissioning above as needed to support operational achievement of guidelines: I.3, M.1, M.2*
5) *IEQ: Vibrations/acoustics/noise: In addition to occupant surveys above, perform physical measurements as needed to support operational achievement of guidelines: I.7, I.8*
6) *Plumbing Systems: Flow Rate*
7) *Envelope Integrity: Test Building Envelope for Water Infiltration*

4 COMMISSIONING PROCESS NARRATIVES

The following section defines the General Commissioning Activities, System Commissioning Activities (in chronological order from Agency Planning to On-Going Operations), and the roles & responsibilities of the various team members.

4.1 GENERAL COMMISSIONING ACTIVITIES

The following are common or general Commissioning activities that occur throughout the Project Phase from Agency Planning to the Correction Period.

The numbers captured enclosed within parentheses (e.g. 1.01) refer to the task number found in *Appendix P-5: Design and Construction Commissioning Matrix.*

4.1.1 Design & Construction Phase Commissioning Plan (1.01):

The Commissioning Plan is a document that outlines the Commissioning Process and its related activities, the roles & responsibilities of the Commissioning Team, and Commissioning-related requirements. Throughout the project phase, the Commissioning Plan is updated to reflect changes in the Design Intent Document. Criteria that could not be met, summation of the associated events, impacts to the Design Intent Document, and the resulting Design Intent Document modifications should be documented.

4.1.2 Commissioning Reports (1.02):

Commissioning Reports shall be prepared at the end of each phase of design and construction documenting progress in and compliance with the Commissioning Plan for that phase. Each report should include recommendations for adjustments in the Com missioning Plan for the next phase. Starting with the Pre-Design Phase and going through the Construction Documents Phase, the Commissioning Reports should include design review comments documenting the Commissioning Team's evaluation of the ability of the facility, as defined or described at the Phase, to meet the Design Intent Document criteria. The end-of-Correction Period Commissioning Report shall be the final deliverable of the Design and Construction Commissioning Process. The Report shall state that the Design and Construction Commissioning Plan has been completed and the Design Intent Document criteria have been achieved. If the owner accepts systems that do not meet the Design Intent Document criteria, the Report shall document which deviations were approved by the owner. The report shall also include, but not be limited to, the following:

- Design Intent Document
- Other System Requirements and Parameters
- Specifics of Equipment and Systems Operation
- Test Procedures
- Testing Record
- O&M Training Record
- Commissioning Team Participants

4.1.3 Review Compliance & Outcome Documentation for SB2030Outcome Documentation (1.03):

Submit documentation as required by the B3 Guidelines at the end of each phase of the design and construction process using the online B3 Guidelines Tracking Tool (www.msbgtracking.com).

4.2 SYSTEMS COMMISSIONING ACTIVITIES

4.2.1 AGENCY PLANNING

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Agency Planning:

Planning Baseline: The Project Manager will work with the Designers to develop broad building-wide expectations and criteria. This becomes the framework for an initial design intent document. Prior to developing the Planning Baseline, the Commissioning Leader can provide the Project Manager with insight as to what to define during these early stages from a commissioning perspective.

4.2.2 PRE-DESIGN – PROGRAMMING

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Pre-Design - Programming:

Programming Baseline: The Project Manager will continue to work with Designers to refine the building criteria and expectations. Prior to developing the Programming Baseline, the Commissioning Leader can provide the Project Manager with insight as to what to define during these early stages from a commissioning perspective.

4.2.3 PRE-DESIGN – SITE SELECTION

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Pre-Design – Site Selection:

Programming Baseline: The Project Manager will continue to work with Designers to refine the building criteria and expectations. Prior to developing the Programming Baseline, the Commissioning Leader can provide the Project Manager with insight as to what to define during these early stages from a commissioning perspective.

Review Site Alternatives for Ability to Achieve Performance Goals (2.02): Review Site Alternatives for their impact on the ability of the systems being commissioned to achieve their Design Intent criteria.

4.2.4 SCHEMATIC DESIGN

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Schematic Design:

Design Baseline: Given the previously developed baselines, the Designer will develop the drawings and specifications which owner's needs and requirements. The schematic design should include (but not limited to): specifications, site details, landscaping, building exterior envelope, structural, building interior, elevators, plumbing, HVAC, HVAC controls, electrical, fire protection, lighting, electrical power distribution, fire alarm, telecommunications, and service facilities.

Design Intent Document (2.02): The Design Intent Document shall quantify functional performance expectations and parameters for each system to be commissioned. The Design Intent Document provides the common understanding that focuses design, construction, and commissioning activities on the desired outcome. The Design Intent Document shall be written in objective and measurable terms. Quantify parameters such as space temperatures, humidity levels, lighting levels, sound levels, and ventilation rates when applied to the conditioned building spaces. The Design Intent Document shall be updated every time the owner accepts an alternate performance criterion – due to owner desires, schedule, or budget. This might occur through normal design evolution, value engineering, change orders, or other supplemental instructions during construction. During the Correction Period and On-Going Operations, the Design Intent Document helps the owner/operators understand the original design intent. It also provides the benchmark for maintenance, repair, and replacement decisions. The Design Intent Document is developed by the Owner.

Basis of Design (2.03): The Basis of Design is a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria. The Basis of Design is developed by the Designers.

Commissioning Design Review (2.04): At least once during each of the Schematic Design, Design Development, and Construction Documents Phases, the Commissioning Leader will review the design progress against the goals of the Design Intent Document. Commissioning Design Review comments shall be documented in writing and responses prepared by the Designers.

1) Performance Check: Commissioning Team shall review design as documented to verify that it meets the physical outcomes and operational performance defined at that phase. Performance areas include, but are not limited to:
    a) Design Intent acceptance criteria for all required or additional pursued guidelines
    b) Requirements for specific operational scenarios of the building
    c) Regular maintenance, cleaning, and servicing (including ISO 14000 cleaning materials)
2) Measurability/ Testability Check: Commissioning Team shall review design as documented to verify that it meets criteria for testing and verification of performance for Design and Construction Commissioning as well as Operations Commissioning monitoring during On-going Occupancy. Performance areas include, but are not limited to:
    a) Measurements and testing required during all phases of Design and Construction Commissioning.
    b) Measurement, monitoring, and control of energy, water, indoor environmental quality during Ongoing Occupancy.

Coordinate with Operations Commissioning Requirements (2.05): Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning. Refer to Guideline P.5 Operations Commissioning for an understanding of what these features might be.

4.2.5 DESIGN DEVELOPMENT

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Design Development:

Commissioning Design Review (2.04): Refer to previous description.

Coordinate with Operations Commissioning Requirements (2.05): Refer to previous description.

4.2.6 CONSTRUCTION DOCUMENTS

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Construction Documents development:

Commissioning Design Review (2.04): Refer to previous description.

Coordinate with Operations Commissioning Requirements (2.05): Refer to previous description.

Incorporate Commissioning Criteria & Scope into Construction Documents (2.07): The Designer will incorporate a commissioning specification section into Division 1 of the project manual. The commissioning specification shall define and elaborate on the contractor's responsibilities as defined in the Commissioning Plan. Incorporate the Commissioning Plan into the contract documents by reference in order to communicate the context of the commissioning specification and information regarding other team member responsibilities. The commissioning specification will be developed by the Commissioning Leader.

4.2.7 CONSTRUCTION

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during Construction:

Coordinate with Operations Commissioning Requirements (2.05): Refer to previous description.

List of I/O Data Points (2.06): The Designer will submit a list of input and output (I/O) data points as part of outcome documentation before the end of Design Development to the Commissioning Leader. These shall be submitted for all computer-based control systems, e.g., HVAC, lighting controls, etc.

Review Contractors' Submittals (2.08): The Commissioning Leader will review Contractor's submittals for commissioned equipment and other commissioned design elements. These design reviews include a general quality review, discipline coordination, specification coordination, and adherence to the design intent.

Verify Installation (2.09): The Contractor will complete customized system installation checklists prior to acceptance by the owner. The installation checklists will be developed by the Commissioning Leader and will be included in the Design and Construction Commissioning Plan.

Verify Functional Performance (2.10): The Contractor will complete all of the customized system functional performance test procedures prior to system acceptance by the owner. The Commissioning Leader will facilitate the Contractor's implementation of these tests. The functional performance test procedures will be developed by the Commissioning Leader and will be included the Design and Construction Commissioning Plan.

Verify O&M Documentation (2.11): The O&M documentation provides information needed to understand, operate, and maintain equipment. The O&M documentation is by the facilities staff as reference throughout the life of the facility. The O&M documentation is provided by Contractors and is component to the systems manuals. The Commissioning Leader will verify that the O&M documentation provides the necessary information to operation and maintain the equipment prior to construction completion and the system acceptance by the Owner.

Verify O&M Training (2.12): The facilities staff is provided with O&M training to ensure they have the knowledge and skills required to understand, operate, and maintain the systems and equipment. Typically, the Designers provide systems training and the Contractors provide equipment training. The Commissioning Leader will verify that the training sessions provide the necessary information to operation and maintain the facility prior to construction completion and system acceptance by the Owner.

Cohesive O&M Systems Manual (2.13): The O&M Systems Manual provides information needed to understand, operate, and maintain the systems. The O&M Systems Manuals are for the facilities staff not involved in the design or construction process and utilized throughout the life of the facility. The O&M Systems Manual are created by the Contractors and are continually updated throughout the design and construction phases of the project. The Contractor will coordinate the contents of the Commissioning Report and combine into the cohesive O&M Systems Manual to be delivered to the Owner.

4.2.8 CORRECTION PERIOD

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during the Correction Period:

Coordinate with Operations Commissioning Requirements (2.05): Refer to previous description.

Deferred Verification (2.14): Some of the system functional performance test procedures will not be practical or meaningful to complete prior to the Correction Period. This may be due to construction phasing or climate constraints. Those test procedures shall be completed at an appropriate time during the Correction Period by the Contractor. The Commissioning Leader will facilitate these deferred test procedures.

Ten-Month O&M Review (2.15): Ten-months into the Correction Period, the Commissioning Team will review the building operation with the O&M staff and create a plan for resolution of outstanding commissioning-related issues.

4.2.9 ON-GOING OPERATIONS

In conjunction with the general Commissioning activities, the following are specific Commissioning activities addressed in during On-Going Operations:

Add any additional Commissioning activities specific to the On-Going Operations Phase.

4.3 ROLES AND RESPONSIBILITIES

Understanding and clearly defining the role of each team member is crucial to successfully implementing the Commissioning Process. These roles and responsibilities should be contractually defined between the (1) Owner and the Contractor and (2) Owner and the Designers.

The roles and responsibilities for the Commissioning Leader, Facilities Operations Manager (FOM), Designers, Contractors, and the Guideline Leader are defined below:

The Suggested Implementation is presented in the form of the attached Design and Construction Commissioning matrix.

Roles and responsibilities for each Commissioning Team member are flexible and need to be defined as part of the project-specific Commissioning Plan. However, some team members are prohibited from performing some of the activities due to inherent conflicts of interest.

4.3.1 GENERAL COMMISSIONING ACTIVITIES

GENERAL COMMISSIONING ACTIVITIES	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Design & Construction Phase Commissioning Plan	Develop and Update	Review	Review	Review	Review	Review
Commissioning Reports	Provide periodic Commissioning Reports	Provide acceptable representation with the means and authority to prepare and coordinate implementation of the Commissioning Process as detailed in the Contract Documents	Review periodic Commissioning Reports	Review and comment on the Commissioning Leader's Commissioning reports and Commissioning Issues Log	Review periodic Commissioning Reports	-

GENERAL COMMISSIONING ACTIVITIES	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Submit Outcome Documentation	Provide outcome documentation from Commissioning activities	-	-	-	-	Submit the Outcome Documentation as required by the B3 Guidelines at the end of each phase of the design and construction process. Interpret and provide guidance relevant to the implementation Minnesota Sustainable Building Guidelines (B3 Guidelines)
Meetings	Conduct and document Commissioning Coordination Meetings Conduct and document Commissioning Kick-off Meetings during the pre-design and pre-construction phases	Participate	Participate	Participate in Pre-Design, Schematic Design, Design Development Phase coordination and review meetings Attend the pre-bid and pre-construction meetings as scheduled by the Commissioning Leader	Participate in the pre-construction and Commissioning Team meetings	Participate

4.3.2 AGENCY PLANNING

AGENCY PLANNING	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Planning Baseline	Advises Owner	Assists in development	Assists in development	Develops	-	-

4.3.3 PRE-DESIGN/PROGRAMMING

PRE-DESIGN / PROGRAMMING	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Programming Baseline	Advises Owner	Assists in development	Assists in development	Develops	-	-

4.3.4 PRE-DESIGN/SITE SELECTION

PRE-DESIGN / SITE SELECTION	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Programming Baseline	Advises Owner	Assists in development	Assists in development	Develops	-	-
Review Site Alternatives for Ability to Achieve Performance Goals	Review to ensure that that systems being commissioned can achieve their Design Intent criteria	-	-	-	-	-

4.3.5 SCHEMATIC DESIGN PHASE

SCHEMATIC DESIGN PHASE	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Design Baseline	Advises Owner	Assists in development	Assists in development	Develops	-	-
Design Intent Document	Facilitate and document DID	Approve	Approve	Participate and assist in the documentation of the DID	-	-
Basis of Design	-	Approve	Approve	Develops based on the DID	-	-
Commissioning Design Review	Review schematic design documents in accordance with the DID Complete Performance Check	-	-	Respond to Commissioning Team design review comments and other issues in a timely manner	-	-
Coordinate with Operations Commissioning Requirements	Assist Designers	-	-	Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning	-	-

4.3.6 DESIGN DEVELOPMENT

DESIGN DEVELOPMENT	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Commissioning Design Review	Review schematic design documents in accordance with the DID Complete Performance Check	-	-	Respond to Commissioning Team design review comments and other issues in a timely manner Review and incorporate (as appropriate) the Commissioning Leader's submittal reviews	-	Verify performance that is not covered under Commissioning Section
Coordinate with Operations Commissioning Requirements	Assist Designers	-	-	Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning	-	-
List of I/O Data Points	Review I/O Data Points for completeness and accordance with the DID	-	-	-	Provide list of I/O data points to the Commissioning Leader for review	-

4.3.7 CONSTRUCTION DOCUMENTS

CONSTRUCTION DOCUMENTS	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Commissioning Design Review	Review design documents in accordance with the DID Review contractors' submittals for completeness and accordance with the DID	-	-	-	Provide submittals to Commissioning Leader for review	-
Coordinate with Operations Commissioning Requirements	Assist Designers	-	-	Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning	-	-

CONSTRUCTION DOCUMENTS	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Incorporate Commissioning Criteria & Scope into Construction Documents	Verify that the Commissioning Process is clearly defined in all scopes of work Assist in the integration of the Commissioning criteria and scope into construction documents Assist in integrating Commissioning activities into the project schedule	-	Include costs for the Commissioning Process in the contract price	Prepare the Construction Documents with the integration of the Commissioning criteria and scope Specify and verify the O&M documentation has been adequately detailed in the construction documents	Provide Commissioning criteria and scope in all subcontractors' contracts Include costs for the Commissioning Process in the contract price Provide Commissioning criteria, scope, and activities in each purchase order or subcontract written Obtain cooperation and participation of all subcontractors and manufacturers Include Commissioning activities into the project schedule	-

CONSTRUCTION DOCUMENTS	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Incorporate Commissioning Criteria & Scope into Construction Documents CONTINUED					Assist in integrating Commissioning activities into the project schedule	

4.3.8 CONSTRUCTION ADMINISTRATION

CONSTRUCTION	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Coordinate with Operations Commissioning Requirements	Assist Designers	-	-	Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning	-	-
Review Contractors' Submittals	Review and Comment in accordance with the DID	Review and Comment	Review and Comment	Review and Comment	Provide submittals to the Owner, Designers, and Commissioning Leader	-

CONSTRUCTION	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Verify Installation	Verify installation by reviewing successful completion of installation checklists Periodically review Record Drawings for accuracy	-	-	Review and accept record drawings as required by construction documents	Complete and submit the installation checklists Continuously maintain the record drawings	-

CONSTRUCTION	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Verify Functional Performance	Verify Functional Performance by facilitating successful completion of functional performance tests Develop, track, and update Commissioning Issues Log Facilitate retesting of functional performance testing	-	-	Review test procedures submitted by the Contractors Review and comment on the Commissioning Leader's Commissioning Issues Log	Notify the Commissioning Leader when the systems and equipment are ready for testing Implement the functional performance tests Remedy deficiencies identified by the Commissioning Leader during the completion of the installation checklists and functional performance testing	-

CONSTRUCTION	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Verify O&M Documentation	Verify that the contractor creates and submits O&M manuals for the owner prior to construction completion and system acceptance by the owner	Accepts O&M Documentation	Accepts O&M Documentation	-	Submit O&M documentation	-
Verify O&M Training	Facilitate training sessions	Provide staff to attend O&M training	Provide staff to attend O&M training	Participate in the training sessions presenting a systems overview	Implement the O&M training as detailed in the contract documents	-
Cohesive O&M Systems Manual	Verify O&M System Manuals for completeness and accordance with the DID	Accepts O&M Systems Manual Documentation	Accepts O&M Systems Manual Documentation	Assist in development of O&M Systems Manual	Complete O&M Systems Manuals	-

4.3.9 CORRECTION PERIOD

CORRECTION PERIOD	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Coordinate with Operations Commissioning Requirements	Assist Designers	-	-	Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning	-	-
Deferred Verification	Facilitate deferred verification of functional performance testing Develop, track, and update Commissioning Issues Log	-	-	-	Implement deferred functional performance testing	-
Ten-Month O&M Review	Participate in 10-Month O&M Review	Participate in 10-Month O&M Review	Participate in 10-Month O&M Review	-	Participate in 10-Month O&M Review	Participate in 10-Month O&M Review

CORRECTION PERIOD	**Commissioning Leader**	**Facilities Operations Manager (FOM)**	**Project Manager**	**Designers**	**Contractors**	**Guideline Leader**
Final Commissioning Report	Develop Final Commissioning Report Update final Commissioning Report (as necessary)	Review the Final Commissioning Reports (as necessary)	Review the Final Commissioning Reports (as necessary)	-	-	-

4.3.10 ON-GOING OPERATIONS

ON-GOING OPERATIONS	Commissioning Leader	Facilities Operations Manager (FOM)	Project Manager	Designers	Contractors	Guideline Leader
Add Commissioning Task						
Add Commissioning Task						
Add Commissioning Task						

5 SUPPORTING COMMISSIONING DOCUMENTATION

5.1 B3 Guidelines Tracking Tool (www.msbgtracking.com)

5.2 Appendix P-0 Suggested Implementation for All Performance Management Guidelines

5.3 Appendix P-4a Design and Construction Commissioning Supporting Information

5.4 Appendix P-4b Design and Construction Commissioning Matrix

Appendix P-5a: Operations Commissioning Supporting Information

Introduction
Operations Commissioning shall be planned for during design, but focuses on the operations of the facility after construction through the next use of the facility. The Operations Commissioning process is the means to verify and document that the systems of a facility and the facility as a whole continue to operate in accordance with their design intent overtime. This includes planning, implementation, and documentation for regular preventative maintenance, Measurement and Verification of system and whole building performance, and improvement and correction of that performance. The Operations Commissioning process is coordinated by the Operations Commissioning Leader and executed by the Operations Commissioning Team. Initial operations input is provided by the participation of the Facility Operations Manager on the Design and Construction Commissioning Team.
Later in design, the Operations Commissioning Team is formed and leads the planning for Operations Commissioning after occupancy.

The following are narrative descriptions of the activities (rows) in the Operations Commissioning Matrix.

1. GENERAL

1.01 Evaluate Existing Facility Operations
Evaluate existing facility operations to provide a reference point of operating issues for use in planning operation of the future facility or the existing renovated facility. Note that all existing state buildings must participate in the B3 Benchmarking Database.

1.02 Participate on Design & Construction Commissioning Team
Identify a Facility Operations Manager (FOM) who will manage maintenance and operations of the facility, be responsible for understanding Operations and Maintenance manuals, and monitor and report ongoing performance of the facility. The FOM should participate throughout the design process for continuity into final operation.

This person shall be part of the Design and Construction Commissioning Team and work closely with the Guideline Leader during design phases. The FOM shall represent operations issues from the beginning of the Design and Construction Commissioning Process and shall also be part of the Operations Commissioning Team once it is formed.

1.03 Engage Operations Commissioning Team
Identify Leader and Members of the Operations Commissioning Team during the Design Development phase of the design and construction project. The team shall be comprised of the following individuals, plus any added expertise needed for specific building systems.
Facilities Operations Manager (FOM) is accountable for facility performance and manages or performs ongoing operational practices, maintenance and corrective actions. FOM may also fill the role of Guideline Leader during ongoing occupancy phases.
The person from the Operations Work Team who will be in charge of compliance with the Guidelines during Ongoing Occupancy (Guideline Leader if applicable to Agency Process). This person will document

ongoing management, maintenance and correction actions, and complete annual and interim reporting as per the Outcome Documentation Forms.

