ENERGY MANAGEMENT STANDARDS MANUAL

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Cleveland Clinic
Energy Management Standards Manual

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ENERGY MANAGEMENT GUIDELINE

PURPOSE

1. The Cleveland Clinic is an Energy Star Partner who is committed to providing world-class patient outcomes and patient experience. As such, it is important that energy programs are not independent of but stem from service to our patients. As traditional energy conservation business cases have the potential to provide fiscal paybacks at the cost of the patient, the Cleveland Clinic will only evaluate proposals that initially prove that impacts to patient outcomes, patient safety and patient experience are neutral or positive.
2. The purpose of this energy standard is to establish acceptable protocols for evaluating and implementing design practices and acceptable alternatives, as well as operational imperatives. The goal of this standard is to further create a culture of engagement by impacting the environment of care throughout its entire lifecycle.
3. This guideline addresses energy design standards, energy conservation measures, education, measurement and verification protocols, commissioning and retro-commissioning activities.
4. Items in bold and underlined are default values that may be revised by the Clinic on a project by project basis.

REFERENCES

1. Where referenced below and unless noted otherwise, the latest versions of the following standards shall be followed:
   a. ASHRAE 90.1. American Society of Heating Refrigeration and Air Conditioning Engineers Energy Efficiency Standard 90.1 for Non-Residential Buildings.
   b. LEED. Leadership in Environmental and Energy Efficient Design, Healthcare, Existing Building, New Construction and Core and Shell.
   c. International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction.
   d. ASHRAE Guideline 0-2005: The Commissioning Process
   e. USGBC Treatment of District or Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction
   f. IESNA RP 29-6: Lighting Design for Healthcare
   g. DOE Design Guides for Small Hospitals, Large Hospitals and Office Buildings.

GENERAL

1. Energy Conservation Goals
   a. New building construction projects.
      i. Shall exceed ASHRAE 90.1 by **10%**.
      ii. Shall achieve minimum LEED **Silver** Certification.
      iii. Shall achieve **10** points under the Energy & Atmosphere Category of LEED.
   b. Major building renovation projects (as defined by LEED).
      i. Shall exceed ASHRAE 90.1 by **5%**.
      ii. Shall achieve minimum LEED **Silver** Certification.
      iii. Shall achieve **10** points under the Energy & Atmosphere Category of LEED.
   c. All building envelope components shall meet, at a minimum, the minimum requirements prescribed in ASHRAE 90.1. Building insulation levels and envelope tightness are key

factors to providing a safe and comfortable environment for our patients. Integrity of the building envelope shall be verified during commissioning by thermal imaging of exterior building walls and roof. The thermal imaging and associated analysis shall be provided as part of the commissioning report.

d. The lighting power density shall not exceed the minimum levels prescribed in ASHRAE 90.1 and lumen levels shall meet IESNA RP 29-6.

e. Renewable Energy should be considered for all projects, this includes thin-film solar photovoltaic (PV), solar thermal and wind. A life-cycle cost analysis shall be performed for all new footprint projects that includes first cost, potential grants/utility incentives, energy costs and maintenance/operational costs from both an ownership and power purchase agreement for third party ownership perspective.

f. A target for the A/E is to have a **minimum of 2%** of the building's energy consumption come from renewable energy if the life-cycle cost analysis indicates the option as feasible, with a simple payback of less than **10 years.**

2. Energy Modeling & Analysis.

a. The following requirements are required of all projects including projects not pursuing LEED.

i. Energy modeling shall be performed utilizing a simulation program such as Trane Trace or DOE.

ii. An energy analysis shall be submitted at the end of schematic design and design development and shall include the following:

- Narrative describing ASHRAE Cost Budget Building assumptions including schedules for thermostats, people, lighting, miscellaneous/plug loads and HVAC equipment.
- Narrative describing energy conservation opportunities evaluated along with first cost impact and life cycle cost analysis.
- Modeling archive file used to model energy consumption.

iii. Life cycle cost analysis shall be based on a comparison of total present value for multiple alternatives and incorporate the following:

- 30 year LCCA period.
- Annual energy cost: Rates consistent with the requirements of LEED shall be utilized.
- Annual maintenance cost.
- Replacement cost for equipment with an expected service life that is less than LCCA period.
- Cost of Capital. **5%** per year shall be the default.
- Escalation.
  - Utility Cost. **5%** per year shall be the default.
  - Maintenance Cost. **3%** per year shall be the default
  - Other Costs. **3%** per year shall be the default.