1.04 Operations Commissioning Plan

The Operations Commissioning Plan shall include directly or by reference provision for all items required in the Commissioning Guideline P.5 for planning, implementing, or documenting activities from Correction Period through the life of the project. The Operations Commissioning Plan includes by reference the following documents that may be packaged separately but shall be coordinated with all other parts of the Operations Commissioning Plan.

- Systems Turnover Process (from Construction to Operations)
- Operations and Maintenance Manuals (O&M Manuals as per conventional contracts)
- Problem Response Plan
- Maintenance Plan
- Measurement and Verification Plan
- Systems Operations Manual
- Funding and Staffing Plan

The Operations Commissioning Plan shall evolve as follows:

Design Development Phase

Operations Commissioning Plan shall be outlined during a project's Design Development Phase; a time when operations issues shall be coordinated with design and construction issues.
Review and participate in coordination of the Operations Commissioning Plan and the Design and Construction Commissioning Plan

Construction Documents Phase

A complete Operations Commissioning Plan shall be developed during the Construction Documents phase of the design and construction project in cooperation with the Design and Construction Commissioning Team.

Correction Phase

The Operations Commissioning Plan shall be finalized during the Correction Period when all technical details of the building systems are known.

The Facilities Operations Manager (FOM) participates in the development and review of the Operations Commissioning Plan. FOM submits a funding and staffing plan that outlines the FOM's methodology to fund and staff all aspects of the Operations Commissioning Plan.

1.05 Annual Operations Commissioning Review & Plan Update

During On-going Operations, review all aspects of the Operations Commissioning Plan at least annually. Update the Plan as needed to reflect changes in equipment or practices.

The FOM updates the facility's operations budget and staffing as required to continue the implementation of the Operations Commissioning Plan based on updates to the Operations Commissioning Plan and changes to the equipment, systems, or operations.

1.06 Annual Operations Commissioning Report

The Operations Commissioning Report is an evaluation of work at a particular point in time in comparison with the Commissioning Plan. After the correction period, complete an Operations Commissioning Report that documents monitored usage and other data, and includes a log of actions taken to address aberrations or problems.

1.07 New Employee Training Program
Orient new members of the facility's operations and maintenance management and staff to the building system documentation and the Operations Commissioning Plan. All staff shall be familiar, at a level appropriate with their responsibilities, with the history and upkeep of project records and their contents from review of prior phases of the Operations Commissioning Plan and its supporting documents.

1.08 Submit Outcome Documentation
Submit Outcome Documentation in the B3 Guidelines Tracking Tool (www.msbgtracking.com) as required by the B3 Guidelines at the end of each phase of the design and construction process and throughout the on-going operations phase.

1.09 Next Use
Provide transition data, history, requirements and Guideline plans and reports to new owner and facility manager. Encourage the new owner to proactively support the Guidelines.

2. SYSTEM TURNOVER PROCESS FROM CONSTRUCTION TO OPERATIONS
2.01 Define Turnover Prerequisites
Define the minimum level of completeness and/or performance required prior to the formal transfer of responsibility from the construction team (contractors) to the operations team (owner). These prerequisites must be objective and enforceable and communicated clearly to the Design and Construction team for inclusion in the bid documents.

2.02 Define Authority for Official Acceptance and Turnover
Define exactly who, typically someone representing the Owner, will have final approval authority for the transfer of the systems from the contractors to the owner.

2.03 Operations Team Familiarization with Project Documentation and Systems
Prepare and follow a schedule for preparing operations and maintenance individuals to take over the building systems. This familiarization should be complete prior to the official turnover:

- Identify the future operations team members and make them available for turnover preparation activities.
- Allow the future operations team members to walk through the construction site as frequently as practical, especially prior to wall and ceiling close-in.
- Introduce the future operations team members to the construction documents and operations & maintenance manuals.
- The future operations team members shall attend the formal equipment and systems training sessions provided by the installing contractors.
- Conduct formal question and answer sessions with the future operations team and the designers and contractors to address remaining questions and concerns prior to turnover.

- Introduce the future operations team members to the Problem Response Plan (refer to Section 3), Maintenance Plan (Section 4), and Energy Efficient Operations Manual (Section 5) components.

2.04 Complete Systems Transfer from Contractors to Operators
Systems shall be turned over to the operations team either all at once or on a pre-defined piecemeal basis. However, once a system is turned over to the owner, the contractors shall obtain permission and provide full documentation for all work performed on any turned-over system.

3. PROBLEM RESPONSE PLAN
The Problem Response Plan is part of the Operations Commissioning Plan and shall cover the systems and materials commissioned under Operations Commissioning Scope. Key components of the Plan are clear assignments of responsibility to individuals and defined lines of communication. Incorporate a planned response to anticipated feedback or triggers indicating potential performance problems such as an increase in IEQ complaints or aberrations in monitored resource use. This includes problems discovered by the Operations Staff as they implement their Work Order Verifications as defined in Section 5.11: Facility Work Order Verifications of this Appendix.

If the project is part of a campus (e.g., under the ownership or management of a single entity such as a corporation, government, college or university), the equipment and/or systems defined under the project shall follow the Problem Response Plan requirements.

Typically, campus-style facilities employ a comprehensive computerized maintenance management systems (CMMS) which manages and documents the campus equipment and systems' preventive maintenance schedules, troubleshooting calls, work orders, etc. If the Problem Response Plan components listed below (3.01 through 3.05) are not covered, they shall be incorporated into and/or supplement the existing campus-wide operations and maintenance program.

If the Problem Response Plan components are already included in the campus-wide operations and maintenance program, the Contractor shall document how each component is addressed for the pre-defined acceptance authority. If there are Problem Response Plan components not included in the existing campus-wide operations and maintenance program, the Contractor shall describe how each such component will be addressed and implemented. This documentation shall be provided to the pre-defined acceptance authority for review and approval (refer to Section 2.02 above).

3.01 Problem Documentation Process
Define a process by which problems are documented and passed on to the appropriate party for attention.

3.02 Problem Response Process
Predefine potential problem responses for use in timely and comprehensive management of each documented problem. Responses may include fixing or replacing broken components (including correction work by installing contractors), recalibrating control devices, performing functional performance tests to help identify the root cause of a problem, redesigning an system that no longer meets the changing needs of the occupants, etc.

3.03 Problem Resolution Documentation Process
The Problem Response Plan process shall include a feedback loop for positive closure.

3.04 Implementation
Implement the Problem Response Plan immediately upon turnover from the contractors to the operations team. Clearly define lines of communication with the installing contractors for correction phase activities. The operations team must be in control of and/or aware of all activities associated with the systems following turnover.

3.05 Annual Evaluation and Reporting
Each problem and its resolution shall be logged for incorporation into the annual Operations Commissioning Report.

4. MAINTENANCE PLAN
The Maintenance Plan is part of the Operations Commissioning Plan and shall apply to all systems and materials commissioned under the Operations Commissioning Scope.

If the project is part of a campus (e.g., under the ownership or management of a single entity such as a corporation, government, college or university), the equipment and/or systems defined under the project shall follow the Maintenance Plan requirements.

Typically, campus-style facilities currently employ comprehensive computerized maintenance management systems (CMMS) which manage and document the campus equipment and systems' preventive maintenance schedules, troubleshooting calls, work orders, etc. If the Maintenance Plan components listed below (4.01 through 4.11) are not covered, they shall be incorporated into and/or supplement the existing campus-wide operations and maintenance program.

If the Maintenance Plan components are already included in the campus-wide operations and maintenance program, document how each component is addressed for the pre-defined acceptance authority. If there are Maintenance Plan components that are not included in the existing campus-wide operations and maintenance program, the Contractor shall describe how each such component will be addressed and implemented. This documentation shall be provided to the pre-defined acceptance authority for review and approval (refer to Section 2.02 above).

4.01 Cleaning Products and Practices
Use ISO 14000 requirements for cleaning supplies in standard maintenance after building occupancy.

4.02 Cleaning Products Documentation
Document all cleaning products used and quantities of each for inclusion in the annual Operations Commissioning Report.

4.03 Moisture Prevention Practices
Establish maintenance procedures that will identify unintended water intrusion, leakage or accumulation quickly and provide drying or removal of building structure elements within 48 hours of the unintended event.

4.04 Moisture Response Practices
When exterior water intrusion, leakage from interior water sources, or other uncontrolled accumulation of water occurs, the intrusion, leakage or accumulation shall be corrected because of potential for these

conditions to cause the growth of mold. (Title 8, Chapter 4, Section 3362(g) of California Occupational Safety and Health Standards, Sept. 2002.)

4.05 Moisture Control Documentation
Document all moisture intrusion events and their resolution for inclusion in the annual Operations Commissioning Report.

4.06 Preventive Maintenance Activities
Implement a preventive maintenance program for IAQ and other Indoor Environmental Quality factors in the building. The preventive maintenance plan shall include regularly scheduled checks to verify ongoing performance and to prevent failures of the facility and its systems, including verification of selected system performance compared to their respective Expected Performance Graph-Diagnostic Diagrams (refer to 6.10 and 6.11 below). This can be modeled after EPA's Building Air Quality Program (1991) or their web-based system called I-BEAM (IAQ building education and assessment).

4.07 Preventive Maintenance Documentation
Document the preventive maintenance program, inventory of equipment, and scheduled work orders in the Operations Commissioning Plan. Log all completed preventive maintenance activities for inclusion in the annual Operations Commissioning Report.

4.08 Implementation
Implement the Preventive Maintenance Plan immediately upon turnover from the contractors to the operations team. During the correction phase of the project, it is critical that required preventive maintenance be performed in order to maintain the validity of equipment manufacturers' warranties.

4.09 Annual Building IAQ Performance Evaluation
Perform an evaluation of building IAQ performance annually. Measure key factor that determines ventilation rate for the building (major pollutant or CO_2) in the building occupied zones. Pollutant concentrations measured should be within the guideline range, and CO_2 levels should be at or below 450 ppm over outdoor levels. If not, additional ventilation must be provided or sources eliminated until concentrations fall below action levels. Action values for each pollutant are given in Appendix I-1.1

4.10 Annual Evaluation and Reporting
Facilities Operations Manager reviews the results of Indoor Environmental Quality management practices and highlights any issues needing resolutions. If, in the judgment of the Facilities Operations Manager, a severe or repeated complaint occurs, the Facilities Operations Manager will arrange for an investigation of the situation, and recommend corrective action if appropriate.

Annually, evaluate the following Systems Operations and Maintenance Practices in comparison to the Maintenance Plan portion of the Operations Commissioning Plan. Document findings and correct maintenance and operations practices, or update the Plan to reflect changes in practices.

- Site Systems
- Water Systems
- Energy Systems
- IEQ Systems
- Materials and Waste Systems

5. ENERGY EFFICIENT OPERATIONS MANUAL (RECOMMENDED/IN DEVELOPMENT)

The Energy Efficient Operations Manual is part of the Operations Commissioning Plan and documents important reference information for operating building systems. Tools supporting the processes outlined here are in development; please check the Operations Program details at www.b3.umn.edu/ for current information. This section of the Operations process shall occur at regular intervals, or in response to other events or triggers at the discretion of the owner, to evaluate the following:

- Mechanical HVAC Comfort and Renewable Energy Systems: As needed to support performance of Guidelines: E.1, E.2, E.3, E.4, I.4, I.5
- Electrical Systems, including Lighting and Daylighting Controls: As needed to support performance of Guidelines: S.5, E.1, E.2, E.3, I.6, I.9
- Indoor Air Quality Elements and Systems: As needed to support performance of Guidelines: I.1, I.2, I.3, I.4, I.5
- The Systems Operations Manual shall include the following elements:

5.01 System Descriptions

Owner's performance requirements, design basis narratives, descriptions of each system, etc.

5.02 As Built Control Drawings and Sequences of Operation

As built control system documentation is typically obtained from the control system contractor following commissioning and acceptance of the systems at the end of project construction.

5.03 Time of Day Schedules and Plan for Assessing their Relevance

Document initial time of day schedules for each piece of controlled equipment. Based on building occupancy and usage, determine if and how often these schedules should be re-evaluated for minimum run times. Program those re-evaluations into the Preventive Maintenance system for automatic reminders.

5.04 Seasonal Considerations

Seasonal startup and shutdown, manual and restart operation procedures, and recommendations regarding seasonal issues that affect energy use. Program seasonal activities into the Preventive Maintenance system.

5.05 Recalibration Schedule

Recommended recalibration frequency for each sensor and device type. Program recalibration of each sensor and device into the Preventive Maintenance system.

5.06 Adjustable Setpoints and Plan for Assessing their Relevance

List of adjustable setpoints and reset schedules. Based on building requirements and performance under actual occupied loads, regularly evaluate the appropriateness of each setpoint for meeting with owner's requirements while minimizing energy consumption. Program those re-evaluations into the Preventive Maintenance system for automatic reminders.

5.07 Recommissioning Tests

Schedule for testing systems with procedures used in initial commissioning process. Program recommissioning tests into the Preventive Maintenance system.

5.08 Allocation of Building Energy

The initial allocation of building energy diagrams shall estimate the building's annual energy consumption by type (e.g., natural gas, steam, chilled water, electricity, etc.). Furthermore, the estimated annual building energy consumption data should be broken down graphically into their respective energy consuming systems (e.g., heating, cooling, lighting, plug loads, etc.). The allocation of building energy diagrams shall be developed by the Energy Modeler during the design phase. For additional Sustainable Building 2030 requirements, refer to the Sustainable Building 2030 Compliance and Reporting Instructions.

5.09 Energy System Diagrams

Based on the allocation of building energy, develop energy system diagrams for systems that consume large amounts of energy, operate continuously, and/or are leading to excessive energy consumption. The development of the energy system diagrams shall be a joint effort between the Controls Contractor and the Commissioning Leader; where the Commissioning Leader is ultimately responsible for the development of the energy system diagrams. The energy system diagrams shall be developed and completed shortly after the approval of submittals during the construction documents phase.

During the on-going operations phase, additional energy system diagrams and/or updates shall be incorporated into existing Systems Operation Manual as equipment is added or removed to the building. Future energy system diagrams shall be developed and/or updated by the involved Controls Contractor and/or Commissioning Leader (if applicable).

5.10 Expected Performance Graph-Diagnostic Diagrams

Develop expected performance graph-diagnostic diagrams for each system that merited an energy system diagram. The expected performance graph-diagnostic diagrams illustrate how systems should operate based on their design and approved sequence of operation. These will be used as tools by the Operations Staff to determine if the systems and/or equipment are operating optimally. The expected performance graph-diagnostic diagrams shall be developed by the Commissioning Leader with input from the Designers shortly after the approval of submittals during the construction documents phase.

During the on-going operations phase, additional expected performance graph-diagnostic diagrams and/or updates shall be incorporated into existing Systems Operation Manual as equipment is added or removed to the building. Future expected performance graph-diagnostic diagrams shall be developed and/or updated by the involved Commissioning Leader.

5.11 Facility Work Order Verification Documents

Create facility work order verification documents where data (e.g., temperatures, equipment status, schedules, etc.) will be collected by the Operations Staff at periodic intervals while the facility is operational and occupied. On a regular basis, the Operations Staff shall compare the facility work order verification data to the expected performance graph-diagnostic diagrams in order to determine if the systems and/or equipment are using more energy than necessary. Deviations will be tracked through the Problem Response Plan process to identify the root cause and to determine the actions necessary to improve or remedy operational issues. Refer to Section 3: Problem Response Plan of this Appendix.

The facility work order verification "template" documents shall be created by the Commissioning Leader prior to substantial completion so they can be incorporated into the Maintenance Plan.

During the on-going operations phase, additional facility work order verification "template" documents and/or updates shall be incorporated into the Systems Operation Manual as equipment is added or

removed to the building. Future facility work order verification documents shall be developed and/or updated by the involved Commissioning Leader. If commissioning is not part of the equipment updates, the Designer and Contractors shall assist in the facility work order verification "template" document development and/or updates.

5.12 Implementation
Implement the systems operational evaluation/recommissioning process immediately upon turnover from the contractors to the operations team. During the correction phase of the project, the systems operational evaluation/recommissioning process and data will help identify any previously undiscovered aberrations in the system design, installation, and/or startup. It will also help to identify equipment failures within their respective correction periods.

5.13 Annual Evaluation and Reporting
The Facility Operations Manager (FOM) shall review the results of the systems operations evaluation/recommissioning process. Are verification work orders being completed on a timely basis? Are anomalies being documented and corrected? Is the documentation complete and orderly? If, in the judgment of the FOM, a severe or repeated problem occurs, the FOM will arrange for an investigation of the situation and recommend corrective action if appropriate.

Annually evaluate the systems operations evaluation/recommissioning process itself in comparison to the Systems Operations Manual portion of the Operations Commissioning Plan. Document concerns and correct or update the Systems Operations Manual to reflect changes in practices.

6. POST OCCUPANCY EVALUATION

6.01 Begin B3 Post Occupancy Evaluation (POE) Process
There are three (3) levels of sustainable POE surveys to choose from: "Scan, Core, and Advanced." The required "Scan" survey is available for select building types and is free for State Funded B3 Guideline required projects. Complete details can be found at www.b3.umn.edu/poe. Buildings with space types with no supported SPOES at 6 months post-occupancy (3 months prior to the first required POE) are exempt from this requirement. Projects may also be exempt if they do not meet the minimum required number of occupants or residents; more details on applicability are available at the B3 POE website.

The goal of these evaluations is to standardize the methodology for studying building's performance from the occupant's points of view, to provide feedback to the owners and operators, and understand how the building performs in practice.

Identify the facility or organization primary contact for the survey collection process and which tool will be used.

"Scan" Survey Level Details (Required)
- Measures "vital signs" of occupant perceptions
- Useful for quick evaluation of human outcomes related to sustainable criteria
- Limited diagnostic potential
- Tool and analysis is free of charge for State Funded B3 Projects

"Core" Survey Level Details
- Includes "Scan" survey level plus additional details about specific IEQ issues and locations

- Allows more analysis to show relationships between results
- Evaluative information plus a diagnostic screening tool
- Fee associated "Core" survey level

"Advanced" Survey Level Details

- Includes "Scan" and "Core" plus other areas owner or research interest
- Custom analyses also possible
- Draws added questions from master menu or unique to survey
- Fee associated with "Advanced" survey level

After the required surveys during the correction period, the FOM shall perform or coordinate completion of optional post-occupancy evaluation when organizational or productivity issues arise or at regular intervals.

6.02 Nine Month Sustainable Post Occupancy Survey (SPOES)

Nine months into the Correction Period conduct the first User Comfort & Satisfaction Survey as defined in the Assessment Plan.

6.03 Eighteen Month Sustainable Post Occupancy Survey (SPOES)

Eighteen months into the Correction Period conduct the second User Comfort & Satisfaction Survey as defined in the Assessment Plan.

Appendix P-5b: Operations Commissioning Matrix

B3 State of Minnesota Sustainable Building Guidelines version 2.2

		PROJECT PHASE									TEAM MEMBERS RESPONSIBILITIES "R" represents Responsible Party "x" represents Participating Party					
	ACTIVITIES	Agency Planning	Pre-Design - Programming	Pre-Design - Site Selectin	Schematic Design	Design Development	Construction Documents	Construction	Correction Period	On-Going Operations	Cx Leader	Facilities Operations Manager (FOM)	Designers	Contractors	Energy Modeler	Guideline Leader
1. GENERAL																
1.01	Evaluate Existing Facility Operations	x										R				
1.02	Participate on Design & Construction Commissioning Team	x	x	x	x	x	x	x	x			R				
1.03	Engage Operations Commissioning Team					x						R				x
1.04	Operations Commissioning Plan					x	x		x		x	R	x	x	x	x
1.05	Annual Operations Commissioning Review & Plan Update									x		R				x
1.06	Annual Operations Commissioning Report									x		R				x
1.07	New Employee Training Program									x		R				
1.08	Submit Outcome Documentation	x	x			x	x	x	x	x		x				R
1.09	Next Use									x		R				
2. SYSTEM TURNOVER PROCESS FROM CONSTRUCTION TO OPERATIONS																
2.01	Define Turnover Prerequisites						x				x	R	x			
2.02	Define Authority for Official Acceptance & Turnover						x					R				
2.03	Operations Team Familiarization with Project Documentation and Systems							x				R				
2.04	Complete Systems Transfer from Contractors to Operators								x			R				
3. PROBLEM RESPONSE PLAN																
3.01	Problem Documentation Process							x				R				
3.02	Problem Response Process							x				R				
3.03	Problem Resolution Documentation Process							x				R				
3.04	Implementation								x	x		R				
3.05	Annual Evaluation and Reporting								x	x		x				R

	ACTIVITIES	PROJECT PHASE									TEAM MEMBERS RESPONSIBILITIES "R" represents Responsible Party "x" represents Participating Party					
		Agency Planning	Pre-Design - Programming	Pre-Design - Site Selectin	Schematic Design	Design Development	Construction Documents	Construction	Correction Period	On-Going Operations	Cx Leader	Facilities Operations Manager (FOM)	Designers	Contractors	Energy Modeler	Guideline Leader
4. MAINTENANCE PLAN																
4.01	Cleaning Products and Practices							x				R				
4.02	Cleaning Products Documentation							x				R				
4.03	Moisture Prevention Practices							x				R				
4.04	Moisture Response Practices							x				R				
4.05	Moisture Control Documentation							x				R				
4.06	Preventive Maintenance Activities							x				R				
4.07	Preventive Maintenance Documentation							x				R				
4.08	Implementation								x	x		R				
4.09	Annual Building IAQ Performance Evaluation									x		R				
4.10	Annual Evaluation and Reporting								x	x		x				R
5. ENERGY EFFICIENT OPERATIONS MANUAL (IN DEVELOPMENT - RECOMMENDED)																
5.01	System Descriptions							x			x		R			
5.02	As built Control Drawings and Sequences of Operation								x		x			R		
5.03	Time of Day Schedules and Plan for Assessing their Relevance						x	x				R		x		
5.04	Seasonal Considerations						x	x			x	R	x	x		
5.05	Recalibration Schedule							x			x	x		R		
5.06	Adjustable Setpoints and Plan for Assessing their Relevance							x				R		x		
5.07	Recommissioning Tests							x			x	R				
5.08	Allocation of Building Energy						x								R	
5.09	Energy System Diagrams							x			R		x	x		
5.10	Expected Performance Graph-Diagnostic Diagrams							x			R		x			
5.11	Facility Work Order Verification Documents							x		x	R					
5.12	Implementation								x	x		R				
5.13	Annual Evaluation and Reporting								x	x		x				R
6. CORRECTION PERIOD USER COMFORT AND SATISFACTION ASSESSMENT																
6.01	B3 Post Occupancy Evaluation Process (POE)							x				R				
6.02	9 Month Occupant Sustainable Post Occupancy Survey (SPOES)								x			R				
6.03	18 Month Occupant Sustainable Post Occupancy Survey (SPOES)								x			R				

Appendix P-6: Life Cycle Cost Supporting Information

Compliance with Legislation

State legislation identifies two different measures for evaluating the performance of new and existing buildings:

1. Section 16B.325 requires in part that the guidelines "focus on achieving the lowest possible lifetime cost for new buildings...";
2. Minnesota Laws 2001, Article 1, Ch 212,Sec.3. Benchmarks for Existing Public Buildings requires a comprehensive plan to maximize energy efficiency in existing public buildings "through conservation measures having a simple payback within ten to 15 years."

How are proposed projects to be evaluated in order to best ensure compliance with these requirements?

- The first requirement references a more comprehensive analysis, an analysis that strives to achieve the lowest possible lifetime cost for a proposed new building. This lifetime cost analysis requirement can be the source of some confusion because of varying definitions and interpretations and the math needed to complete the calculations. The materials in the following section are intended to serve as an introduction to this type of comprehensive analysis.
- The second requirement for energy efficient projects in existing buildings with a simple payback within ten to 15 years is simple enough, but in its simplicity it fails to recognize some important considerations. Some alternative measures that can be used in addition to the simple payback calculation are discussed below.

Why Discounting?

The process of converting streams of benefits and costs over time in the future back to an equivalent "present value" is called discounting. If the costs and the benefits (i.e. energy cost savings) of a particular proposal occur in the same time period the analysis is quite simple. If you were trying to pick the most cost effective choice between 2 rental cars for a weekend the analysis would be quite straightforward. If a hybrid rents for $50 a day and gets 50 MPG and a more traditional compact rents for $40 a day and gets 22 MPG, it is easy to envision the analysis. The most cost effective choice will depend on how many miles you expect to drive and the cost of gasoline. You might have some difficulty quantifying other considerations (i.e. you like or don't like the looks of the hybrid), but you could weigh such preferences against the least costly alternative. Does it make the choice easier or harder? How big a economic penalty are you willing to pay to support your styling preference?

But what if the costs and benefits are spread out over time? The same simple calculations don't work very well since we all have a "time value of money". If you are deciding which car to buy and the hybrid costs $24,000 and the traditional compact costs $21,000, how do you compare them? The extra $3,000 is a current expenditure while the gas savings will be spread over the years. Most people would not consider the hybrid to be the same cost as the traditional car if it saved exactly $3,000 in gasoline costs over 10 years. You would require more future savings than that to compensate for the fact that the benefits are spread over so many years. And what about maintenance and repairs? How will they compare? To properly compare these two alternatives you would need to convert costs and benefits to comparable Present Values and complete a "life-cycle cost analysis".

Discounting and Present Values

Discounting and Present Values are perhaps best understood as the reverse of compound interest. If you have $100 and invest it at 5% interest compounded annually for 10 years, it will grow by more than $50 over 10 years because of compounding. It will grow to $105.00 at the end of year 1, $110.25 in year 2, $115.76 in year 3, and so forth until in totals $162.89 at the end of year 10. Calculating a Present Value amounts to reversing the compounding process in order to answer the question, "What amount received today would have the same utility to me as $162.89 received ten years from now?" If my discount rate is 5%, the answer will be calculated to be $100.

Just as the interest rate is central to determining the total amount accumulated over the investment period, so the choice of discount rates drives the Present Value calculation. In the above example, if my discount rate were 8% instead of 5%, the $162.89 received in year 10 would have a Present Value of only $75.45. The choice of discount rates is very important to the validity of an analysis, overshadowed only by the critical importance of being consistent with the choice of discount rates throughout an analysis.

Federal Energy Management Program Guidance

The Federal Energy Management Program's Guidance on Life-Cycle Cost Analysis Required by Executive Order 13123 provides some useful definitions and guidance. "Section 707 of Executive Order 13123 defines life-cycle costs as *"...the sum of present values of investment costs, capital costs, installation costs, energy costs, operating costs, maintenance costs, and disposal costs over the life-time of the project, product, or measure."*

"Life-cycle cost analysis (LCCA) is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and disposing of a project are considered important to the decision. LCCA is particularly suited to the evaluation of design alternatives that satisfy a required performance level, but that may have differing investment, operating, maintenance, or repair costs; and possibly different life spans. LCCA can be applied to any capital investment decision, and is particularly relevant when high initial costs are traded for reduced future cost obligations."

The FEMP guidance goes on to explain the need for time adjustments , defines the life cycle cost formula, and discusses application of life cycle cost analysis. Included in the FEMP guidance are some important comments on the shortcomings of a simple payback analysis. These sections of the FEMP guidance are quoted below.

Time Adjustments

Adjustments to place all dollar values expended or received over time on a comparable basis are necessary for the valid assessment of a project's life-cycle costs and benefits. Time adjustment is necessary because a dollar today does not have equivalent value to a dollar in the future. There are two reasons for this disparity in value. First, money has real earning potential over time among alternative investment opportunities, and future revenues or savings always carry some risk. Thus an investor will require a premium or extra return for postponing to the future the spending of that dollar. Second, in an inflationary economy, purchasing power of money erodes over time. Thus a person would demand more than a dollar at some future time to obtain equivalent purchasing power to a dollar held today.

The process of converting streams of benefits and costs over time in the future back to an equivalent "present value" is called discounting. A discount rate is used in special formulas to convert future values. When future values are expressed in current (nominal) dollars, where inflation is included in the future values, a market (nominal) discount rate is used. It takes into account both inflation and the earning potential of money over time. When future values are expressed in real (constant dollar) terms, where general price inflation has been stripped out, a real discount rate is used. It takes into account only the earning potential of money over time. Both approaches yield identical results as long as you use real

discount rates in discounting constant-dollar future amounts and market discount rates in discounting current-dollar future amounts.

Choices among energy-savings projects can be made either by estimating for each alternative project a stream of life-cycle costs and savings relative to a "base case," and computing the net present value (NPV) of that stream (looking for the maximum NPV), or by calculating the present value of each project's life-cycle cost, and choosing the alternative (including "do nothing") that yields the minimum present value life-cycle cost (PVLCC.)

Life-Cycle Cost Formula

To find the total LCC of a project, sum the present values of each kind of cost and subtract the present values of any positive cash flows such as a resale value. Thus, where all dollar amounts are converted to present value by discounting, the following formula applies:
Life-cycle cost = first cost + maintenance and repair + energy + water+ replacement - salvage value.
Eventually, when additional considerations for values such as worker or occupant productivity and community or social values can be assessed and calculate with more certainty, they will be incorporated in the model as well. At this time, however, there are too many variables and little conclusive data associated with these topics to make them part of the standard calculations. However, Appropriated Agencies may want to consider the cost benefits of worker productivity improvements within their own models and use those as additional factors when considering the overall outcomes for net present value.

Applications of LCCA

Projects may be compared by computing the LCC for each project, using the formula above and seeing which is lower. The alternative with the lowest LCC is the one chosen for implementation, other things being equal.

The LCC method can be applied to many different kinds of decisions when the focus is on determining the least-cost alternative for achieving a given level of performance. For example, it can be used to compare the long-term costs of two building designs; to determine the expected savings of retrofitting a building for energy or water conservation, whether financed or agency-funded; to determine the least expensive way of reaching a targeted energy use for a building; or to determine the optimal size of a building system.

In addition to the LCC formula shown above, there are other methods for combining present values to measure a project's economic performance over time, such as Net Savings, Savings-to-Investment Ratio, Adjusted Internal Rate of Return or Discounted Payback.

Note on Discounted Payback (DPB) and Simple Payback (SPB)

Discounted Payback (DPB) and Simple Payback (SPB) measure the time required to recover initial investment costs. The payback period of a project is expressed as the number of years just sufficient for initial investment costs to be offset by cumulative annual savings. DPB is the preferred method of computing the payback period for a project because it requires that cash flows occurring each year be discounted to present value to adjust for the effect of inflation and the opportunity cost of money. The SPB does not use discounted cash flows and therefore ignores the time value of money, making it a less accurate measure than the DPB. In practice, the DPB or SPB is used to measure the time period required for accumulated savings to offset initial investment costs. Any costs or savings incurred during the remainder of the project life-cycle are ignored. The DPB and the SPB are therefore not appropriate

measures of life-cycle cost effectiveness and should be used only as screening tools for qualifying projects for further economic evaluation.

Analyzing a Proposed Project

- It is very likely that any entity proposing a significant state funded project will have the resources needed to prepare a discounted cash flow analysis of the project. Such an analysis, typically prepared with a software program such as Excel, will detail all of the initial costs of design and construction and then project future annual operating and maintenance costs, utility costs, replacement costs, and the residual value of the building and equipment. If these future costs are presented in current dollars in each year (showing the impact of inflation), they are then discounted back to the present using a nominal discount rate (a discount rate that recognizes inflation.) If future costs are expressed in constant dollars (not adjusted for inflation), then they are discounted back to the present using a real discount rate. (For example, FEMP discount and inflation rates, valid for energy and water conservation and renewable energy analyses conducted between 4/1/2004 and 3/31/2005 are: 3% Real Discount Rate, 4.8% Nominal Discount Rate, and a 1.75% Inflation Rate.) The initial costs and the discounted future costs are the summed to provide the discounted present value (discounted cost) of the proposed project over its life cycle. By completing a life cycle cost analysis of different options under consideration and then comparing the discounted present value of each, it is possible to work towards identifying the building option that has the lowest possible lifetime cost.

Appendix S-0: Suggested Implementation for All Site and Water Guidelines

This document is intended to offer guidance on the issues to consider throughout the planning, design, construction and operation processes to help achieve and improve on the performance for each guideline. This document is optional and is not a checklist to insure compliance. See the guidelines sections to identify specific requirements and any time-sensitive deadlines for those requirements.

S.1 Avoidance of Critical Sites

Agency Planning

- Determine ideal spatial needs for existing or new development.

Predesign-Programming

- Identify critical sites for preservation or restoration on the project site, as defined the Guidelines.
- Determine what type of buildings and related infrastructure will be required for the developed areas and their spatial requirements.
- Begin to allocate broad spatial footprints for the developed sites while preserving the critical sites identified during the predesign phase.

Schematic Design through Construction Documents

- Develop site plans and details that preserve, protect, and/or enhance critical sites within the project area.

Construction

- Hold a pre-construction meeting to identify requirements for protection/preservation of critical sites during and after the construction process.

Ongoing Occupancy and Next use

- Consider developing easements for critical sites that will preserve those sites beyond the life of the project.

S.2 Stormwater Management

Agency Planning

- Seek direction from Local Government Unit or authority having jurisdiction over the project's stormwater management. Understand applicable rules, regulations, and permitting requirements.

Predesign-Programming

- Perform a topographic, utility, boundary, and wetland surveys, as applicable.
- Identify areas on-site where the site conditions and topography will facilitate stormwater management.Identify areas on-site where the site conditions do not allow for stormwater treatment or infiltration, such as groundwater recharge areas or karst topography.

- Perform a geotechnical analysis of the site to determine soil types, infiltration rates, and areas best suited for stormwater management.

Schematic Design

- Complete general calculations to estimate the volume of stormwater that will need to be treated on-site per the Guideline requirements. Identify stormwater management techniques that are appropriate for the amount and type of stormwater generated by the developed site.

Design Development through Construction Documents

- Finalize stormwater calculations to determine the volume of stormwater that will need to be treated on-site per the Guideline requirements.
- Develop details and specifications for the stormwater management techniques identified for the project and size the techniques based on the stormwater calculations.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Make bidders aware of specific requirements for stormwater management.

Construction

- Hold a pre-construction meeting to identify requirements for the construction of stormwater management areas and for protection during and after the construction process.
- Construct stormwater management features in a sustainable manner, according to drawings and specifications.

Ongoing Occupancy and Next Use

- Develop an Operations and Maintenance manual for the ongoing care of the stormwater management arreas.
- Maintain stormwater management areas per the Operations and Maintenance manual.
- Maintain as-built records of stormwater systems.
- Monitor the stormwater management techniques and record the performance data.

S.3 Soil Management

Schematic Design through Construction Documents

- Develop a soil management plan to prevent erosion, maintain and protect topsoil, amend soil, and provide adequate soil rooting volume to grow large, healthy trees per the Guideline requirements.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Design Team shall observe that performance criteria of the soil management plan are being met.

Construction

- Hold a pre-construction meeting to identify requirements for protection, preservation, and enhancement of site soil during and after the construction process.
- Implement practices to meet performance criteria according to the drawings and specifications.

Correction Period

- Confirm successful implementation of performance criteria

S.4 Sustainable Vegetation Design

Predesign-Site Selection

- Select a site where the proposed building and infrastructure will have minimal disturbance on the existing vegetation and the supporting soil and hydrologic conditions that support it.

Schematic Design through Construction Documents

- Identify areas of vegetation or high-quality areas for restoration that will be protected or restored during the design and construction process.
- Integrate techniques that minimize negative impacts on soil, water, and vegetation on the site and adjacent sites that are to be preserved or restored.
- Develop details and specifications that support the use of native plantings, maintain existing biodiversity, and promote enhancement of site conditions per the Guidelines.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Make bidders aware of specific responsibilities for integrating the on-site vegetation management with connections to vegetation on adjacent sites.

Construction

- Hold a pre-construction meeting to identify requirements for protection/preservation of vegetation during and after the construction process.
- Protect existing plants and trees indicated to remain and maintain or improve soil and water conditions to promote and improve vegetation growth.

Ongoing Occupancy

- Create an Operation and Maintenance manual to protect and maintain the vegetation on-site.

Next Use

- Document the existing condition of the vegetation, the reason why it was preserved or enhanced, and its ability to function in its current capacity. Note what enhancements, and enlargements or reductions in spatial area would be needed to accommodate a different building type in the future.

S.5 Light Pollution Reduction

Schematic Design

- Define zones that require high, medium, and low levels of lighting based safety, security, and environmental concerns. Take into consideration existing nighttime ambient lighting levels.

Design Development

- Develop coverage patterns of lighting and design of light fixtures in relation to the scale of the development and the need for light or safety. Focus on enhancing way-finding, increasing safety, and minimizing glare and light trespass. increase wayfinding, and minimize light trespass at site periphery.

Construction Documents

- Develop site lighting that:
  - Adds and directs light only where it is required.
  - Is efficient in its use of energy.
  - Maximizes safety and minimizes light trespass.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Make bidders aware that plans are diagrammatic; adjustments will need to be made when installing lighting in.

Construction

- Install site lighting upright and plumb, with correct fixtures and attachments.
- Test lighting for correct coverage pattern and color rendition.

Ongoing Occupancy

- Monitor and maintain vegetation around lighting to keep it from obscuring light coverage pattern.
- Clean/replace light lenses at regular intervals.

Next Use

- Study existing site lighting to see if the light poles could be re-used for future projects.

S.6 Erosion and Sedimentation Control During Construction

Agency Planning

- Seek direction from Local Government Unit or authority having jurisdiction over the project's erosion and sedimentation control. Understand applicable rules, regulations, and permitting requirements.

Predesign-Site Selection

- Determine soil type, soil structure, and limitations of soil, by performing a detailed geotechnical analysis.

Schematic Design through Construction Documents

- Determine what types of erosion and sedimentation control measures are appropriate for the specific types of soils on the site.
- Develop drawings and specifications that protect soil, water and utilities form erosion and sedimentation.

Construction Administration

- Monitor submittals for compliance with plans and details.

- Hold a pre-construction meeting to identify requirements for sediment control during and after the construction process.
- Coordinate with contractors to ensure correct application of erosion and sedimentation controls and necessary modifications.

Construction

- Maintain temporary erosion control until the site is fully vegetated and stabilized and the stormwater management techniques are fully functional and online.

Ongoing Occupancy

- Create an Operations and Management manual that requires at least inspections and necessary maintenance of the site and stormwater management areas for erosion and sedimentation.

S.7 Landscape Water Efficiency

Schematic Design

- Evaluate the site for existing natural features for water capture and vegetated areas that require low water input.
- Define areas of different plant communities based water input requirements. Identify opportunities for water harvest and reuse.
- Perform general calculations for water consumption and identify available sources for the water.

Design Development

- Select native and water-efficient plant communities based on the community's location, slope, soil and hydrologic regime.
- Finalize calculations for water consumption needs and sources of the water.
- Develop details and specifications for irrigation, water harvest, and water re-use systems.

Construction Documents

- Finalize the plant list for the various plant communities by their ability to perform given their location, natural hydrologic regime, and water input.
- Finalize details and specifications for irrigation, water harvest, and water re-use.
- Consider requiring a first and second year maintenance program to ensure establishment of plant communities, which will enable them to continue to perform, once established, with the designed level of water and chemical inputs.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Make bidders aware of specific requirements for landscape water efficiency and maintenance requirements.

Construction

- Hold a pre-construction meeting to identify requirements for landscape water efficiency and maintenance requirements.

Ongoing Occupancy

- Create an Operation and Maintenance manual to protect and maintain the plant material and the irrigation from potable and non-potable sources used on the site.

S.8 Building Water Efficiency

Agency Planning

- Develop a water efficiency improvement goal per the guideline requirements.

Predesign-Programming

- Adapt the water efficiency goal and document it in the program

Schematic Design

- Communicate the water efficiency goal to all design team members. The goal shall also be documented in the schematic design submittals.

Design Development

- Document the water efficiency goal in the design development submittal.
- Provide annual water use calculations showing the reduction in water use compared to code. Use the total daily water requirements from the Minnesota Plumbing Code and the Energy Policy Act the basis of the calculations.

Construction Documents

- Clearly indicate the water efficiency goal in the construction documents.
- Confirm or revise calculations from the design development phase.
- Specify appropriate fixtures.

Construction Administration

- Review submittals and verify compliance with specifications.
- Confirm installation on site.

Ongoing Occupancy

- Repair or replace plumbing fixtures with equal or improved water use performance.

S.9 Appropriate Location and Development Pattern

Predesign-Site Selection

- Seek out and evaluate opportunities to locate development in areas where existing infrastructure will support increased densities and where additional development can improve site use.
- Work with local government units and community representatives to inventory potential sites that will enhance environmental and economic performance for communities and agencies alike.
- Choose to develop a site where community revitalization is occurring, provided the required development density is achieved by the project's completion.

- Integrate community feedback into density development proposals, working closely with municipalities to coordinate development efforts.
- Document development density goals.

Schematic Design through Construction Documents

- Maximize use of existing infrastructure and target maximum development densities appropriate to the site.

Construction Administration

- Make bidders aware of specific requirements for sustainable development.

S.10 Brownfield Redevelopment

Agency Planning

- Seek direction from Local Government Unit or authority having jurisdiction over the project's brownfield redevelopment. Understand their rules, regulations, and permitting requirements.
- In planning for new facilities, include the Brownfield redevelopment option, based on its ability to meet expectations of key locations, appropriate size, and sufficient infrastructure to support planning goals.

Predesign-Programming

- Select a building approach that is adaptable to Brownfield redevelopment.

Predesign-Site Selection

- Preferably, select a site that is eligible for the EPA's Brownfield Redevelopment program.

S.11 Heat Island Reduction

Predesign-Site Selection

- Consider sites where existing vegetation or site features provide shading that can be integrated into the built area.
- Evaluate effects of maturing plantings or changing uses on future heat island effects.
- Consider sharing building space or amenities, such as parking, to minimize the development footprint and surfaces that promote the heat island effect.

Schematic Design through Construction Documents

- Preserve or propose landscape features that provide shade for surfaces that contribute to the heat island effect.
- Orient the building and pavement surfaces that maximize shade for surfaces that contribute to the heat island effect.
- Minimize building and pavement surfaces that are exposed to the sun.
- Consider replacing impervious surfaces (i.e. roofs, sidewalks, roads, driving lanes, etc.) with open grid paving or high albedo materials.
- Consider replacing roofing surfaces with high albedo materials or vegetated surfaces.