iv. The A/E should submit to the Cleveland Clinic an Energy Model Narrative (Refer to Appendix A for Template) that outlines assumptions and energy usage between the baseline and proposed building model.

v. The model shall be certified by a Professional Engineer registered in the state of Ohio for the purposes of submission to the Public Utilities Commission of Ohio pursuant to the enacted energy efficiency portfolio standards. For Cleveland Clinic projects outside of the state of Ohio, local state requirements will take precedence over Ohio requirements unless none exist.

b. For buildings utilizing central plant for cooling/heating plant, the energy model shall be performed in accordance with the *USGBC Treatment of District of Campus Thermal Energy*

in LEED V2 and LEED 2009 – Design & Construction document. There are two means of compliance

i. Streamlined Approach – building stand-alone scenario
   - ♦ The energy source is modeled as purchased energy in both the Proposed and Baseline buildings for all air handlers, fan-coil units, and other downstream equipment serviced by district or campus energy systems in order to hold the district energy system (DES) cost-neutral in the model.
     - Refer to *USGBC Treatment of District of Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction, Table 2* for calculation methods.
   - ♦ When necessary, building Baseline HVAC system types from Table G.3.1.A & B (*ASHRAE 90.1*) are modified to be consistent with the purchased energy source as outlined in Table 3 (*USGBC Treatment of District of Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction).*

ii. Full-accounting Approach – the aggregate building/DES scenario
   - ♦ Baseline: Model as required by Appendix G (*ASHRAE 90.1*)
   - ♦ Proposed: The DES should be modeled as a "virtual on-site plant" where the secondary pumping energy, leaks, and thermal losses between the DES central plant and the connected building in both directions must be accounted for in the Proposed Case model for all cases where they apply. Projects shall use actual DES operational data if the DES is pre-existing, or for new DES's design estimates based on expected operation may be substituted.
     - Refer to Appendix C of the *USGBC Treatment of District of Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction* for further guidance on calculating virtual plant efficiencies.

c. Reference:
   i. Appendix A: Energy Model Narrative – Template

3. Measurement and Verification (M&V)
   a. The following requirements are required of all projects, including projects not pursuing LEED.
      i. Develop an M&V Plan, as outlined in Credit Energy and Atmosphere (EA) Credit 5 under LEED Version 3.0. The compliance paths are:
         - ♦ Option D: Calibrated Simulation (Savings Estimation Method 2) as specified in the *International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003*.
         - ♦ Option B: Energy Conservation Measure Isolation (utility metering and submetering) as specified in the *International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003*.
      ii. Achieve Designed to Earn Energy Star
      iii. The Clinic intends to comply with the requirements of the upcoming ISO 50001 Standard for Energy Management
      iv. Review energy model inputs and results during design and provide comments.
      v. Compare energy simulation model used for EA-c1 to actual energy consumption. Calibrate energy model by adjusting to reflect actual operating parameters.
      vi. Subtract energy conservation measures form baseline energy consumption.
      vii. Subtract baseline energy consumption from the actual energy use.
      viii. Develop a corrective action plan.

b. Metering and submetering: meters for all utilities shall be included in any new construction or renovation and shall monitor the energy usage of the entire facility and submeter, at a minimum, by the following categories:
   i. Floor;
   ii. Equipment Usage (lighting, receptacle and power panels
   iii. Programmatic building usage (i.e. office, triage, outpatient, etc.).
   iv. All scheduled HVAC, energy consuming, equipment.

c. Goals/Requirements
   i. Provide a process for corrective action if the results of the M&V Plan indicate that energy savings are not being achieved.
   ii. Include an M&V period, at a minimum, of 1-year post construction occupancy.
   iii. Appropriately implement energy efficiency measures, calculate real savings, establish an accepted energy performance for the building, and monitor ongoing building energy performance.
   iv. After this acceptable level of performance is set for the building, the actual energy performance for each following year can be compared to the accepted energy performance.
   v. Operational problems can be found and reconciled so that the building's energy consumption stays within a reasonable range.
   vi. The metering equipment used for the measurement and verification period will remain in the building and serve as a helpful diagnostic tool for the building operator.
   vii. For buildings supplied with heating/cooling from a central plant, the M&V scope must cover the central plant in cases outlined in Section 2.7 of the *USGBC Treatment of District of Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction*

d. Reference:
   i. Appendix B: Measurement and Verification Plan – Template
   ii. Appendix E: Measurement and Verification – Sample Specifications