Construction Administration

- Monitor submittals for compliance with plans and details. Make bidders aware of specific requirements for heat island reduction.

Construction

- Install site or plant features as designed.

Ongoing Occupancy

- Monitor and maintain vegetation around site to preserve its beneficial effects and mitigate negative developments.

Next Use

Study existing site shading to see if additional plantings may be necessary to maintain or increase benefits.

S.12 Transportation Impacts Reduction

Agency Planning

- Perform a transportation survey of future building occupants to identify transportation opportunities and needs.
- Determine number of vehicle trips per square foot of building and equate that to amount of CO2 produced or 'reduced' over a one year life cycle by providing alternative transportation methods and monitor their use.

Predesign-Programming

- Include transportation amenities such as bicycle racks and showering/changing facilities, alternative fuel refueling stations in the building and site program.

Predesign-Site Selection

- Seek location accessible to two or more bus lines or a light rail station and within walking distance of retail and public services. Also consider sites that offer the possibility of sharing transportation facilities such as parking lots and refueling stations with neighboring developments.

Schematic Design through Construction Documents

- Size parking capacity not to exceed minimum local zoning requirements. Add no new parking for rehabilitation projects.
- Provide preferred parking for carpools, van pools, plug in electric or hybrid vehicles. Design to encourage use by occupants with clearly marked carpool parking, pick-up areas, and covered waiting spaces within close proximity of the building entrance.
- Design means for securing bicycles, with convenient changing/shower facilities for use by cyclists.
- Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.
- Enhance the design hybrid/carpool/vanpool parking to encourage its use by occupants.
- Create and conveniently locate plug in electric charging stations conveniently to encourage its use by occupants.
- Develop specifications and drawings to support bicyclists, pedestrians and mass transit/carpool members.

Next Use

- Evaluate if existing transportation alternatives support next use. Maintain and improve them where possible (including connections to new trailways or transportation opportunities.)

S.13 Wastewater Reduction and Management

Agency Planning

- Seek direction from Local Government Unit or authority having jurisdiction on which water utility districts in the local community are stressed and will be impacted by this development.
- Engage the water authority about alternative proposals of graywater treatment, in order to streamline the approval process.

Predesign-Programming

- Consider ways to reduce blackwater going to the municipal wastewater system or on-site conventional septic system.Note that reduction of building water consumption also contributes to reduced waste water generated.
- Consider ways to use graywater for non-potable water uses such as irrigation, toilets, vehicle washing, sewage transport, HVAC/process make-up water, etc. Determine whether gray water or biological wastewater treatment systems are appropriate based on program and activities within the building and on the site. If so, develop goals and objectives for gray water reclamation or biological treatment.
- Develop specific programming criteria and standards for biological waste treatment.

Predesign-Site Selection

- In areas not served by a public waste treatment facility, select a site that can accommodate approved exterior biological waste treatment systems such as peat moss, drain fields, treatment wetlands, etc.

Schematic Design through Construction Documentation.

- Evaluate availability of potential storage and treatment areas on the site.
- Research and analyze systems early in the design process to ensure successful and effective design solutions.
- Evaluate requirements for permits and/or variances.
- Develop appropriate design strategies and select appropriate systems based on program, occupants, and site.
- Research and implement best available alternative waste treatment fixtures and technologies.
- If considering constructed wetland systems, identify design requirements based on users, capacity, pollutants to be removed from water, area, and detention time necessary for thorough treatment, vegetation and aquatic life survival requirements, and aesthetics.

Design Development

- Where biological wastewater treatment systems are under consideration, evaluate savings incurred from minimized amount of piping required because of reduced volume of wastewater.
- Select and design appropriate treatment system based on site and building determinants.

Construction Administration

- Monitor submittals for compliance with plans and details.
- Make bidders aware of specific requirements for heat island reduction.

Construction Documents

- Specify type of system, or multiple systems, selected for the site and building. Specify the type of storage area that is most applicable for the project.

Correction Period

- Educate occupants and operations staff about biological wastewater treatment strategies and systems.
- Perform appropriate testing.

Ongoing Occupancy

- Create an Operations and Management manual that requires inspections and necessary maintenance of the wastewater systems.

Next Use

- Determine whether existing systems are appropriate for next use.

S.14 Bird-Safe Building

Predesign-Site Selection

- If the building use is likely to be associated with large glazed areas, consider increased risk/adjustments needed on highly vegetated sites.
- Consider an ecological assessment of the site that includes an evaluation of bird species and habitat.

Schematic Design

- Identify attractant areas for birds on the site, plan deterrents for facades adjacent to attractants and keep glazed areas of buildings greater than fifty feet away from them.
- Configure building to minimize bird collision “traps.” “Traps” can include clear barriers, transparent railings or other glazed see-through conditions. See guideline for complete conditions deemed to be “traps.”
- Evaluate early designs through the Bird-Safe Calculator (Appendix S-14a) to inform and adjust design to meet bird-safe criteria.

Design Development

- Check design against bird-safe criteria and update the WBTF in the bird-safe building calculator to confirm it still complies
- Incorporate bird safe first year monitoring into the commissioning plan
- Incorporate Lights Out program criteria into the operations commissioning plan
- Coordinate with lighting engineer regarding controls for lights to accommodate Lights Out program compliance
- If pursuing Bird-Safe Case Study narrative, coordinate with lighting engineer on documentation of lighting benefits anticipated from Lights out program.
- If pursuing S.5 B and S.5 C under S.5 Light Pollution, consider documentation of bird-safe features for S.14 J Bird Safe Lighting Design

Construction Documents

- Confirm continued compliance with all required and pursued recommended bird-safe criteria, adjusting documentation and design as needed.
- Confirm that contract documents include those features needed for bird-safe compliance, as calculated using the Bird-Safe Calculator (Appendix S-14a).

Construction Administration

- Make bidders aware of specific requirements for sustainable construction according to B3 Guidelines.
- Watch for substitutions that would change the bird-safe performance of the building.

Construction

- Construct features affecting bird-safe design, according to drawings and specifications.

Correction Period

- Confirm correct implementation of features affecting bird-safe performance according to drawings and specifications.
- Comply with Lights Out Management Program during relevant seasons according to the guidelines.
- Perform required first year bird-safe monitoring

Ongoing Occupancy

- Comply with Lights Out Management Program during relevant seasons according to the guidelines.
- Perform any recommended ongoing monitoring that was pursued, using appendix S-14a for First Year Building Monitoring.

Appendix S-14c: Bird-Safe Building Narrative Template

If pursuing the recommended guideline S.14.I Bird-Safe Building Narrative, use this narrative template or create your own with similar content.

Name of Project

Building Type (or Types) *i.e. office, school, etc…*

Street Address

City

State, Zip

Size of building *number of stories and square footage*

Size of property

Year Constructed/Renovated

Does your site/project relate to birds/conservation?

Description of property and adjacent area
(industrial, natural, urban, suburban)

Ecological context
(habitat on property/in area, wildlife presence, attractants including water and feeding/nesting)

History of bird-window problems in area or building (if a renovation)?

Describe or attach documentation of

- Building design process, tools used, consultants if applicable
- Describe materials used, decisions process, manufacturer / product number
- Survey activity performed
- Findings from surveys
- Special efforts
- Rationale
- Benefits/ side benefits/ public relations benefits/staff pride
- Lights out energy savings if calculated (connected watts, normal hours of operation from midnight to dawn compared to watts used during reduced hours

Whole Building Threat Factor achieved

Strategies implemented

Estimated additional cost of implementation of S-14.A

Are any additional benefits achieved from implemented strategies *such as improved energy performance, lower glare, etc…*

Have you been part of any enhanced monitoring or related work regarding birds/buildings?

Appendix S-7: Irrigation Water Consumption

GENERAL WATER CONSUMPTION GUIDELINES IRRIGATION SYSTEMS

SPRAY IRRIGATION

Type of Sprinkler	AREA 1 acre (43,560 sq. ft.)	Gallons (1/2" water over 1 acre)
Pop-up Spray Head - 15' spacing: Used for small lawns, boulevards, narrow areas of grass, shrubs Average of 2.0 gallons per minute (gpm) per head	715 gpm x 19 minutes	13,585
Pop-up mid-range Rotary Sprinkler - 40' spacing: Used for large lawns, and similar open areas Average of 3.0 gallons per minute (gpm) per head	160 gpm x 85 minutes	13,600
Pop-up long-range Rotary Sprinkler – 55' spacing: Used for athletic fields, golf courses, and similar large open areas Average of 15 gallons per minute (gpm) per head	300 gpm x 45 minutes	13,500

Note: 1" of water over 1 acre = 27,154 Gallons. Double the total gallons to achieve 1" per acre.

DRIP IRRIGATION Amount of Dripline Needed

Calculations based on 1 Acre	Gallons Per Minute
12" Drip @1.53 GMP/100 Feet	666.5 (43,560 Feet of Dripline)
18" Drip @ 1.02 GPM/100 Feet	296.2 (29,040 Feet of Dripline)
24" Drip @ .77 GPM/100 Feet	167.7 (21,780 Feet of Dripline)

Formula to Determine Dripline Need Based on Size of Irrigated Area:
(Area in Square Feet x 12)/Lateral Row Spacing in Inches

DRIP IRRIGATION Application Rate

Calculations Based on .9 Gallons per Hour	Inches Per Hour
12" Drip	1.44
18" Drip	.64
24" Drip	.36

Formula to Determine Application Rate:
(Emitter Flow Rate in Gallons Per Hour)/(Lateral Row Spacing in Inches x Emitter Spacing in Inches)

Appendix E-0: Suggested Implementation for All Energy and Atmosphere Guidelines

E.1 Energy Use (pre-SB2030 projects only)

Comparative analysis is required for all buildings over 5,000 square feet that are heated. The required process is similar for all buildings, though there is a different path to compliance for buildings less than 30,000 gross square feet. Buildings entering Schematic Design after August 1, 2009 are exempt from 30% energy use reduction, and must instead apply energy standards defined by Minnesota Sustainable Buildings 2030 (website at www.mn2030.umn.edu).

E.1A, E.1B (30% energy use reduction)
Agency Planning

- Budget for building performance at 30% better than code
- Verify with B3 Guidelines help at msbghelp@umn.edu that your project will be pre-SB2030 project.

Predesign-Programming

- Use Daylight Factor Calculator to proportion and characterize programmed spaces and areas where daylighting is desirable and/or allowable.
- Review guidelines for building geometry and daylighting design
- Identify and review potential energy conservation strategies for your building type

Predesign-Site Selection

- Evaluate building geometry, daylighting depth and site development implications for primary north and south exposure

Schematic Design

Buildings over 30,000 Square Feet:

- Use Daylight Factor Calculator to confirm proportion and characterize programmed spaces and areas where daylighting is desirable and/or allowable.
- Provide base building characteristics for an hourly energy performance simulation model based on a specific building geometry.
- Perform baseline energy simulation modeling to establish a Code Base Case that meets the minimum prerequisite standard of the Minnesota State Energy Code and the IAQ standards identified within this guideline. [1]
- Establish energy strategies to investigate in each of the following categories [2]
    - Envelope
    - Lighting Control
    - Lighting Design
    - HVAC system efficiency levels
    - Load Responsive control
    - Outside Air control

[1] Allowable software for buildings over 30,000 GSF includes calculation tools the meet the criteria for simulation tools as per Appendix G of ASHRAE 90.1-2004.
[2] Variables must be sufficient to allow meaningful comparative analysis. At least three options per category must be evaluated.

Buildings under 30,000 Square Feet: [3]

- Use Daylight Factor Calculator to confirm proportion and characterize programmed spaces and areas where daylighting is desirable and/or allowable.
- Calculate building envelope metrics using the Small Buildings Methodology for pre-SB2030 projects, Appendix E-1f .
- Evaluate building envelope and system options in the Small Buildings Methodology included in this guide.

Design Development

Buildings over 30,000 Square Feet:

- Use the baseline energy simulation model and simulate isolated Energy Conservation Measures (ECMs) (strategies) to compare with the Code Base Case
- Develop, document and distribute modeling parameters for use in comparative cost estimating
- Develop incremental costs for each ECM based on the difference of the cost of constructing the ECM versus the cost of constructing the code level requirement for the strategy.
- Bundle and compare ECMs to approximate lowest life time cost
- Select a bundled ECM option to implement
- Enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit with DD package. (See Appendix P-0a for details of reporting processes.)

Buildings under 30,000 Square Feet

- Develop net incremental cost estimates to compare bundled options to the cost of constructing the code level requirement
- Select bundled option to implement
- Comply with building envelope and system options in the Small Buildings Methodology included in this guide.
- Enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit with DD package. (See Appendix P-0a for details of reporting processes.)

Construction Documents

- Design team includes all ECMs from the selected bundle
- Guideline Leader and Commissioning Team review construction documents at 95% completion to verify design progress against modeling assumptions and reports findings back to design team. (See Appendix P-0a for details of review processes.)
- Design team makes additions, deletions or corrections, if any, and bids project.
- Enter updated results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit with CD package. (See Appendix P-0a for details of reporting processes.)

Construction

- Review shop drawings to assure compliance with ECMs

Correction Period

- Guideline Leader for ongoing occupancy provides benchmarking data
- Commissioning Leader reviews execution of Measurement and Verification protocol during commissioning phase. (See Appendix P-0a for details of review processes.)

[3] The model presented here is for small office buildings. For other building types or for variations to the prescriptive bundles presented, you may use the methodology for buildings over 30,000 gross square feet.

Ongoing Occupancy

- Guideline Leader (or possibly Utility Provider in future) sends monthly energy consumption to benchmarking collection team each year. (See Appendix P-0a for details of reporting processes.)

E.1C Follow requirements of the SB 2030 program

All Phases

- For phase-specific guideline requirements, please refer to the SB 2030 project website, at www.mn2030.umn.edu and Appendices E-1a through E-1f.

E.2 Renewable and Distributed Energy Evaluation

Predesign-Programming

- Identify the potential investment value of on-site generation to offset 2% of predicted energy use

Predesign-Site Selection

- Evaluate building geometry and orientation for solar-based energy solutions.
- Investigate the viability and potentiality of other on-site renewable and distributed energy options.
- Investigate the proximity to nearby renewable and distributed energy generation sources and the transmission potential to your site and/or the investment potential for your project.

Schematic Design

On-site:

- Locate renewable and distributed energy installation areas on plans, elevations and sections as appropriate.
- Investigate spatial and loading impact on site, architectural, mechanical and electrical systems.
- Develop preliminary performance specifications for the selected technology(s)
- Calculate available area and refine performance/cost assumptions based on installation intentions and anticipated system efficacy at this stage of design.
- Enter preliminary results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit at SD phase completion .

Supplemental off-site:

- Determine availability of resource relative to project demands
- Investigate spatial and loading impact on site, architectural, mechanical and electrical systems.
- Develop preliminary purchase contract language
- Refine performance/cost assumptions based on contractual intentions and anticipated system efficacy at this stage of design.
- Enter preliminary results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit at SD phase completion.

Design Development

On-site:

- Develop dimensioned installation profiles on plans, elevations and sections.
- Refine performance specifications for the selected technology(s), identify and contact potential vendors
- Refine performance/cost assumptions based on installation profiles and anticipated system efficacy at this stage of design.
- Enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit at DD phase completion. (See Appendix P-0a for details of reporting processes.)

Supplemental off-site:

- Confirm availability of resource relative to project demands
- Develop design to accommodate spatial and loading impact on site, architectural, mechanical and electrical systems if any
- Develop final purchase contract language
- Refine performance/cost assumptions based on contractual intentions and anticipated system efficacy at this stage of design.
- Enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com and submit at DD phase completion. See Appendix P-0a for details of reporting processes.

Construction Documents

On-site:

- Develop dimensioned installation details and specifications for the selected technology(s) and specify potential vendors
- Refine performance/cost assumptions based on installation profiles and anticipated system efficacy at this stage of design.
- Update results in B3- Guidelines Tracking Tool at www.msbgtracking.com and submit with CD package. (See Appendix P-0a for details of reporting processes.)

Supplemental off-site:

- Re-confirm availability of resource relative to project demands
- Complete design to accommodate spatial and loading impact on site, architectural, mechanical and electrical systems if any
- Refine performance/cost assumptions based on contractual intentions and anticipated system efficacy at this stage of design.
- Update results in B3 Guidelines Tracking Tool www.msbgtracking.com and submit with CD package. (See Appendix P-0a for details of reporting processes.)

Construction Administration

- Review shop drawings to assure compliance with renewable and distributed energy equipment specifications.

E.3 Efficient Equipment and Appliances

Agency Planning

- Budget for energy efficient (Energy Star) equipment and appliances

Construction Documents

- Provide drawings, cut sheets, and specifications highlighting compliance of equipment and appliances with Energy Star requirements. Document efficiency ratings of motors and drives, water service equipment, and other electrical load components.
- Enter data in B3 Guidelines Tracking Tool www.msbgtracking.com and submit at CD phase completion. (See Appendix P-0a for details of reporting processes.)

Construction

- Review shop drawings to assure compliance with Energy Efficient equipment specifications.

E.4 Atmospheric Protection

Predesign-Programming

- Determine on-site fire suppression requirements

Schematic Design

- Plan and organize building to minimize the need for the use of Halon fire suppression systems
- Using the tables below and other information as may be available at the time of design, identify candidate refrigerants that have a low Global Warming Potential, short Atmospheric Lifetime and a low Ozone Depletion Potential.
- Use one of the weighted evaluation metrics provided to evaluate the refrigerants.
- Prioritize the list in the order given.

Design Development

- Evaluate the economic impacts of the prioritized list
- Evaluate the community impacts of the prioritized list
- Adjust priorities pursuant to the analysis

Construction Documents

- Develop specifications based on adjusted priorities

Construction Administration

- Verify shop drawings to assure compliance

Appendix E-1f: Small Building Methodology for Pre-SB2030 Projects

Prescriptive Bundle Option Method for Office Buildings less than 30,000 GSF

- This section describes energy strategy requirements for three different *Prescriptive Bundle Options* for use in meeting energy performance compliance for *office building* projects less than 30,000 gross square feet. Project designs using this approach are required to select and implement one of the three bundle options in its entirety. **Note that projects entering schematic design (SD) phase after August 1, 2009 are not eligible to use this method. All projects entering SD after that date are subject to energy standards defined in Minnesota Sustainable Building 2030 (www.mn2030.umn.edu).**
- As an alternative to using the Prescriptive Bundle Option method, projects less than 30,000 gross square feet or non-office projects less than 30,000 GSF may use the comparative analysis method defined for larger buildings in part A (guideline E.1a). Project teams may also contact the Department of Commerce for additional options.
- The Prescriptive Bundle Options represent three different objectives to meet the energy performance goals of this section. The options defined provide a range of energy strategy solutions based on building design parameters and preferences of the Design Team and Building owner. The three bundles are grouped by building system focus below:

Bundle 1 - Lighting dominates performance	**Bundle 3 – Balanced** Lighting and HVAC balance performance	**Bundle 2 – HVAC** dominates performance
Focuses implementation of Daylight, and lighting control and design high performance strategies	Focuses implementation of a balanced approach between lighting and HVAC design and control high performance strategies.	Focuses implementation of HVAC system and control high performance strategies.

- Each Prescriptive Bundle Option identifies which strategies are required and or a minimum level of strategy component performance for the following four building system sections:
  - Envelope Requirements based on building envelope metrics
  - Calibrated Daylight Control Requirements based on building metrics and the Prescriptive Bundle Option selected.
  - Lighting Control and Design Requirements based on Prescriptive Bundle Option selected
  - HVAC Control and Design based on Prescriptive Bundle Option selected.

Envelope Requirements

Intent: To reduce the thermal heating and cooling load of the building envelope.

- The Prescriptive Bundle Option Method requires the calculation of the following building envelope design metrics:

BUILDING ENVELOPE METRIC	RATIO	BUILDING COMPONENT	SQUARE FEET
Ratio of window + skylight area (ft^2) to building gross floor area (ft^2)		[1] Window and skylight area	
		[4] Gross floor area	
Ratio of above grade wall area (ft^2) to building gross floor area (ft^2)		[2] Above grade wall area	
		[4] Gross floor area	
Ratio of roof area (ft^2) to building gross floor area (ft^2)		[3] Roof area	
		[4] Gross floor area	

Note 1: Area calculated for glazed rough opening areas for all windows and skylights

Note 2: Area calculated for all gross wall surfaces above grade including window and door area, excluding parapets

Note 3: Area calculated for all gross roof surface area including rough opening skylight areas

Note 4: Area calculated from the outside of exterior perimeter walls for all conditioned spaces

- Design the building envelope to meet the thermal characteristics for all window, wall, and roof areas identified in the table below based on the envelope area metrics calculated:

Ratio of Window + Skylight area to Floor area	**0 to 0.10**	**0.10 to 0.20**	**Over 0.20**
Unit U-Factor[1] (btuh/sf*F^o)	< 0.46	< 0.42	< 0.38
Solar Heat Gain Coefficient[2] (dimensionless)	< 0.56	< 0.38	< 0.30
Visible Light Transmittance[3] (dimensionless)	> 0.45	> 0.45	> 0.40
Ratio of above grade Wall area to floor area	**0 to 0.25**	**0.25 to 0.50**	**Over 0.50**
Wall Insulation R-Value[4] (btuh/sf*F^o)	> R-11	> R-14	> R-18
Ratio of Gross Roof area to Roof area	**0 to 0.45**	**0.45 to 0.65**	**Over 0.65**
Roof Insulation R-Value (btuh/sf*F^o)	> R-26	> R-30	> R-32

1 Unit U-factor is the U-factor of the glass and frame assembly together. The unit U-factor of the glass and frame assembly is typically higher than the center-of-glass U-factor only. Lower U-factors reduce heat loss.

2 Solar Heat Gain Coefficient is the ratio of the amount of solar radiation transmitted through the glass compared to the amount of exterior radiation incident on the glazings exterior surface. Lower SHGC values reduce cooling loads.

3 Visible light transmittance is the ratio of the amount of light radiation transmitted through the glass compared to the amount of light striking the glazing's exterior surface. Higher values provide more daylight.

4 Wall and Roof insulation R-values include the entire opaque wall and roof envelope construction assembly including air films.

Daylight Control Requirements

Intent: To reduce the electric lighting energy consumption within areas of the building design where daylight can provide a substantial amount of the required illumination during the day.

- For the building design calculate the Total Ratio of Daylight floor area to building gross floor area.

Space type Daylight floor area	**Square feet**
Open Office Daylight floor area (ft^2)	
Private Office Daylight floor area (ft^2)	
Lobby/Circulation Daylight floor area ($ft^{2)}$	
Sum of Total Daylight floor area (ft^2) above	
Gross Building Floor Area (ft^2)	
Ratio of Total Daylight floor area (ft^2) to building gross floor area (ft^2)	

- Calculation method to determine Daylight floor area by space type

Space Type Area		Depth of zone		Length of zone
Open Office Daylight floor area (ft^2):	=	(Window head height from floor in ft.) x (**2.0**)	X	Space length (ft) where the window area equals more than **20%** of the zone depth per linear foot of wall
Private Office Daylight floor area (ft^2)	=	(Window head height from floor in ft.) x (**1.8**)	X	Space length (ft) where the window area equals more than **15%** of the zone depth per linear foot of wall
Lobby/Circulation Daylight floor area (ft^2)	=	(Window head height from floor in ft.) x (**1.5**)	X	Space length (ft) where the window area equals more than **15%** of the zone depth per linear foot of wall

- Design the building lighting system to meet the bundle option selected for the building design.

Calibrated Daylight Controls	**Bundle 1 Lighting**	**Bundle 2 Balanced**	**Bundle 3 HVAC**
Total Ratio of Daylight floor area (ft^2) to building gross floor area (ft^2)	**> 0.50**	**> 0.35**	**> 0.20**
Calibrated Stepped Daylight controls in all Daylight floor areas for, Lobby / Vestibule / Circulation areas. Requirements: Use interior or exterior photo sensors or astronomical time-clock to control electric light relay for ½ of all lamps in each daylight zone.	Yes	Yes	Yes
Continuous Dimming Daylight Control in all Daylight floor areas for Perimeter Open office areas. Requirements: Use dimming ballasts with interior photo sensor for each Open office space.	Yes	Yes	Yes
Strategic Switching controls in all Daylight areas for Perimeter Private office areas. Requirements: Use two manual wall switches per private office space. o. One switch located by the door to control ½ the lamps in each fixture of the room, The second switch is located away from the door and controls the other lamps within the fixture.	Yes	Yes	Yes

Electric Lighting and Control Strategies

Intent: To reduce the electric lighting load within the building utilizing lighting design and lighting control strategies that reduce consumption.

- Design the building lighting system to meet the bundle option selected for the building design.

LIGHTING CONTROL REQUIREMENTS BY SPACE TYPE	BUNDLE 1 LIGHTING	BUNDLE 2 BALANCED	BUNDLE 3 HVAC
Open Office	OS	N/R	N/R
Private Office	OS	OS	OS
Conference Rooms	OS	OS	OS
Circulation	OS	N/R	N/R
Toilets	OS	OS	OS
Storage Rooms	OS	OS	N/R

Notes:
OS: Occupancy sensor control
N/R: No occupancy sensor controls required

LIGHTING DESIGN MINIMUM POWER DENSITY BY SPACE TYPE	BUNDLE 1 LIGHTING	BUNDLE 2 BALANCED	BUNDLE 3 HVAC
Open Office connected (W/ft^2)	< 0.90	< 1.10	< 1.25
Private Office connected (W/ft^2)	< 1.10	< 1.30	< 1.50
Conference Rooms connected (W/ft^2)	< 1.35	< 1.55	< 1.75
Circulation connected (W/ft^2).	< 0.65	< 0.75	< 0.80
Toilets connected (W/ft^2)	< 0.65	< 0.75	< 0.80
Storage rooms connected (W/ft^2)	< 0.65	< 0.75	< 0.80
Mechanical Rooms connected (W/ft^2)	< 0.65	< 0.75	< 0.80

Notes:
Lighting design power densities to be increased by area factor calculation in Minnesota Energy Code.

HVAC Requirements

Intent: To reduce heating, cooling, fan, and pump energy consumption and peak electric demand within the building utilizing equipment efficiency and operation control strategies that reduce consumption**.**

Cooling System Efficiency Requirements	**BUNDLE 1 LIGHTING**	**BUNDLE 2 BALANCED**	**BUNDLE 3 HVAC**
Air Cooled Equipment			
Single Package <65,000 Btu/h, SEER	> 10.2	> 10.7	> 11.2
Split System <65,000 Btu/h, SEER	> 10.5	> 11.0	> 11.5
Split System & Single Package >65,000 and < 135,000 Btu/h, EER	> 9.3	> 9.8	> 10.3
Condensing Units > 135,000 Btu/h, EER	> 10.4	> 10.9	> 11.4
Chiller greater than or equal to 150 tons KW/ton	< 1.34	< 1.27	< 1.20
Chiller less than 150 tons KW/ton	< 1.23	< 1.17	< 1.11
Water Source Equipment			
Water Source Heat Pumps < 65,000 Btu/h, Standard Rating Indoor Air (80°F db/65° wb) and Entering Water (85°F) EER	> 9.8	> 10.2	> 10.7
Water Source Heat Pumps < 65,000 Btu/h Standard Rating Indoor Air (80°F db/67° wb) and Entering Water (75°F) EER	> 10.7	> 11.2	> 11.7
Water Source Heat Pumps > 65,000 Btu/h and < 135,000 Btu/h, Standard Rating Indoor Air (80°F db/67° wb) and Entering Water (85°F) EER	> 11.0	> 11.6	> 12.1
Water Source Heat Pumps > 65,000 Btu/h and < 135,000 Btu/h, Standard Rating Indoor Air (80°F db/67° wb) and Entering Water (75°F) EER	> 11.6	> 12.1	> 12.7
Groundwater – Cooled Heat Pumps < 135,000 Btu/h, Standard Rating Entering Water (70°F) EER	> 11.6	> 12.1	> 12.7
Groundwater – Cooled Heat Pumps < 135,000 Btu/h, Low Rating Entering Water (50°F) EER	> 12.1	> 12.7	> 13.2
Water Cooled Equipment			
Centrifugal KW/ ton (non-CFC)	< 0.69	< 0.66	< 0.62
Helical-rotary (screw) KW/ton (non-CFC)	< 0.76	< 0.72	< 0.68
Reciprocating or scroll KW/ton	< 0.88	< 0.84	< 0.79

Heating System Efficiency Requirements	**BUNDLE 1 LIGHTING**	**BUNDLE 2 BALANCED**	**BUNDLE 3 HVAC**
Gas Furnace efficiency	> 0.83	> 0.85	> 0.90
Gas Boiler efficiency	> 0.83	> 0.85	> 0.90
Water Source Heat Pumps < 135,000 Btu/h Entering Water (70°F) COP	> 4.0	> 4.2	> 4.4
Water Source Heat Pumps < 135,000 Btu/h Entering Water (75°F) COP	> 4.1	> 4.3	> 4.5
Ground Source Heat Pumps < 135,000 Btu/h High Temperature Rating Entering Water (41°F)	> 2.8	> 3.0	> 3.1
Ground Source Heat Pumps < 135,000 Btu/h Low Temperature Rating Entering Water (32°F)	> 2.6	> 2.8	> 2.9
Load Responsive Control Requirements	**BUNDLE 1 LIGHTING**	**BUNDLE 2 BALANCED**	**BUNDLE 3 HVAC**
VFD's on VAV supply and return fan motors	YES	YES	YES
VFD's on chilled water pump	NO	NO	YES
VFD's on hotwater water pump	NO	NO	YES
Outside Air Control Requirements	**BUNDLE 1 LIGHTING**	**BUNDLE 2 BALANCED**	**BUNDLE 3 HVAC**
Total energy recovery of exhaust air for VAV systems	NO	NO	YES
Total energy recovery of exhaust air for Constant Volume systems	NO	YES	YES
CO2 control of outside ventilation air	YES	YES	YES
Fan/pump motor Efficiency Requirements	**BUNDLE 1 LIGHTING**	**BUNDLE 2 BALANCED**	**BUNDLE 3 HVAC**
Supply and return fan motors	Premium	Premium	Premium
Chilled water pump motor	Code Level	Code Level	Premium
Hot water pump motor	Code Level	Code Level	Premium

Note: Premium efficiency requirements are listed in Table below

Code vs. Premium Motor Efficiencies

All efficiency values are nominal efficiencies.

Horse power	Open drip-proof motors*						Totally-enclosed fan-cooled motors*					
	Code			Premium			Code			Premium		
	3600 rpm	1800 rpm	1200 rpm	3600 rpm	1800 rpm	1200 rpm	3600 rpm	1800 rpm	1200 rpm	3600 rpm	1800 rpm	1200 rpm
1		82.5%	80.0%		85.5%	82.5%	75.5%	82.5%	80.0%	77.0%	85.5%	82.5%
1.5	82.5%	84.0%	84.0%	84.0%	86.5%	86.5%	82.5%	84.0%	85.5%	84.0%	86.5%	87.5%
2	84.0%	84.0%	85.5%	85.5%	86.5%	87.5%	84.0%	84.0%	86.5%	85.5%	86.5%	88.5%
3	84.0%	86.5%	86.5%	85.5%	89.5%	89.5%	85.5%	87.5%	87.5%	86.0%	89.5%	89.5%
5	85.5%	87.5%	87.5%	86.5%	89.5%	89.5%	87.5%	87.5%	87.5%	88.5%	89.5%	89.5%
7.5	87.5%	88.5%	88.5%	88.5%	91.0%	90.2%	88.5%	89.5%	89.5%	89.5%	91.7%	91.0%
10	88.5%	89.5%	90.2%	89.5%	91.7%	91.7%	89.5%	89.5%	89.5%	90.2%	91.7%	91.0%
15	89.5%	91.0%	90.2%	90.2%	93.0%	91.7%	90.2%	91.0%	90.2%	91.0%	92.4%	91.7%
20	90.2%	91.0%	91.0%	91.0%	93.0%	92.4%	90.2%	91.0%	90.2%	91.0%	93.0%	91.7%
25	91.0%	91.7%	91.7%	91.7%	93.6%	93.0%	91.0%	92.4%	91.7%	91.7%	93.6%	93.0%
30	91.0%	92.4%	92.4%	91.7%	94.1%	93.6%	91.0%	92.4%	91.7%	91.7%	93.6%	93.0%
40	91.7%	93.0%	93.0%	92.4%	94.1%	94.1%	91.7%	93.0%	93.0%	92.4%	94.1%	94.1%
50	92.4%	93.0%	93.0%	93.0%	94.5%	94.1%	92.4%	93.0%	93.0%	93.0%	94.5%	94.1%
60	93.0%	93.6%	93.6%	93.6%	95.0%	94.5%	93.0%	93.6%	93.6%	93.6%	95.0%	94.5%
75	93.0%	94.1%	93.6%	93.6%	95.0%	94.5%	93.0%	94.1%	93.6%	93.6%	95.4%	94.5%
100	93.0%	94.1%	94.1%	93.6%	95.4%	95.0%	93.6%	94.5%	94.1%	94.1%	95.4%	95.0%
125	93.6%	94.5%	94.1%	94.1%	95.4%	95.4%	94.5%	94.5%	94.1%	95.0%	95.4%	95.0%
150	93.6%	95.0%	94.5%	94.1%	95.8%	95.4%	94.5%	95.0%	95.0%	95.0%	95.8%	95.8%
200	94.5%	95.0%	94.5%	95.0%	95.8%	95.4%	95.0%	95.0%	95.0%	95.4%	96.2%	95.8%

**Code values are from Energy Policy Act of 1992, also reference NEMA Standard MG1-1998, Revision 2, Section 12.59 and Table 12-11, as tested in accordance with IEEE Standard 112 Method B.*

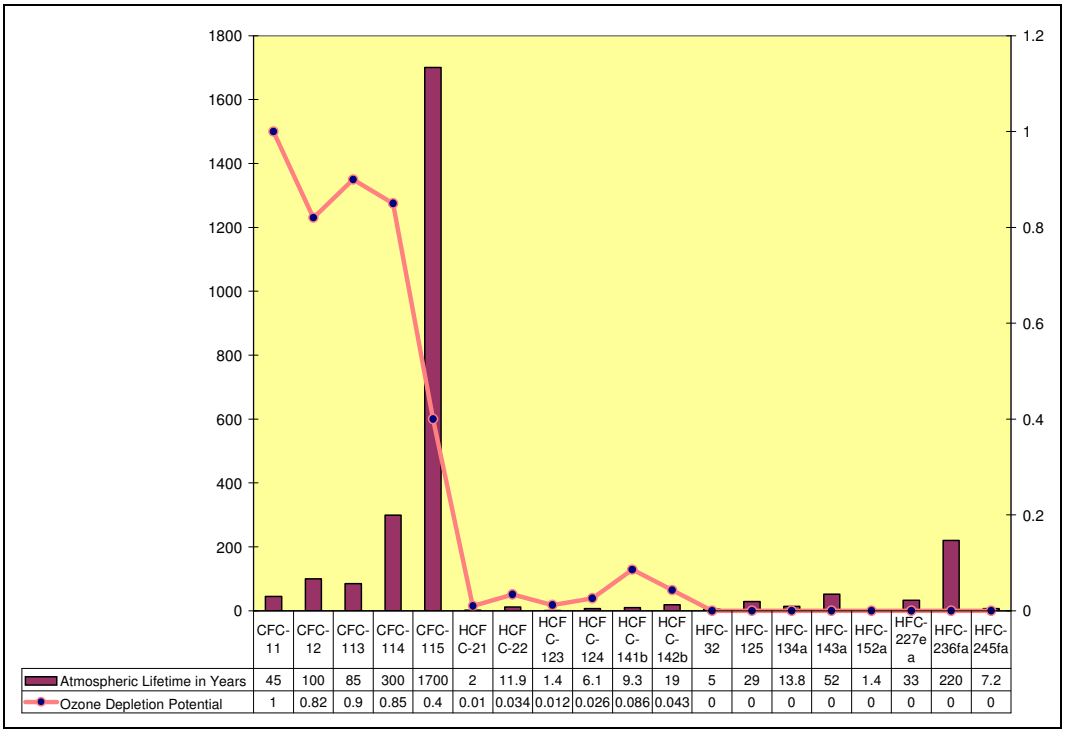
***Premium values are from NEMA Standard MG1-1998, Revision 2, Section 12.60 and Table 12-12, as tested in accordance with IEEE Standard 112 Method B.*

Appendix E-4: Refrigerant Properties

Table E-1 Refrigerant Climate Data Meeting the Guidelines[1] [2]

Refrigerant	Atmospheric Lifetime in Years	Ozone Depletion Potential	Global Warming Potential
HFC-152a	1.4	0	120
HCFC-123	1.4	0.012	120
HCFC-21	2	0.01	210
HFC-32	5	0	550
HCFC-124	6.1	0.026	620
HFC-245fa	7.2	0	950
HFC-134a	13.8	0	1300
HCFC-22	11.9	0.034	1700
HFC-125	29	0	3400
HFC-227ea	33	0	3500

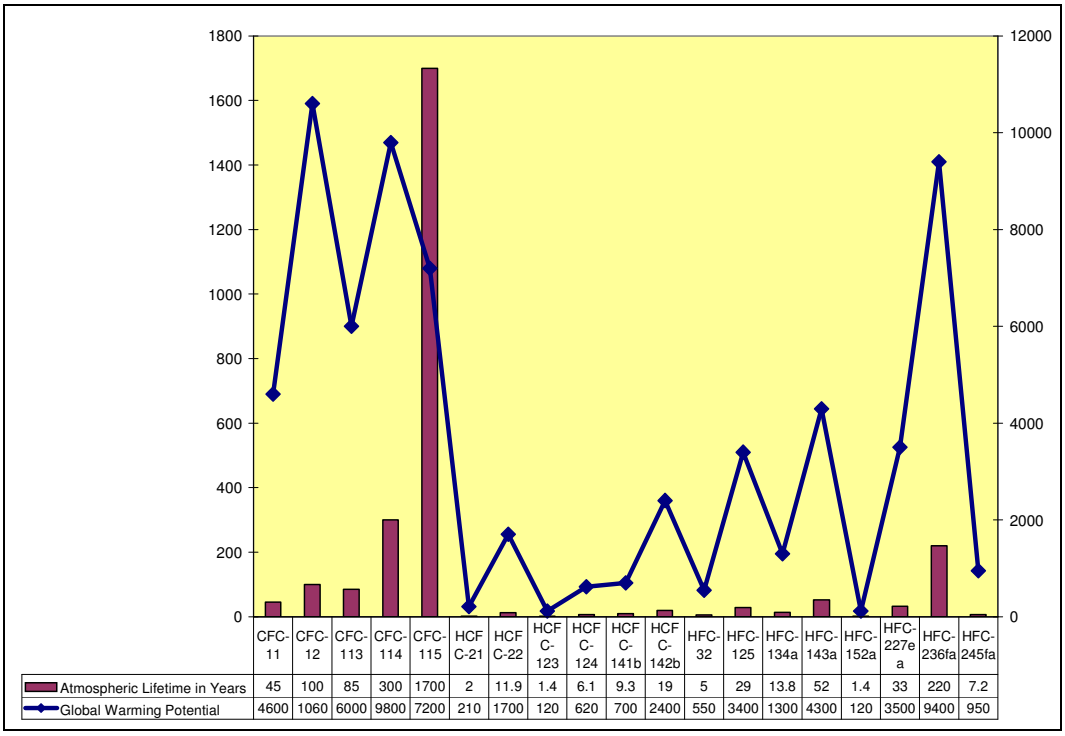
Table E-2 Atmospheric Lifetime and Ozone Depletion Potential



	CFC-11	CFC-12	CFC-113	CFC-114	CFC-115	HCFC-21	HCFC-22	HCFC-123	HCFC-124	HCFC-141b	HCFC-142b	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-236fa	HFC-245fa
Atmospheric Lifetime in Years	45	100	85	300	1700	2	11.9	1.4	6.1	9.3	19	5	29	13.8	52	1.4	33	220	7.2
Ozone Depletion Potential	1	0.82	0.9	0.85	0.4	0.01	0.034	0.012	0.026	0.086	0.043	0	0	0	0	0	0	0	0

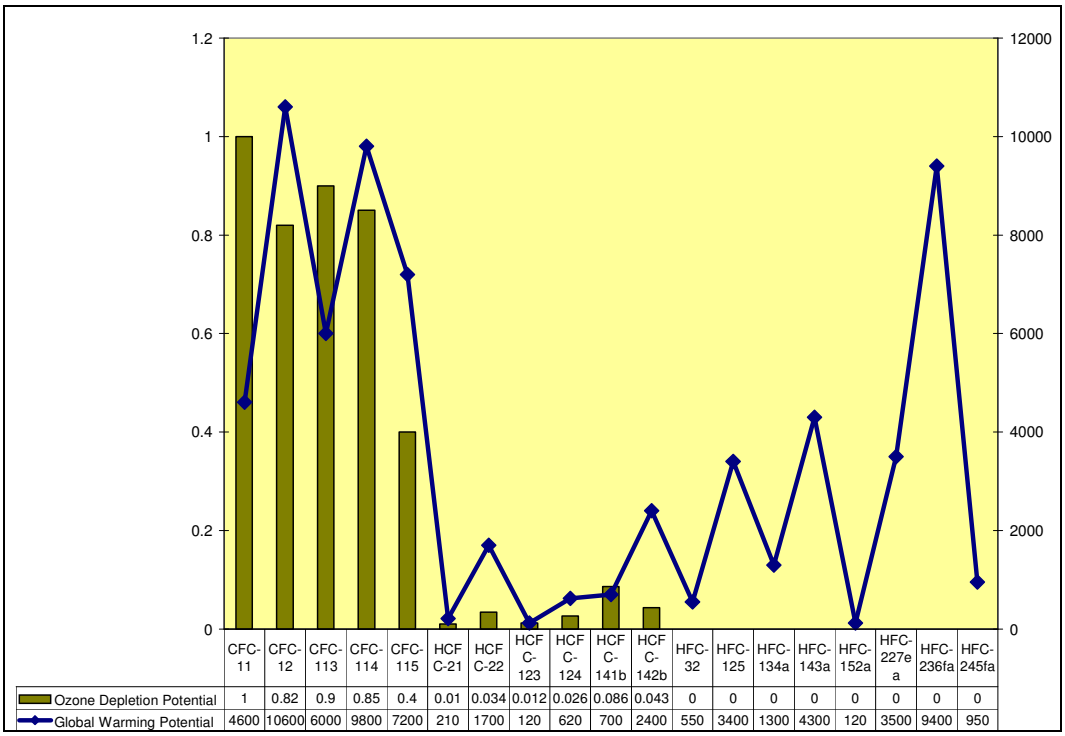
1 James M. Calm "Refrigerant Data Summary" Engineered Systems Magazine Nov 2001.
2 Additional criteria such as equipment efficiency and net environmental impact may be applied to the selection of the refrigerants to be used in a project.