4. Commissioning
   a. The following requirements are required of all projects, including projects not pursuing LEED.
      i. Develop a Commissioning Plan, as outlined in LEED Version 3.0 Energy and Atmosphere Credits **EA-pr1: Fundamental Building System Commissioning** and **EA-c3: Enhanced Commissioning**
         - Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs.
         - Commissioning during the construction of this project is intended to achieve the following specific objectives:
            - Quality
            - Value
            - Comfort
            - Energy Efficiency
            - Serviceability
            - Sustainability

   b. Energy and Atmosphere Prerequisite **EA-pr1 Fundamental Building Systems Commissioning** services include:
      i. Obtain Owner's Project Requirements (OPR) and Basis of Design (BOD) from owner and design engineer of record. Review for compliance with LEED and provide comments will define:

ii. Develop the commissioning specifications for incorporation in the design documents. Specifications shall define:
- Contractor's commissioning responsibilities, systems to be commissioned, pre-functional checklists and functional test.
- Training requirements, including documentation to be provided.
- Contractor's responsibility to pay the commissioning authority to witness functional tests beyond one failed functional test.
- Contractor's responsibility to provide written response to the Commissioning Authority's proposed corrective action plans (CAP) within 15 working days.

iii. Prepare separate design phase and construction phase commissioning plans including the following elements:
- A brief overview of the commissioning process.
- A list of commissioned features and systems.
- Identification of primary commissioning participants and their responsibilities.
- A description of the management, communication, and reporting of the commissioning plan.
- An outline of the commissioning process scope including submittal review, observation, start-up testing, training and warranty period activities.
- A list of expected work products.
- An activity schedule.
- A description of the rigor and scope of testing.

iv. Review start-up and check-out forms provided by contractor.

v. Conduct construction phase commissioning kick-off meeting to introduce the commissioning process and to discuss standards, strategies, and target requirements of the commissioned systems.

vi. Observe installation of each commissioned system by conducting site visits.

vii. Witness functional testing of commissioned systems. Develop a corrective action plan (CAP) for each failed functional test.

viii. Develop a Commissioning Report to include: a list of each commissioned feature or system; disposition on commissioning compliance for each system; outstanding commissioning issues; future testing requirements, a list of compromises; and completed functional testing.

ix. Witness opposite season functional testing. Develop a corrective action plan for each failed functional test.

x. Update Commissioning Report.

xi. Complete LEED online template (if applicable).

c. Energy and Atmosphere Credit **EA-c3: Enhanced Commissioning** services include:

i. At a minimum, perform a commissioning design review of the 50% design documents and back-check the review comments in the final construction document review submission.

ii. Review contractor shop drawings for commissioned systems.

iii. Develop a systems manual for the commissioned systems to include: a final version of the BOD, systems single line diagrams, as-built controls diagrams and set points, schedule and procedures for retesting of commissioned systems, and schedule for calibrating sensors.

iv. Facilitate and verify the training of maintenance staff meets the requirements in the contract documents.

v. Review building operation with O&M staff with a focus on resolution of outstanding warranty and commissioning related issues within 10 months of certificate of occupancy.

vi. Complete LEED online template (if applicable).

d. Goals/Requirements
   i. For buildings supplied with heating/cooling from a central plant, the commissioning process scope must include the central plant in cases outlined in Section 2.3.2 of the *USGBC Treatment of District of Campus Thermal Energy in LEED V2 and LEED 2009 – Design & Construction*

e. Reference:
   i. Appendix D: Commissioning Plan – Template
   ii. Appendix E: Commissioning – Sample Specifications
   iii. Appendix G: Commissioning/Retro-commissioning – Pre-functional checklists and Functional Testing Procedures.

5. Retro-Commissioning
    a. Benefits of retro-commissioning include identification of system operating, control, and maintenance issues; reduction of maintenance cost and premature equipment failure; reduction of energy cost and waste; documentation of building systems; training of operating staff; and data for long-term planning and maintenance budgeting.. Additionally, retro-commissioning can be used as a continuous advanced training tool to educate maintenance staff on various control strategies and the logic behind them, as well as educating them in identifying energy conservation opportunities.
    b. The following program elements shall be developed for buildings undergoing retro-commissioning:
        i. Develop a Retro-Commissioning Plan to include the following:
            - ♦ List of retro-commissioned system(s) and schedule
            - ♦ Pre-functional checklists and functional testing procedures
            - ♦ Detailed issue log of the on-going commissioning process
            - ♦ Corrective Action Plan (CAP) as a resolution for the issues encountered during the retro-commissioning process.
        ii. Retro-commissioning should be performed on a yearly basis.
    c. Reference:
        i. Appendix F: Retro-commissioning Plan – Template
        ii. Appendix G: Commissioning/Retro-commissioning – Pre-functional checklists and Functional Testing Procedures.