Table E-3 Atmospheric Lifetime and Global Warming Potential



	CFC-11	CFC-12	CFC-113	CFC-114	CFC-115	HCFC-21	HCFC-22	HCFC-123	HCFC-124	HCFC-141b	HCFC-142b	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-236fa	HFC-245fa
Atmospheric Lifetime in Years	45	100	85	300	1700	2	11.9	1.4	6.1	9.3	19	5	29	13.8	52	1.4	33	220	7.2
Global Warming Potential	4600	1060	6000	9800	7200	210	1700	120	620	700	2400	550	3400	1300	4300	120	3500	9400	950

Table E-4 Ozone Depletion Potential and Global Warming Potential



	CFC-11	CFC-12	CFC-113	CFC-114	CFC-115	HCFC-21	HCFC-22	HCFC-123	HCFC-124	HCFC-141b	HCFC-142b	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-236fa	HFC-245fa
Ozone Depletion Potential	1	0.82	0.9	0.85	0.4	0.01	0.034	0.012	0.026	0.086	0.043	0	0	0	0	0	0	0	0
Global Warming Potential	4600	10600	6000	9800	7200	210	1700	120	620	700	2400	550	3400	1300	4300	120	3500	9400	950

Appendix I-0: Suggested Implementation for all Indoor Environmental Quality Guidelines

I.1 Restrict Environmental Tobacco Smoke

Agency Planning

- The Owner certifies that the building will be operated as a smoke-free building and establishes a no-smoking policy for the building. Therefore, special barriers and controls will not be designed inside these buildings.

Construction Documents

- In design documentation state explicitly that the building was designed assuming that smoking would not occur in the building.
- In plan drawings and other documentation indicate outdoor designated smoking areas to ensure that smoke will not be introduced into the building through doorways, windows, outdoor air intakes or other openings.

Ongoing Occupancy

- Maintain the location of designated outdoor smoking areas or relocate areas with building changes or additions to ensure that smoke will not be introduced into the building through doorways, windows, outdoor air intakes or other openings.

Next Use

- The decision that this building was designed to be operated as a smoke-free building should be clarified for any new owner.
- The proper location of designated outdoor smoking areas should be communicated to any new owner, property manager, and occupants.

I.2 Specify Low-emitting Materials

Schematic Design

- For those building materials and furnishings covered by the performance criteria and any additional materials or products included in the design. Specifications should include the requirement that pollutant emission rates of the materials are certified by the manufacturer.

Design Development

- Verify continued selection of materials and products to reflect guideline requirements or more stringent project team goals for material emission limits.
- Develop drawings and specifications which support material properties selected.

Construction Documents

- Specify low-emitting materials in construction documents. Ensure that emission limits are clearly stated in each section where materials covered by this guideline are addressed.

Construction

- Adopt an appropriate management plan during construction to prevent problems that will adversely affect IAQ when the building is occupied. See P.4 Design and Construction Commissioning.

Construction Administration

- Monitor submittals and construction site to ensure that materials, products, and systems are being correctly installed to preserve project goals and objectives. Review substitutions based on performance criteria to ensure consistency and compliance with goals as represented in the drawings and specifications.
- Document changes to requirements for construction that occur that may seriously impact the provision or installation of materials, products, or components that were intended to ensure indoor air quality standards are achieved.

Ongoing Occupancy

- Based on the Operations Commissioning Plan (developed prior to occupancy, see P.5 Operations Commissioning), use low or no-VOC emitting materials for products including cleaning supplies, pest management applications, minor remodeling, and maintenance associated with "churn" or standard product replacement of furnishings and finishes.

I.3 Moisture Control

Predesign-Programming

- In the program document, note any unusual water uses in the building for this occupancy class.

Predesign-Site Selection

- In site selection documents, note any potential water intrusion potential associated with the site.

Schematic Design

- Design building envelope and mechanical systems to meet the performance criteria for I.3. Calculate dew points for interior surfaces of all exterior wall elements at winter design day conditions.

Construction Documents

- In bid documents, describe how materials at construction site are to be stored to protect them from moisture damage during construction and procedures that will be followed to remove moisture-damaged materials from the construction site.

Construction

- Store materials appropriately to prevent water damage. Do not accept moisture sensitive materials with evidence of moisture damage, including stains. Remove them from the site and dispose of properly. Replace any moldy materials with new, undamaged materials.
- Sequence drying of construction materials appropriately during the construction process to prevent future problems. Follow guidance found in Appendix P-3a. Also See Performance Management.

Ongoing Occupancy

- Conduct regular inspections that ensure there are no visible signs of moisture intrusion or accumulation.
- Conduct regular testing of exterior wall construction to detect moisture in the exterior wall system.
- When exterior water intrusion, leakage from interior water sources, or other uncontrolled accumulation of water occurs, correct the intrusion, leakage or accumulation because of the potential for these conditions to cause the growth of mold. (Title 8, Chapter 4, Section 3362(g) of California Occupational Safety and Health Standards, Sept. 2002.) Establish maintenance procedures that will identify unintended water intrusion, leakage or accumulation quickly and provide drying or removal of building structure elements within 48 hours of the unintended event (Horner, 2001.) Review past water damaged materials to ensure mold growth has not occurred. Also See Performance Management.
- In spaces adjacent to new construction remove source of moisture intrusion or accumulation.

Next Use

- Site information and ways the design team prevented potential problems should be passed to new owners. See Performance Management.

I.4 Ventilation Design

Predesign-Programming

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Obtain ASHRAE 62.1– 2004 (or later version) and all applicable referenced standards and addenda.
	X	**X**	Work with the owner to identify high occupancy areas in the building.
	X	**X**	Determine design occupancy levels to calculate design CO2 emissions in occupied zones. Use estimated design occupancy levels or ASHRAE design occupancy levels by space type.

Schematic Design

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Incorporate the requirements of ASHRAE 62.1 into the design process as appropriate for the phase**.**
	X	**X**	When the initial ventilation design is completed using ASHRAE 62.1, compute the expected steady-state CO2 concentrations in high occupancy areas of the building.
		X	Determine the ventilation rate per person needed to limit CO2 concentrations to 450 ppm above the outdoor concentrations in all occupied zones. Use CO2 generation rates based on the activity level of occupants. See appendix a of the 62.1 user's manual or other source of metabolic rates of building occupants.
		X	Compare these ventilation rates with those calculated in based on ASHRAE standard 62.1. The guideline design ventilation rate for each space is the larger of the value required from 62.1 or the CO2 concentration requirement above.
		X	Coordinate with the energy analysis process, so that actual design ventilation rates are the same in both ventilation and energy design processes. The design team should consider using strategies that will provide the opportunity to reduce energy use associated with ventilation. The list recommended to consider includes but is not limited to: • CO2 or other occupancy control to reduce ventilation in the building when it is unoccupied. • Use of ventilation strategies that increase ventilation efficiency such as displacement ventilation. • Using economizer cycles where possible. • Using heat recovery strategies in the ventilation design chosen.

Design Development through Construction Documents

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Incorporate the requirements of ASHRAE 62.1 into the design process as appropriate for this phase.
	X	**X**	Specify appropriate instrumentation to monitor CO2 continuously in high occupancy areas of the building.
X	**X**	**X**	Update the design ventilation rate as any changes are made to the design occupancy levels planned for the building. Communicate these changes to the parties evaluating energy performance, so that significant changes in ventilation rate can be taken into account in energy calculations and strategies that address minimizing energy use in the building.

Construction

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Follow a Construction IAQ Management Plan during construction to prevent problems that will adversely affect IAQ when the building is occupied. See P.4 Design and Construction Commissioning. At a minimum, utilize the requirements found in section 7 of standard 62.1 for construction and startup phases of the building.

Ongoing Occupancy

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Use the requirements found in section 8 of Standard 62.1 for operations and maintenance of the building. Observe the minimum maintenance frequencies presented in table 8.1 of Standard 62.1 for ventilation system components.
	X		Compare the expected values of CO_2 concentrations found in high-occupancy spaces in the building with those expected from the building design using ASHRAE 62.1. This should be done at three-month intervals during the initial year of occupancy and annually thereafter.
		X	Compare the expected values of CO_2 concentrations found in high-occupancy spaces in the building with those expected from the building design using ASHRAE 62.1 and the supplementary CO2 requirement. This should be done at three-month intervals during the initial year of occupancy and annually thereafter.

Next Use

I.4B	I.4C	I.4D	Task
X	**X**	**X**	Transfer assumptions about ventilation rates and carbon dioxide concentrations in high occupancy spaces to a new owner of the building. See P.5 Operations Commissioning for record keeping and transfer procedures.

I.5 Thermal Comfort

Predesign-Programming

- Determine special thermal comfort requirements or problems that may be encountered in the building due to work activities or siting or design considerations.
- Review conditions that affect thermal comfort using ASHRAE Standard 55-2004 or Human Factors Design Handbook. Perform any baseline studies on thermal problems or issues that may exist in current facilities if the project involves a move or remodel.

Schematic Design

- Estimate thermal comfort performance measures using ASHRAE Standard 62 occupancy limits for spaces and comfort zone and other thermal conditions in ASHRAE Standard 55. Ensure that no major design characteristic of the building required by these guidelines will push these variables outside general comfort ranges as defined by the guidelines.

Design Development

- Consider additional calculations of thermal comfort indices as appropriate to specific project conditions. Additional measures may include operative temperature, new effective temperature (which combines air temperature and relative humidity,) or wet-bulb globe temperature (which combines dry bulb, wet bulb and globe temperature measures.) The latter is the effective index under potential heat stress conditions.

Correction Period

- Measure performance variables on site. (See Guideline P.4 Design and Construction Commissioning for commissioning procedures.)

Ongoing Occupancy

- Document thermal comfort-related complaints. (See P.5 Operations Commissioning for documentation procedures.) and resolve as appropriate to satisfy these guidelines and general Human Factors Engineering practices.

I.6 Quality Lighting

Predesign-Programming

- Incorporate performance criteria into lighting design criteria in program document. Develop additional quality lighting criteria as needed for special facility issues. Example: security or anti-vandalism lighting may need to be incorporated into lighting considerations.

Schematic Design

- Conduct a first order check for design constraints on lighting design. Ensure that general daylighting schemes and lighting plans are not in conflict with achieving lighting quality and any additional lighting criteria.

Design Development

- Complete a lighting analysis and develop the lighting design in conformance with performance criteria. Perform any lighting modeling studies as needed to confirm or substitute for calculations.

Construction Administration

- Observe and verify that the room, window, finish, and lighting variables (upon which estimated compliance was based) are proceeding according to goals as reflected in drawings and specifications.

Correction Period

- Conduct onsite measurements once all lighting is operational. (See P.4 Design and Construction Commissioning for commissioning requirements.)

Ongoing Occupancy

- Log complaints related to lighting conditions. (See P.5 Operations Commissioning for record keeping requirements.)

I.7 Effective Acoustics

Predesign-Programming

- Include performance criteria in programming document. Develop any additional special acoustical performance requirements to support functional programming of building. (E.g. sources of recurrent noise that needs to be controlled, special user populations which may have distinct auditory performance limitations, multiple uses of building spaces which may have different acoustic criteria. Investigate and choose appropriate acoustics modeling software for the project. (See Tools.)

Schematic Design

- Consider performance in building layout and form. Ensure that there are no inherent acoustic conflicts or limits to meeting performance criteria at schematic design level. Perform initial software simulations to ensure that general acoustics parameters are met.

Design Development

- Demonstrate complete compliance with acoustical performance criteria via calculations or more detailed simulation modeling.

Construction Documents

- Address explicit performance criteria in design and materials selection and specification. Check to ensure materials selection meets necessary criteria for acoustical controls.

Correction Period

- Measure acoustic performance onsite with full systems running. Check against predictions from software models.

Ongoing Occupancy

- Log noise and other sonic environment complaints. Check for needed sonic modifications if programmed activities of spaces change to require different supports. (See Guideline P.5 Operations Commissioning for recordkeeping procedures.)

I.8 Reduce Vibration in Buildings

Predesign-Programming

- Include performance criteria in programming document. Identify any potential sources of unusual vibration conditions within building (e.g. heavy equipment or machinery operations, inclusion of windpower generators, etc.)

Schematic Design

- Consider performance criteria in placement of machinery and in general building form and layout. Confirm isolation of vibration sources in schematic design, or tag for special treatment in design development.

Design Development

- Demonstrate compliance via structural calculations or table citation.

Correction Period

- Verify achievement of performance criteria onsite with full systems running and with stops and starts of systems at varying degrees of load.

Ongoing Occupancy

- Log vibration related complaints. (See Guideline P.5 Operations Commissioning for recordkeeping procedures.)

I.9 Daylight

Predesign-Programming

- While programming identify and list continuously occupied spaces without security, hazard or other restrictions to windows and daylighting as appropriate for daylighting.
- Using the Daylight Factor Calculator or other tool to establish room proportions, window area and surface properties that satisfy the required performance criteria for each of the main prototype spaces.

Schematic Design

- Using the Daylighting Factor Calculator or similar tool establish room proportions, window area and surface properties that satisfy the required performance criteria, if this has not already been completed. Begin organizing the building volume and fenestration so as to maintain the required performance criteria. Use the output from the Daylighting Factor Calculator to check the performance periodically as the design evolves.
- For each of the main prototype spaces, test and determine the implications for orientation, room proportion, window area, and finishes that achieve the performance criteria. Coordinate this effort with related lighting quality (I.6) and view space guidelines (I.10) and with energy conservation approaches (E.1.)
- The Daylighting Factor Calculator is designed to identify the physical attributes for room dimensions, surfaces and fenestration in order to just meet the performance criteria for standard CIE overcast sky conditions. It does not currently take into account light shelves, partitions, non-orthogonal planes, significant exterior obstructions or exterior reflecting surfaces. For such parameters that go beyond the current capability to the Daylighting Factor Calculator, physical models or computer simulations are recommended to refine the volumetric and surface attributes of the final design in order to assure compliance with the required and recommended performance criteria.

Design Development

- Demonstrate compliance using the Daylighting Factor Calculator, computer simulation or physical modeling whichever tool is appropriate. For each of the main prototype spaces, show a summary of calculations, and quantitative results indicating conformance with performance criteria. Coordinate this effort with related lighting quality (I.6) and view space (I.10) guidelines and with energy conservation approaches (E.1.)

Construction Administration

- Observe and verify that the room, window, finishes (upon which estimated compliance was based) are proceeding according to goals and are reflected in drawings and specifications.

Correction Period

- Acceptance Testing: Measure performance criteria on site. Develop sampling plan to confirm daylighting performance over first three years of occupancy. Compare performance at specific test times to what would be expected under same conditions in model. For example, if the onsite lighting measurements are taken at noon, on September 21, compare to a model condition at noon on September 21.
- Acceptance Testing: Demonstrate that performance criteria are maintained via a sampling plan of daylighting performance over varying conditions during the first three years of occupancy.

I.10 View Space and Window Access

Predesign-Programming

- Include performance criteria in the program document. Develop any special view and window requirements during functional programming of activities for the building. Examples: presence of an amenity view space, special security concerns for windows in certain locations of the building.

Schematic Design

- Determine implications of performance criteria for space planning and incorporate into schematic design. Perform first order estimates of view access given projected uses within building and initial sizing and placement of windows. Identify any problems with window configuration and placement.

Design Development

- Confirm compliance with a check of design development drawings.

Construction Administration

- Observe and verify that the room, window, and furnishing variables (upon which estimated compliance was based) are proceeding according to goals as reflected in drawings and specifications.

Correction Period

- Verify that performance criteria are met by checking performance on site.

Ongoing Occupancy

- Log comments relating to view space and window access. (See P.5 Operations Commissioning for record keeping procedures.)

I.11 Personal Control of IEQ Conditions and Impacts

Predesign-Programming

- Include performance criteria in programming documents. Perform an ecological matrix analysis to demonstrate the planned means of occupant control over environmental quality variables under their routine and foreseeable extreme variations.

Schematic Design

- Consider personal control criteria impact on the schematic design. Check that there are no obvious limits on personal control strategies in the schematic design and that personal control strategies are incorporated in the general design of building.

Design Development

- In the design documentation and documentation of compliance for this phase, call out the personal control strategies enabled by and included in the design.

Construction Documents

- Include testing of occupant control options over indoor environmental qualities in the commissioning plan.

Correction Period

- Verify achievement of performance criteria by exercising the range of occupant control strategies available on site per the commissioning plan. (See P.4 Design and Construction Commissioning for commissioning plan.)

Ongoing Occupancy

- Log complaints or shortcomings noticed in lack of personal control over indoor environment. (See P.5 Operations Commissioning for record keeping procedures.)

I.12 Encourage Healthful Physical Activity

Predesign-Programming

- Look for opportunities in programming of building to encourage healthful physical activity by occupants. Include suggestions for activities and explicit performance criteria in programming documents.

Schematic Design

- Incorporate physical movement strategies in design of building. Include general layout and programming considerations for increasing occupant circulation as well as amenities that accommodate exercise activities during daily operations (e.g. inclusion of shower and locker to accommodate lunchtime joggers.)

Design Development

- In the design documentation and documentation of compliance for this phase, call out explicit physical movement strategies. Include necessary signage in design to encourage and direct circulation.

Correction Period

- Test stair use for potential variety of users. Check that signage and circulation amenities are present and installed correctly. (See P.4 Design and Construction Commissioning for commissioning plan.)

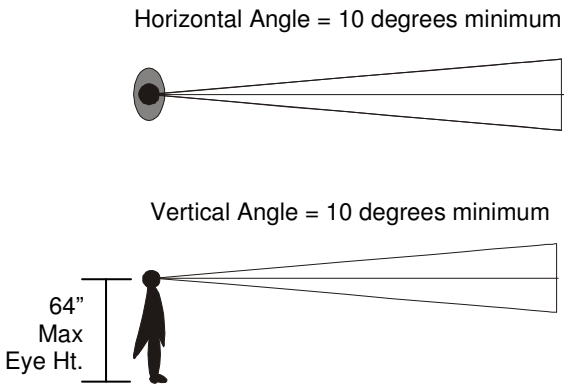
Ongoing Occupancy

- Include a physical-movement-related question on scheduled staff surveys. Track improvements in staff health and organizational productivity related to better physical circulation and social communication and analyze and document results in the annual Guideline Report. (See P.5 Operations Commissioning for record keeping procedures.)

Appendix I-10: View Space Diagrams and Tables

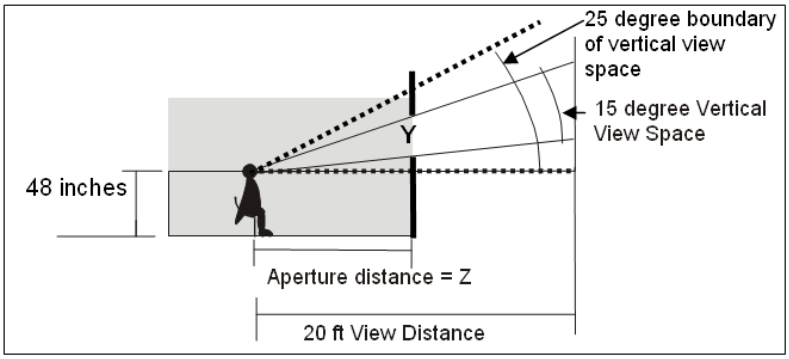
Illustration of recommended criteria for guideline I.10 View Space and Window Access

"A. From every continuously occupied position in spaces there shall be visual access to an external window view that is at least 10 degrees in horizontal and vertical visual angle at no greater than the 50th percentile standing average eye height of 64 inches."

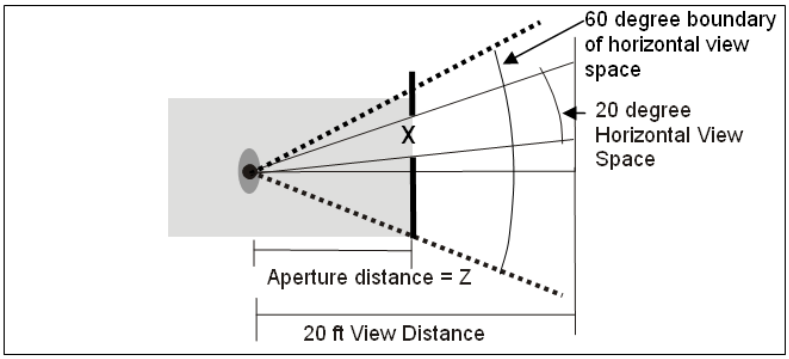


"B. From every assigned and continuously occupied workstation position at seated eye height of 48 inches there shall be visual access to a view space that is at least 20 feet away. The view space shall be at least a continuous 20 degrees horizontal angle beginning at not more than 10 degrees from the centerline of sight. The view space shall also be at least a continuous 15 degrees vertical view angle beginning at not more than 10 degrees from the horizontal centerline of sight and shall also be above that horizontal centerline.. As an alternate to the 20 degree horizontal by 15 degree vertical dimensions of the line of sight, the table "View Space Aperture Approximately Corresponding to a 20 degree Horizontal by 15 degree Vertical View Angle" found in Appendix I-6 may be used."

Side View



Plan View



View Space Aperture Approximately Corresponding to a 20 degree Horizontal by 15 degree Vertical View Angle

	Aperture Distance (Z) in Feet from Viewer																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Minimum Horizontal Dimension in feet (X) of Aperture to the 20-foot-view (Approximately Corresponding to the 20 deg. Horizontal View Angle)	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.2	3.6	4.0	4.3	4.7	5.0	5.4	5.8	6.1	6.5	6.8	7.2
Minimum Vertical Dimension in feet (Y) of Aperture to the 20-foot-view (Approximately Corresponding to the 15 deg. Horizontal View Angle)	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.4	3.7	4.0	4.2	4.5	4.8	5.0	5.3

Appendix M-0: Suggested Implementation of All Material and Waste Guidelines

M.1 Life Cycle Assessment of Building Assemblies

Agency Planning

- Refer to Performance Management Guideline P.2 Planning for Conservation for phase recommendations in addition to those indicated below. Coordinate efforts of P.2 with M.1 so that all aspects of life cycle materials use are considered together.
- Establish recommendations for life of building and major building systems based on typical program, expectations for future expansion and reuse, and considerations for flexibility and adaptability.

Schematic Design

- Complete Guideline M.1 evaluation using either the *Athena Eco-Calculator for Assemblies* , or *Athena Environmental Impact Estimator*. Enter building data in B3 Guidelines Tracking Tool at www.msbgtracking.com to establish a custom LCA benchmark for embodied carbon impacts. Enter results from Athena calculations and submit with the SD package.
- If the material lifecycle plan includes disassembly goals, establish materials, products, or components that support disassembly goals and develop design strategies to achieve these goals. At this design phase, employ design strategies to reflect the following considerations as needed to meet disassembly goals:
    - Use structural systems, cladding systems, and non-load bearing wall systems that facilitate disassembly.
    - Use structure/shell systems that maintain integrity when demounted or disassembled (i.e. steel, glass, or concrete and panel claddings)
    - Use materials, systems, and components that can be assembled or fastened in a manner that facilitates reassembly into new construction or remodeling.
    - Provide cost and environmental data for comparison and evaluation.
- Where disassembly is not an option, or proves less efficient because of the expectations for the full life cycle of the building, establish materials, products, and components that promote durable construction that supports life-cycle goals.

Design Development

- Refine selection of materials and products to reflect project plan team recommendations for overall environmental performance for maximum flexibility, adaptability, and disassembly. At this design phase, employ design strategies to reflect the following considerations:
    - Use materials, systems, and components that can be recycled or reused in whole or in part.
    - Use materials that are durable, weather well, and last for the intended lifetime of the structure (including masonry, steel, glass, and some timber products such as beams, columns, floorboards, etc.)
    - Use materials, systems, and components that can be assembled or fastened in a manner that facilitates reassembly into new construction or remodeling.
    - For greatest flexibility, use homogeneous materials, products, or assemblies that facilitate separation and reuse, additional lateral recycling, or are readily

biodegradable. However, if using composite, glued, adhered, or laminated components, select those that can be reused, deconstructed, recycled again, or composted, if possible. Ensure if composite, glued, laminated, or adhered materials are selected which have the potential to off-gas, they are properly sealed during or after fabrication and before occupancy.

- Determine final building assemblies and enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com.

Construction Documents

- Represent chosen building assemblies from Guideline M.1 in drawings and specifications.
- Develop final drawings and specifications detailing specific system requirements for disassembly, including description of fastening systems, connectors, and recommendations for reuse of materials to be reused within existing construction or which could be reused for other construction in the future.

Construction Administration

- Document any changes to recommendations for construction that occur that may seriously impact the future disassembly of components or materials.
- Observe construction site to verify that materials, products, and systems are being correctly installed to preserve project goals and objectives as represented in the drawings and specifications.

Next Use

- During considerations for the "next use" of the facility, consult the project data history to identify and inventory systems and building components that can be disassembled for reuse, salvage, or recycling and document their inclusion in project renovation, remodeling, or deconstruction for use in the future or at another location.

M.2 Evaluation of Environmentally Preferable Materials

Schematic Design

- Based on the service life of the building, select materials that have durability appropriate for that service life, materials that are salvaged or reused, and materials that are renewable / bio-based.
- Make initial selection of building materials and products and enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com
- Provide cost data for comparison and evaluation.

Design Development

- Refine selection of materials and products and enter results in B3 Guidelines Tracking Tool at www.msbgtracking.com
- Research suppliers, costs, scheduling and availability of materials that may impact material selection.
- Provide updated cost data for comparison and evaluation.

Construction Documents

- Represent chosen materials from Guideline M.2 in drawings and specifications.

- Develop detailing and construction recommendations that minimize material use and maximize performance of materials to support 'material resource efficiency' requirements.
    - Compile material and product documentation from the manufacturer, declaring life cycle and warranty recommendations indicating durable life cycle projections for building components.
    - Provide specifications that require contractor submittals highlighting service life of materials installed.
- Provide updated cost data for comparison and evaluation.

Construction Administration

- Monitor submittals to ensure project includes selected materials; review substitutions based on selected criteria to ensure consistency and compliance with goals and objectives.
- Monitor construction site to verify that materials, products, and systems are being correctly installed to preserve project goals and objectives.

Next Use

- During considerations for "next use" of the facility, incorporate material selections which reflect selections that support use of durable materials, which can be disassembled, reused, or recycled.

M.3 Waste Reduction and Management

Predesign-Programming

- Evaluate agency operational waste management procedures and develop implementation goals for incorporation in building program and design. Set a goal to reduce and recycle at least 50% of the waste generated during building operation
- Provide dedicated recycling areas, processing and holding space, and reverse distribution space in the building. A guideline is to provide 20 square feet of space for recycling for every 10,000 square feet of occupied space up to 50,000 square feet. Over 50,000 square feet, provide at least 100 square feet of space.
- Reduction of construction waste through deconstruction, salvage, recovery, and appropriate design and detailing are primary goals.
- Set goals for reduction/recycling/salvage/disposal for construction and packaging waste based on project type and availability of local programs.

Schematic Design

- Establish project occupancy goals for waste management during the life cycle of the building. Incorporate areas to support those goals through first and subsequent occupancy cycles.
- Establish goals for landfill diversion and adopt a construction waste management plan to achieve these goals.
    - Minimal list for inclusion: Recycling land clearing debris, cardboard, metals, brick, concrete, plastic, clean wood, glass, gypsum wallboard, carpet, and insulation.

Design Development

- In planning, set aside a staging area on site for collecting, storing, and processing packaging that needs to be returned to the vendor, along with an area for construction waste management (salvage/recycling/disposal.)
- Develop environmentally responsible packaging criteria. Identify suppliers that use environmentally responsible approaches to packaging. Favor suppliers that meet these criteria.
- Refine selection of materials and products to reflect project team recommendations for overall environmental performance for minimal creation of construction, packaging, and hazardous waste.

Construction Documents

- Develop details and specifications that support the minimization of material use and clearly require construction waste management that meets project requirements.
- Include specification language mandating compliance with the pursued level of construction waste landfill diversion.
- Request reduced, reused or eliminated material packaging.

Construction Administration

- Monitor submittals to ensure project construction waste program includes materials specified; review revisions to program to ensure consistency and compliance with goals and objectives. Enter actual construction waste disposal and recycling in B3 Guidelines Tracking Tool at www.msbgtracking.com.

Ongoing Occupancy

- Enter actual operations waste disposal and recycling in B3 Guidelines Tracking Tool at www.msbgtracking.com.

Next Use

- During considerations for "next use" of the facility, verify selections that can be recycled or salvaged.

Appendix M-3a: Example Specification Language for Construction Waste Management

The following pages show example language that may be of assistance for reference. This specific language is not required. Project teams should create their own specification language that meets the appropriate elements and requirements of their project.

SECTION 01690
WASTE MATERIALS
MANAGEMENT AND RECYCLING

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of each prime Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY :

A. Section Includes: This Section includes required recycling and recovery of the following waste materials and applies to listed waste materials produced during the Work:

1. Land Clearing Debris: Solid waste generated solely from land clearing operations, such as stumps and trees.

2. Concrete and Masonry: Clean concrete, brick, rock, and masonry.

3. Metals: Metal scrap including iron, steel, copper, brass, and aluminum.

4. Untreated Wood: Unpainted, untreated dimensional lumber, timber beams, engineered wood products, plywood, oriented strand board, Masonite, particleboard, wood shipping pallets, and crates.

5. Gypsum Wallboard Scrap: Excess drywall construction materials including cuttings, other scrap, and excess materials. [Edit to suit project.]

6. Paper and Cardboard: Discarded office refuse including unwanted files, correspondence, etc. Clean, Corrugated cardboard used for packaging, etc.

B. Non-Recyclable Waste: Collect and segregate non-recyclable waste for delivery to an permitted landfill site.

1. Mixed Solid Waste: Solid waste commonly collected as a municipal service, exclusive of waste materials listed above.

1.3 DEFINITIONS:

A. Waste Materials are defined as large and small pieces of listed materials which are excess to contract requirements and generally include materials to be recycled and/or recovered from existing construction and items of trimmings, cuttings and damaged goods resulting from new installations, which cannot be effectively used in the Work.

B. Recycling is defined as the process of collecting and preparing recyclable materials and reusing them in their original form or in manufacturing processes that do not cause the destruction of recyclable materials in a manner that precludes further use.

C. Recovery is defined as any process that reclaims materials, substances, energy, or other products contained within or derived from waste on-site. It includes waste-to-energy, composting, and other processes.

1.4 SUBMITTALS :

A. Construction Waste Management Plan: Before start of construction, submit a construction waste management plan for approval of Contracting Officer's Representative indicating how Contractor proposes to collect, segregate, recycle, and recover at least 75% of construction wastes and debris generated by the Work. Submit documentation indicating compliance with regulations specified under "Quality Assurance" article below. Include a list of recycling facilities to which indicated recyclable materials will be sent for recycling. Identify materials that are not recyclable or otherwise recoverable that must be disposed of in a landfill or other means acceptable under governing State of Minnesota and local regulations. List permitted landfills and/or other disposal means to be employed. Indicate instances where compliance with requirements of this specification does not appear to be possible and request resolution from the Contracting Officer through the Contracting Officer's Representative.

B. Delivery Receipts: Provide to the Construction Quality Manager delivery receipts for waste materials salvaged and sent to permitted waste materials processors or recyclers within 48 hours of delivery that indicate the location and name of firm accepting recyclable waste materials, types of materials, net weights of each type, date of delivery and value of materials.

1.5 QUALITY ASSURANCE :

A. Regulatory Requirements: Comply with applicable requirements of the State of Minnesota and applicable local ordinances and regulations concerning management of construction, demolition, land clearing, inert, and yard trash debris and subsequent modifications and amendments to same.

B. Disposal Sites, Recyclers, and Waste Materials Processors: Use only facilities properly permitted by the State of Minnesota and by local authorities where applicable.

C. Pre-Construction Waste Management Conference: Prior to beginning work at the site, schedule and conduct a conference to review the Construction Waste Management Plan and discuss procedures, schedules and specific requirements for waste materials recycling and disposal. Discuss coordination and interface between Contractor and other construction activities. Identify and resolve problems of compliance with requirements. Record minutes of the meeting, identifying conclusions reached and matters requiring further resolution. Maintain waste management as an agenda item at future construction meetings.

1. Attendees: Contractor and related Contractor personnel associated with work of this section, including personnel in charge of the waste management program; Construction Quality Manager; Architect; material suppliers where appropriate; and such additional Owner personnel as Owner deems appropriate.

2. Plan Revision: Make revisions to Construction Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit revised plan to Architect for approval.

D. Implementation: Designate an on-site party responsible for instructing workers and implementing Construction Waste Management Plan. Distribute copies of Construction Waste Management Plan to jobsite foreman and each subcontractor. Include waste management and recycling in worker orientation. Provide on-site instruction on appropriate separation, handling, recycling, and recovery methods to be used by all parties at the appropriate stages of the work at the site. Include waste management and recycling discussion in pre-fabrication meetings with subcontractors and fabricators. Also include discussion of waste management and recycling in regular job meetings and job safety meetings conducted during the course of work at the site.

1.6 STORAGE AND HANDLING:

A. Site Storage: Remove materials for recycling and recovery from the work location to approved containers or storage area as required. Failure to remove waste materials will be considered cause for withholding payment and termination of Contract.

B. Position containers for recyclable and recoverable waste materials at a designated location on the Project Site. If materials are sorted on site, provide separate collection containers or storage areas for not less than the following materials:
1. Concrete and masonry.
2. Metals.
3. Untreated lumber.
4. Gypsum wallboard scrap. [Edit to suit project]
5. Paper and cardboard.

C. Change-out loaded containers for empty containers as demand requires.

D. Handling: Deposit indicated recyclable, and recoverable materials in storage ars or containers in a clean (no mud, adhesives, solvents, petroleum contamination), debris-free condition. Do not deposit contaminated materials into the containers until such time as such materials have been cleaned.

E. If the contamination chemically combines with the material so that it cannot be cleaned, do not deposit into the recycle containers. In such case, request resolution by the Construction Quality Manager for disposal of the contaminated material. Directions from the Construction Quality Manager do not relieve the Contractor of responsibility for compliance with all legal and regulatory requirements for disposal, nor shall such directions cause a request for modification of the Contract.

1.7 PROJECT/SITE CONDITIONS:

A. Environmental Requirements: Transport recyclable and recoverable waste materials from the Work Area to containers and carefully deposit in the containers without excess noise and interference with other activities, to minimize noise and dust.

1. Do not place recyclable waste materials on the ground adjacent to a container.

B. Existing Conditions: Coordinate with "Instructions to Bidders" and "Supplementary Conditions".

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION:

3.1 WASTE MANAGEMENT

A. General: Implement waste management procedures in accordance with approved Construction Waste Management Plan. Maintain procedure throughout the life of this Contract.

B. Source Separation On- or Off-Site: Either separate, store, protect, and handle at the project site all identified recyclable and recoverable waste products to prevent contamination of materials and maximize recyclability and recoverability of materials. Or mix all identified recyclable and recoverable waste products for separation off-site.

C. Arrange for the regular collection, transport from the site, and delivery to respective approved recycling centers of indicated recyclable waste materials. Maintain records accessible to the Architect for verification of construction waste materials recycling and recovery.

D. Delivery Receipts: Arrange for timely pickups from the site or deliveries to approved recycling facilities of designated waste materials to keep construction site clear and prevent contamination of materials. Keep and maintain records of deliveries to recycling facilities and pickups of waste materials at the site by others as specified above.

3.2 RECYCLABLE WASTE MATERIALS HANDLING: [Note to author: Edit the following to meet project requirements.]

A. General: The following paragraphs supplement handling requirements for various of the materials identified for classification and recycling listed in Part 1 "Summary" article above. (Note to author: If the following materials are not recyclable in your area, delete them from the specifications.)

B. Land clearing Debris: Pile wood debris from land clearing in a clean storage area free from large amounts of dirt and other non-wood materials. Chip smaller size tree limbs on site and use as plant mulch. Cut larger tree limbs and trunks into 16 inch lengths and advertise as green firewood if hardwood or softwood suitablefor burning. Transport other wood including tree roots to a County waste and recycling center.

C. Concrete and Masonry: Free of metals, woods and other contaminates. If possible during demolition, crush existing concrete and concrete masonry units on-site into aggregate size. Store crushed material on-site in clean area to avoid contamination from other materials or building processes. Reuse on-site crushed material for fill, for stabilizing soils, or as base and sub-base materials. If crushing on site is impractical, store material during demolition

processes on site in clean, uncontaminated area. Transport concrete andmasonry materials to a certified concrete recycler as needed.

D. Metals: Cut items to lengths and sizes to fit within the container provided when necessary. Where there is sufficient quantity of a specific recyclable waste item (for example; salvaged metal roofing or duct work), make special arrangements for items to be bundled, banded or tied, and stack in a designated location for a special pick-up. Coordinate special arrangements with the Construction Quality Manager.

E. Untreated Wood: Salvaged wood materials to be free of metals, concrete, gypsum wallboard, insulation, and other contaminating materials. Stack dimensional wood into like piles. For example, store 2x4s with other 2x4s, and 2x6s with other 2x6s. Also, if quantity is sufficient, separate piles into lengths of 4-foot increments. Reuse lumber on site as studs, backing, blocking or other uses where appropriate. Stack non-dimensional wood in piles for possible reuse on-site or transport off-site. Depending on size of lumber, recycle or chip wood for plant mulch. If wood materials cannot be used on site, transport to a certified wood recycler or reuse center.

F. Gypsum Wallboard Scrap: Separate gypsum wallboard from other wastes. Dispose of waste gypsum wallboard off-site at a gypsum reclamation or recycling facility, or on-site as a soil amendment.

1. For on-site application as a soil amendment, incorporate waste gypsum wallboard in landscape areas under construction, at a rate of 50 pounds per 1000 square feet, or approximately one ton per acre.

    a) Material must be unpainted gypsum wallboard from new construction, ground to reduce material to a fine particle size (70% passing a 100 mesh screen), and must be fully incorporated into the soil surface.

G. Paper and Cardboard: Classify and handle waste paper goods as follows:

1. Bond Paper: General office quality paper used for specifications, correspondence, copiers, PC laser printers, and FAX machines. Collect in separate container at each workstation and deposit loose inappropriate recycle container as required.

2. Newsprint: Newspapers and tabloid style advertising (slick finish magazines and advertising materials are not typically recyclable). Collect in single location and deposit as required in appropriate recycle container.

3. Diazo Prints (drawings): Set up single location for collection. Roll together to minimize space. Deposit as required in appropriate recycle container.

4. Cardboard and paper board cartons and boxes: Knock-down, fold flat, and deposit in appropriate recycle container.

H. Other Items: Where recyclability classification of any given waste material is unclear, verify with the Construction Quality Manager.

END OF SECTION

Glossary

Appropriated Agency
The agency that received funding from the capital bond proceeds on behalf of the project and is responsible for compliance review. The appropriated agency is responsible for reviewing, (but not determining), compliance with the guidelines according to the Compliance Review process based on the extent of compliance represented and documented in the Compliance Summary Form, Outcome Documentation Forms, and optional Guideline Report. The Appropriated Agency also reviews and decides whether to accept applications for variance from the guidelines according to the Variance Process. (See P.0 Guideline Management, Supporting Information.)

Atmospheric Lifetime (AtL)
Atmospheric Lifetime is a measure of the average persistence of the refrigerant if released. A longer lifetime has worse environmental effects.

Baseline
Baselines demark a reference case for comparison and are used to determine performance improvements for compliance with guidelines throughout this document.

Baseline(s), Measurement and Verification
Measurement and Verification Baseline(s) are used to calculate savings as part of the Measurement and Verification Process. They should be coordinated with other baselines but may have other requirements per IPMVP reference standard. See details of Measurement and Verification under Guideline P.5 Operations Commissioning and Appendix P-5a.

Benchmarking
Benchmarking is a component of the Buildings, Benchmarks, and Beyond (B3) Project (in addition to Guidelines development , project management, and project delivery process.) Benchmarking will identify the energy performance of existing public buildings in order to direct energy conservation improvements where they are most needed and most cost-beneficial. As new state-funded projects are constructed and operated in accordance with B3 Guidelines, more detailed information on energy and other sustainable performance factors will also be tracked.

Best Management Practices (BMPs) (Stormwater context)
Engineered devices or strategies implemented to control, treat or prevent storm water runoff. BMPs can include, but are not limited to, schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to storm water, receiving waters or storm water conveyance systems. BMPs also include treatment practices, operating procedures and practices to control site runoff, spillage or leaks, sludge or water disposal or drainage from raw materials storage.

Biodiversity
The variety, variability, and number of plants and animals in a defined area. A term generally used to describe the health of a site, and its ability to sustain itself over time.

Buildings, Benchmarks, and Beyond (B3) Project
The State of Minnesota Sustainable Building Guidelines are a component of a larger project of the Departments of Administration and Commerce called "Buildings, Benchmarks and Beyond" (B3). The other primary component of the B3 project, called "benchmarking," will identify the energy performance of existing public buildings in order to direct energy conservation improvements where they are most needed and most cost-beneficial. As new state-funded projects are constructed and operated in accordance with the new sustainable guidelines, more detailed information on energy and other sustainable performance factors will also be tracked. The third, management component of the B3 project facilitates integration of the guideline and benchmarking efforts and coordinates public input.

Blackwater
Blackwater is water flushed from toilets. Also, water from a kitchen sink, garbage disposal or dishwasher is considered blackwater because of high concentrations of organic waste. Only after appropriate treatment can blackwater be reused for non-potable applications, such as subsurface landscape irrigation.