ENERGY CONSERVATION STRATEGIES

1. Develop an ongoing commissioning program that consists of the following:
    a. Retro-commissioning / Level II ASHRAE Energy Audit.
    b. Process improvement measures that streamline patient care.
    c. Re-commissioning management manual.
2. Incorporation of utility metering, BAS and integrating these two systems to help indentify energy conservation opportunities, potential maintenance issues and to verify the effectiveness of measures implemented to reduce energy and/or address maintenance issues.
    a. BAS / metering integration platform.
    b. Standardized BAS control sequences, points list, specifications (Samples have been included).
    c. Standardized functional test procedures and pre-functional checklists.
    d. Standardized commissioning scope of work.
    e. Measurement and verification plan.
    f. Integrated facilities management performance metrics.
3. Heat recovery (air side) should be implemented on all major HVAC systems. Typically, a run-around coil should be utilized in units where the zone has a higher exhaust rate (e.g. isolation rooms); while enthalpy wheels could be implemented in the other areas (e.g. patient rooms)
4. Heat recovery (water side) should be evaluated as part of central plant upgrades, these include co-generation, boiler stack economizers, heat recovery chillers, condenser water heat recovery, etc.
5. LED Lighting shall be considered for downlighting, architectural lighting, parking lot lighting and parking garage lighting on all projects. The Cleveland Clinic has a list of approved lamps and luminaries and a review process for additional models seeking approval. The design shall only utilize LED Lighting that is pre approved by the Cleveland Clinic. A life-cycle cost analysis shall be performed when analyzing this option and include: first cost, energy costs and maintenance/operational costs.
6. Shading should be implemented and optimized during the energy modeling process to reduce solar load through glazing. There are optimization calculations available based on the project site latitude and longitude.
7. The building envelope should be optimized with respect to roof, window and wall U-values and window solar heat gain coefficient.
8. External static pressure of all HVAC equipment to increase supply, return and exhaust duct work and minimize fan motor horsepower.
9. Occupancy sensor controls should be implemented to control lighting and setback HVAC system in appropriate areas (e.g. exam rooms, offices, etc.).

APPENDIX A:
ENERGY MODEL NARRATIVE – TEMPLATE

APPENDIX B:
MEASUREMENT AND VERIFICATION PLAN – TEMPLATE

APPENDIX C:
MEASUREMENT AND VERIFICATION – SAMPLE SPECIFICATIONS

APPENDIX D:
COMMISSIONING PLAN – TEMPLATE

APPENDIX E:
COMMISSIONING – SAMPLE SPECIFICATIONS

APPENDIX F:
RETRO-COMMISSIONING PLAN – TEMPLATE

APPENDIX G:
COMMISSIONING/RETRO-COMMISSIONING – PRE-FUNCTIONAL CHECKLIST AND FUNCTIONAL TESTING PROCEDURES

Including:

FT-1: Heating Plant
FT-2: Cooling Plant
FT-3: Steam to Hot Water Heating Plant
FT-4: Variable Volume Air Handling Unit
FT-5: Constant Volume Air Handling Unit
FT-6: Terminal Unit
FT-7: Hot Water Cabinet & Unit Heater
FT-8: Hot Water Radiant Ceiling Panel & Fin Tube
FT-9: Exhaust Fans w/Time of Day Control
FT-10: Exhaust Fans w/Thermostat Control
FT-11: Exhaust Fans – General Control
FT-12: Lab Ventilation
FT-13: Computer Room Air Conditioning Units
FT-14: Kitchen Ventilation

APPENDIX H:
CONTROL SCHEMATIC – SAMPLE DRAWINGS

Including:

M-700: Control Legend

M-701: Cooling Plant

M-702: Heating Plant Heat Exchanger

M-703: Variable Volume Air Handler

M-704: Dual Duct Air Handler

M-705: Multi-zone Air Handler

M-706: Make-up Air Handler

M-707: Variable Volume Terminal Unit

M-708: Fan Powered Variable Volume Terminal Unit

M-709: Exhaust Fan, Fan Coil Unit, Computer Room Unit, Cabinet Unit Heater