Brownfields
Previously developed sites where the redevelopment, reuse, or expansion is impacted by the presence or potential presence of contaminants in the soil. Brownfields can occur in urban, suburban, and rural areas.

CSBR:
The Center for Sustainable Building Research (CSBR) at the University of Minnesota acts as the B3 Guidelines tracking team. CSBR leads the B3 Guidelines Tracking Process, updates and maintains project information with required forms and optional Guideline Reports from each phase of project development and each year of operational data. This data may be posted on a B3 Guidelines informational website. It may also be used for selected audits, to improve the usability and effectiveness of the B3 Guidelines, and to translate building performance in to state economic, human, and environmental outcomes. CSBR tracks the B3 Guidelines on direction of the State. (See P.1 Guideline Management, Appendix P-0b.)

Certified *(Materials)*
Validation by an approved, third-party resource, that material or product meets specifications for performance or prescriptive criteria. An example is the Forest Stewardship Council Certified Wood programs.

Churn
For any given period of time, the number of occupants who discontinue their current use of a space and require modifications to structural components, building systems, interior finishes, or furnishings, divided by the average number of total occupants. Churn rate provides insight into the life cycle cost of materials.

Clean Water Act
The federal Water Pollution Control Act (33 U.S.C. '1251 et seq., established in 1972.), and any subsequent amendments thereto.

Commissioning Process, Commissioning Plan, Commissioning Report for Design and Construction Commissioning

Design and Construction Commissioning refers to the commissioning process that shall begin in schematic design and conclude after the correction period or after completion of a full year of operation, which ever is last. The Design and Construction Commissioning Process is the means to verify and document that the systems of a facility operate in accordance with their design intent and that the operations staff fully understands the system operational procedures. This includes documenting system operational goals and design parameters, planning for verification and testing in the design and specifications, confirming the successful completion of the verification process, documenting the system operational procedures and training the operations staff. The Design and Construction Commissioning Process is coordinated by the Design and Construction Commissioning Leader and executed by the Design and Construction Commissioning Team. (See P.4 Design and Construction Commissioning and Appendix P-4a.)

Commissioning Process, Commissioning Plan, Commissioning Report for Operations Commissioning

Operations Commissioning shall be planned for during design, but focuses on the operations of the facility after construction through the next use of the facility. The Operations Commissioning process is the means to verify and document that the systems of a facility and the facility as a whole continue to operate in accordance with their design intent overtime. This includes planning, implementation, and documentation for regular preventative maintenance, Measurement and Verification of system and whole building performance, and improvement and correction of that performance. The Operations Commissioning process is coordinated by the Operations Commissioning Leader and executed by the Operations Commissioning Team. Initial operations input is provided by the participation of the Facility Operations Manager on the Design and Construction Commissioning Team. Later in design, the Operations Commissioning Team is formed and leads the planning for Operations Commissioning after occupancy. (See P.5 Operations Commissioning and Appendix P-5a.)

Commissioning Leader, Commissioning Team for Design and Construction Commissioning

The Design and Construction Commissioning Leader is the person who coordinates the efforts of the Design and Construction Commissioning Team and assembles the Design and Construction Commissioning Plan, commissioning design reviews and the Design and Construction Commissioning Reports. The Commissioning Leader shall be a distinct role from the design team, but may be employed within one of the firms providing design services. The Commissioning Team serves the planning and review needs to coordinate with the commissioning process and to complement the skills of the Commissioning Leader. The Commissioning Team shall include the Commissioning Leader, a representative of the owner's facilities operations team, the Guideline Leader, the architect and engineers of multiple disciplines as needed to cover the expertise to plan and execute commissioning of selected systems, the contractor, and appropriate subcontractors. (See P.4 Design and Construction Commissioning, and Appendix P-4a.)

Commissioning Leader, Commissioning Team for Operations Commissioning

The Operations Commissioning Leader is the person who coordinates the efforts of the Operations Commissioning Team and assembles the Operations Commissioning Plan, commissioning design reviews and the annual Operations Commissioning Reports. The Operations Commissioning Leader can be from any group, including a member of the owner's facilities operations team. The Operations Commissioning Team serves the planning and review needs to coordinate with the Operations Commissioning Process and to complement the skills of the Commissioning Leader. The Operations Commissioning Team shall include the Operations Commissioning Leader, the Guideline Leader for the Ongoing Occupancy Phase,

and any other staff or consultants as needed to cover the expertise to plan and execute operations commissioning. (See P.5 Operations Commissioning, and Appendix P-5a.)

Compliance Review Process
The process for regularly reviewing compliance with the guidelines over time from initial phases through ongoing occupancy. There are three key components. First, the Work Team (or its Guideline Leader) submits the end-of-phase online Compliance Summary using the B3 Guidelines Tracking Tool (www.msbgtracking.com) to the Appropriated Agency for review. Then, the Appropriated Agency reviews the extent and nature of compliance as documented by the guideline leader and decides if the extent of compliance is acceptable. (The Appropriated Agency, does not *determine* compliance.) Finally, the Appropriated Agency either approves the extent of compliance for that phase, or directs the Guideline Leader to revisit compliance measures with the team. (See P.0 Guideline Management, and Appendix P-0b.)

Construction Activity (Site Guidelines Context).
Activities subject to NPDES Construction Permits. These include construction projects resulting in land disturbance of 1 acre or more. Such activities include, but are not limited to, clearing and grubbing, earthwork, and demolition.

Global Warming Potential (GWP)
Global Warming Potential is an indicator of the potency of the refrigerant to warm the planet by action as a greenhouse gas. A higher GWP has worse environmental effects.

Goal
The purpose toward which activity is directed. Goals relate the outcome sought to the issues relevant to a particular topic (site, energy, water, etc.). Goals are established on the basis of principles and associated desired outcomes.

Graywater
Graywater derives from domestic or commercial water uses, containing very low and harmless levels of organic contaminants. Water from sinks, baths, showers, and washing machines are a source of graywater, and can be used for subsurface irrigation of non-edible landscape plants and in some situations for toilet flushing.

Greenfields
Sites which have not experienced construction development and its associated uses (e.g. commercial, residential, industrial, or mining, excluding agriculture) and on which there are no known or suspected contaminates in the soil. Greenfields can occur in urban, suburban, and rural areas.

Guideline Leader: The Guideline Leader is the person who coordinates the completion, and documentation of tasks to comply with the sustainable guidelines. They shall work within the organization contractually responsible for a phase (or be a consultant hired by that organization), thus the role may be filled by different people for each phase. They are the contact person for guideline compliance. Some Agency processes may have a different name for this role, or not designate this role, leaving it up to a representative from the Work Team to coordinate the tasks of the Guideline Leader. (See P.0 Guideline Management and Appendix P-0b.)

Guideline Management Process
The process for ensuring that the project complies with the guidelines by regularly reviewing compliance with the guidelines from initial phases through ongoing occupancy. The Guideline Management Process is led by the Guideline Leader and consists of the following key components. 1) The work team for the responsible organization (planning team, design team, construction team, or operations team depending on phase) works to meet the guidelines. 2) The work team, Coordinated by the Guideline Leader, submits the online Compliance Summary using the B3-Guidelines Tracking Tool (www.msbgtracking.com) at the end of the phase, or annually during Ongoing Occupancy to the Appropriated Agency for Compliance Review. 3) The Appropriated Agency reviews the submitted materials and may approve or disapprove the extent of compliance. 4) This data is used to give feedback to the State on the guidelines and for benchmarking performance data during the ongoing occupancy phase. (See P.0 Guideline Management and Appendix P-0b.)

Guidelines
A set of rules and instructions (performance criteria), based on objectives, intended to achieve a goal and ultimately lead to the successful completion of a desired outcome. Guidelines may require total or partial compliance with rules or instructions (performance criteria). Guidelines may be of a prescriptive or performance nature. The term guidelines is used here to refer to the entire B3 document as well as the specific required or recommended items within each topic section. For example, "P.3 Planning for Conservation is the third *guideline* in the Performance Management topic of B3 *Guidelines*."

Hazardous Materials
Any material, including any substance, water or combination thereof, which because of its quantity, concentration or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property or the environment when improperly treated, stored, transported, disposed of or otherwise managed.

Illegal Discharge
Any direct or indirect non-storm water discharge to the storm drain system, except as exempted under this procedure.

Illicit Connections
An illicit connection is defined as ether of the following:

1. Any drain or conveyance, whether on the surface or subsurface, which allows an illegal discharge to enter the storm drain system including but not limited to any conveyances which allow any non-storm water discharge including sewage, processed industrial and mining wastewater, and wash water to enter the storm drain system and any connections to the storm drain system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted or approved by a government agency; or

2. Any drain or conveyance connected to the storm drain system which has not been documented in plans, maps or equivalent records and approved by the Local Governing Unit (LGU).

Impervious / Imperviousness *(Site Surfaces)*
Surfaces that prohibit or greatly slow down the movement of precipitation from the land surface into the underlying soil. This precipitation becomes surface water and contributes to downstream impacts.

Imperviousness is expressed as the percentage of a sub-basin, watershed, sub-watershed, or site, which is covered by impervious surfaces such as roof tops, parking lots, sidewalks, driveways, streets, and highways.

Industrial Activity
Activities subject to NPDES Industrial Permits as defined in 40 CFR, Section 122.26 (b)(14) (Reference: Code of Federal Regulations, Title 40: Protection of Environment, Part 122- NPDES).

Intent
The portion of a guideline that summarizes its purpose and usually its relationship to the objective and goal it is trying to accomplish.

Life Cycle *(Materials)*
Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal.

Life Cycle Assessment (LCA)
Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system or building component throughout its life cycle.

Life Cycle Costing
Life Cycle Costing is a process to determine the sum of all the costs associated with an asset or part thereof, including acquisition, installation, operation, maintenance, refurbishment and disposal costs. It is therefore pivotal to the asset management process. Life Cycle Costing incorporates both Life Cost Planning which occurs during development or manufacture and implementation of that plan by Life Cost Analysis as the asset is used or occupied. Life Cycle Costing forms an input to evaluation processes such as Value Management, Economic Appraisal and Financial Appraisal. (See Guideline P.6 Lowest Life Cycle Cost and Appendix P-6 for more details and definitions.)

Life Cycle Impact Assessment
Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of a product system.

Life Cycle Impact Category Indicator
Quantifiable representation of an impact category. Note that the shorter expression "category indicator" is used throughout the text of International Standard 14040 for improved readability.

Life Cycle Interpretation
Phase of life cycle assessment in which the findings of either the inventory analysis or the impact assessment, or both, are combined consistent with the defined goal and scope in order to reach conclusions and recommendations.

Life Cycle Inventory Analysis
Phase of life cycle assessment involving the compilation and quantification of inputs and outputs, for a given product system throughout its life cycle

Locally/Regionally Manufactured
Materials manufactured regionally within a radius of 250 miles of project site to specified qualifications, or are manufactured within the State of Minnesota and contain products from state-sponsored, approved, or acknowledged recycling programs.

Minnesota Pollution Control Agency (MPCA)
Among other things, the MPCA has regulatory authority to ensure compliance with Federal Clean Water Act requirements.

B3 Guidelines Tracking Process
This process consists primarily of updating and maintaining the project information. Related activities may include posting data from the project on an informational B3 website, using project information to improve the usability and effectiveness of the B3 guidelines, and translating reported building performance into economic, human, and environmental outcomes for use by the State of Minnesota The steps of this process consists of the following elements: Appropriated Agency submits online Compliance Summary form at the end of each phase, and annually during operations to CSBR for use in the B3 Tracking Process. Depending on the phase, Outcome Documentation may also call for Commissioning or other reports to be attached. CSBR uses the information received to update and maintain project information at the direction of the State of Minnesota. (See P.0 Guideline Management and Apendix P-2.)

National Pollutant Discharge Elimination System (NPDES) Storm Water Discharge Permits
General, group and individual storm water discharge permits that regulate facilities defined in federal NPDES (Phase I enacted in 1990 and Phase II enacted in 2003) regulation pursuant to the Clean Water Act or under state adopted implementation plans as applicable.

Non-Storm Water Discharge
Any discharge to the storm drain system that is not composed entirely of storm water.

No Net Increase
No net increase in nonpoint source pollution - Stormwater control systems designed to prevent the degradation of water quality in receiving watercourses from nonpoint source pollution associated with stormwater runoff.

1. No net increase in sediment loadings - Stormwater control systems designed to reduce to the maximum extent possible, the total suspended solids (TSS) from stormwater runoff for storm events with magnitudes as high as the Water Quality Storm and to retain, as closely as possible, the pre-development hydrologic response of the site and the watershed.

2. No net increase in stormwater runoff rates and stream channel erosion - Stormwater control systems designed so that, to the maximum extent possible, the postdevelopment stormwater runoff rates from the site and at any point in the watershed between the site are no greater than pre-development rates, in order to retain as closely as possible the pre-development hydrologic response of the site and the watershed.

3. No net increase in stormwater runoff volumes - Wherever suitable infiltration, soil permeability, and favorable geological conditions exist, stormwater control systems designed so that all stormwater runoff is infiltrated into the soil or retained on-site for re-use for the1.25” rainfall (Source: NRSC TR-55).

Native Plants
Indigenous species that were present in a defined area prior to European human contact and settlement.

Objective
A plan of action that sets the path to be used to reach the goal that is sought.

Outcomes
The desired end result, based on guiding principles, that is to be accomplished by meeting performance criteria. Here, the desired outcomes are beneficial impacts to human, community, environment, and life-cycle economic conditions. Specific units and methodologies for measuring outcome performance will be developed further in subsequent versions of the B3 Guidelines.

Outdoor Environmental Quality (OEQ)
Refers to characteristics of the exterior environment with regard to the impact of air quality, lighting, acoustics, microclimate, and spatial orientation on human health, safety and comfort. Air quality refers to characteristics with regard to movement, temperature, humidity, and contaminants (particulate matter, gases, pollen, allergens and fumes).

Performance *(guideline, performance criteria)*
A description of a guideline which stipulates a calculable and measurable desired result as part of the criteria for meeting a goal. Usually, the method to calculate the result is also a part of the criteria. The result and calculation method (based on desired impacts) are defined; the physical means of achieving the result are left to the design team. ("Achieve this result, and show us how it was calculated and can be verified.")

Performance Criteria
The portion of a guideline that describes the rules and instructions for meeting the intent of the guideline. Performance criteria may include units of measure, specific analysis methodology, and documentation requirements. Here, each performance criteria is followed by "Tasks by Phase" which describe in more detail the steps to be taken throughout the planning, design, construction, and occupancy process.

Pollutant
Anything which causes or contributes to pollution (sources that generate discharges include but, are not limited to: industrial, commercial, mining, and agriculture). Pollutants may include, but are not limited to, paints, varnishes and solvents; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter or other discarded or abandoned objects, articles and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides and fertilizers; hazardous substances and wastes; sewage, fecal coliform, endocrine disruptors, and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result from constructing a building or structure (including but not limited to sediments, slurries and concrete rinsates); and noxious or offensive matter of any kind.

Pre-Development or Pre-Existing Conditions
Site conditions existing prior to proposed improvements.

Pre-Settlement Conditions
Conditions prevalent before European human contact and settlement.

Post-Development Conditions
Site conditions after site improvements are completed.

Premises
Any building, lot, parcel of land or portion of land whether improved or unimproved including adjacent sidewalks, parking strips, and utility connections.

Prescriptive *(guideline)*
A description of a guideline which stipulates a norm or standard as *the* means for meeting a goal. The physical means are defined (based on perceived connection to a desired result); the actual resulting impact is unknown. ("Do THIS and we'll call it compliance without ever knowing its true impact or merits.")

Principle
A (social) principle is an agreed upon set of moral or ethical standards or judgments governing the behavior of a collective. Here, the principles pertain to human (building occupants), community, environmental sustainability, and life-cycle economic performance.

Project Archive
The Project Archive is the performance planning, design, and ongoing maintenance history of the project. This body of information should include: performance parameters and basis for design, design actions taken towards B3 Guidelines criteria, ongoing monitoring, measurement and verification over time, actions to resolve problems over time, and results of those actions. It includes each released version of the Guideline Reports and Commissioning Reports. The Guideline Leader and Work Team maintain the Project Archive each phase and facilitate its transition to leaders of following phases. (See P.0 Guideline Management.)

Proxy *(guideline)*
A description of a guideline (or guideline system) that is a surrogate, not well linked to the desired outcome. Any requirement that is not a direct measure of impacts on desired outcomes (the environment, the economy, the community or people.) Any score-keeping, award or credit system is inherently a proxy. Prescriptive guidelines are often proxies. The concept of a proxy is relative to how the desired outcomes are defined. For example, money is not a proxy in the economy but it is a proxy in terms of human performance and for environmental impacts. Point based guideline systems are all proxies for impacts on the environment, the economy, the community or people.

Rainwater Harvesting
Rainwater is non-human generated precipitation (rain, snow, ice, etc.) collected and concentrated to meet water needs. This type of water is normally used to supplement common residential water requirements. Rainwater is most commonly used for above ground exterior irrigation systems and for watering gardens. Other uses include toilet flushing, car washing, swimming pool make-up water, and in the southern United States evaporative coolers. Rainwater is considered a subset of Graywater (see separate listing.)

Raw Material
Primary or secondary material that is used to produce a product.

Recharge, On-site Water Recharge Areas
Those areas on a site where the soils are porous and allow water infiltration deep enough to recharge the water table and deep and shallow aquifers.

Remanufactured
Products or systems reassembled, after dismantling, cleaning, and repair, to prescribed standards and specifications using state-of-the-art equipment and components. During this process, new components may be installed which meet or exceed performance standards of the original product.

Renewable Bio-Based Materials
Materials must be either: (a) residues from the processing of renewable, bio-based materials; OR (b) grown or harvested under a recognized sustainable management system.

Salvaged
Salvage is the act of removing something for reuse. Salvaged materials or products may be installed at the same site, in new construction on the same site, or installed at a different location.

Site Hydrologic Cycle
The cyclical process of how precipitation normally acts upon a site. Water falls to the ground as rainfall precipitation. Managing water in a sustainable manner at the site, sub-watershed, and watershed level is based on an understanding of this process. Some of the rainfall runs off the site into surface water bodies (approximately 10%), some evaporates into the atmosphere (approximately 40%), some infiltrates into the soil recharging the water table and deep and shallow aquifers (approximately 50%). The water that is not infiltrated into the water table is taken up by plants for growth. The remaining water is in turn evapotranspired back into the atmosphere through the plants' leaves. Once the water is transpired into the atmosphere, the cycle is complete, and the process starts over again.

Storm Drain System
Facilities by which storm water is collected and/or conveyed, including but not limited to any roads with drainage systems, municipal streets, gutters, curbs, inlets, piped storm drains, pumping facilities, retention, and detention basins, natural and human-made or altered drainage channels, reservoirs and other drainage structures.

Storm Water
Any surface flow, runoff and discharge consisting entirely of water from precipitation events.

Storm Water Pollution Prevention Plan
A document which describes BMPs and activities to be implemented by a person, department or operational area to identify sources of pollution or contamination at a site and the actions to eliminate or reduce pollutant discharges to Storm Water, Storm Water Conveyance Systems and/or Receiving Waters to the Maximum Extent Practicable.

Strategy
An individual or set of resources, including technologies, procedures or operations, that is part of a plan of action for meeting the performance criteria of a guideline. Strategies are implemented (– they are things you can DO to achieve what you WANT.)

Variance Review Process
The Variance Review Process defines the steps for reviewing a request to not adhere to a portion of the guideline as written. This is intended to be used very sparingly, for issues such as non-applicability to a building type or scale. It is led by the Appropriated Agency and consists of the following key steps: The Work Team (or Guideline Leader if applicable) submits a variance request using the online B3 Guidelines Tracking Tool (www.msbgtracking.com) to the Appropriated Agency before the completion of the schematic design phase. The request shall document the reasons for each variance request. After review, the Appropriated Agency either accepts or rejects the request for variance, or may specify a compromise equivalency or conditions for the variance. (See P.0 Guideline Management and Appendix P-0b.)

Wastewater
Any water or other liquid, other than uncontaminated storm water, discharged from a facility.

Waters of the United States
Surface watercourses and water bodies as defined in 40 CFR Section 122.2 (Reference: Code of Federal Regulations, Title 40: Protection of Environment, Part 122- NPDES) including all natural waterways and definite channels and depressions in the earth that may carry water, even though such waterways may only carry water during rains and storms and may not carry storm water at, and during, all times and seasons.

Watershed
The entire land area drained by a waterway that empties into a water body. Spatial area is determined by the topographic high points (human made and natural) without regard to human-created jurisdictional boundaries on the land at which point surface water flows in two different directions.

Work Team
The Work Team is responsible for the facility performance progress in a particular phase. Depending on the phase, this may be the planning team, predesign team, design team, construction team, or operations team. This team works towards the guideline performance criteria appropriate to their phase, and completes Compliance Summary and Outcome Documentation using the B3 Guidelines Tracking Tool at www.msbgtracking.com at the end of each phase (or annually during Ongoing Occupancy.) (See Appendix P.0 Guideline Management and Appendix P-0b.)