

## SECTION 01 13 01 – DESIGN GUIDELINES FOR ENERGY & ENVIRONMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Brown University invests considerable resources each year in upgrading and updating existing facilities. This document is intended to assist those involved with the process to verify that newly renovated or constructed facilities include consideration of long-term energy costs, and outlines Brown's energy use and design guidelines as they relate to building design.
- B. Generally speaking, this document addresses required efficiency and performance criteria for equipment, systems, and processes as they relate to energy consumption. In order to achieve Brown University's High Performance Design (HPD) goals, rated efficiency and performance data shall be a minimum of 25%, and up to 50%, better than the minimum efficiency and performance criteria established in the Rhode Island adopted International Energy Conservation Code (IECC 2012) or latest edition current at time of permit application. In addition to this requirement, this document provides guidelines for best practices based upon Standards, utility company incentives, and a least-operating-cost focus.
- C. These guidelines should be further supported with on-going investigation, pilot studies and projects, and feedback from A/E Firms and project participants. As such, it is the intent that this document be updated on a regular basis.

#### 1.2 RELATED SECTIONS:

- A. Section 01 13 51– Utility Rebate Programs
- B. Section 01 17 71 – Project Turnover Requirements
- C. Section 01 17 73 – Operations & Maintenance Manuals
- D. Section 23 00 10 – HVAC Design Criteria
- E. Applicable Division 26 (Electrical) Standards

#### 1.3 REFERENCED PUBLICATIONS:

- A. The documents or applicable portions thereof listed in this section, as well as their referenced documents, shall be considered part of the requirements of this Standard. Utilize latest adopted editions.
  - 1. Rhode Island State Energy Conservation Code SBC-8
  - 2. Rhode Island adopted International Energy Conservation Code
  - 3. ASHRAE 90.1 – Energy Standard for Buildings Except Low Rise Residential Buildings
  - 4. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality

5. ASHRAE Applications – Chapter 37, Service Life Estimates
6. ASHRAE Project 1237TRP – Equipment Life/Maintenance Cost Survey

#### 1.4 BACKGROUND & OBJECTIVES:

- A. Brown University is facing ever-increasing costs and environmental impacts due to campus expansion, aging infrastructure and increasing energy rates. This design guideline provides an overview of steps to be taken or actions to consider to achieve the following in new building construction or existing building renovations:
1. Reduced life-cycle cost
  2. Reduced environmental impact
  3. Improved employee environment
  4. Improved profitability and operations for all stakeholders.
- B. Energy and Environmental Mission: In order to develop sustainable and equitable patterns of local and global resource use, Brown University will minimize its energy use, reduce negative environmental impacts and promote environmental stewardship. Brown University will use the opportunities created by these actions.

#### 1.5 REQUIRED DESIGN DELIVERABLES:

- A. For all non-LEED projects which include a design phase, the project manager shall provide the project design team with Brown University's "High Performance Design Report," located with the University's design standards, which the project design team shall fill out, complete, and submit for review. The report shall be used for all energy-consuming components, systems, and equipment contemplated for inclusion in the project. The report shall be used to compare, evaluate and select equipment, components, and systems on the basis of their rated efficiency and performance, their lifecycle cost, and other financial criteria. In addition, the report shall be used to demonstrate compliance with the High Performance Design requirements in Paragraph 1.08 below. The project design team shall provide the following information, for each class of equipment or systems, in the report:
1. Identify base reference equipment which meets the minimum IECC efficiency performance for that equipment class
  2. Identify alternate "best-in-class" equipment which provides increased levels of performance (up to 50% better than code), usually at higher initial costs
  3. For such equipment, provide the initial costs, replacement costs (if any), O&M costs, rebates, and annual energy consumption. The "High Performance Design Report" can then calculate the resultant financial performance of the equipment alternates to include IRR (integrated rate of return), lifecycle cost, and payback.
  4. Provide a summary list of project incentives and rebates for all equipment, components, and systems in accordance with Paragraph 1.20 below.

- B. For LEED projects, the project design team shall demonstrate reductions in total energy use when compared to standard reference designs stipulated in Section C407 (“Total Building Performance”) of IECC 2012. Energy modeling which compares proposed designs to standard reference designs (or “baseline building performance”) shall meet the criteria established in Section C407. The project design team may use their proprietary reporting tools to demonstrate such compliance. Alternatively, the project design team may use the “High Performance Design Report” described above. In either case, the project design team shall provide the following information:
1. Identify equipment to be incorporated into a base reference design whose energy model demonstrates compliance with the whole-building standard reference design stipulated in the Code.
  2. Identify alternate equipment which, when incorporated into the design, provides an increased level of performance (minimum 25% better than, and up to 50% better than, the standard reference design in the Code)
  3. For such equipment, provide the initial costs, replacement costs (if any), O&M costs, rebates, and annual energy consumption. The project design team shall then use their proprietary reporting tools, or the “High Performance Design Report” to provide the resultant financial performance of the equipment alternates to include IRR (integrated rate of return), lifecycle cost, and payback.
  4. Provide a summary list of project incentives and rebates for all equipment, components, and systems in accordance with Paragraph 1.20 below.
- C. The project manager shall coordinate resolution between base reference designs and optional alternatives, and shall provide the project design team with final equipment or system selections which shall be incorporated into the final design documents. Provide revised reports for all components, systems, and equipment for which substitutions are made during construction. The project design team (in lieu of the Contractor) shall be responsible for such revisions.

#### 1.6 DESIGN ANALYSIS BASIS:

- A. **MINIMUM EFFICIENCY REQUIREMENTS FOR EQUIPMENT:** At the time of project permit application, all new or replacement equipment for new construction and renovations shall have rated efficiencies which are a minimum of 25% better than the associated minimum efficiency stipulated in IECC 2012, up to a maximum of 50%.
- B. **LIFECYCLE COST:** Assuming that equipment meets the minimum efficiency requirements above, then final selection of equipment and systems shall be generally based upon a least lifecycle cost analysis, which considers both the total life cycle cost of various options and a minimum threshold IRR that must be met. Lifecycle cost analyses shall be conducted in accordance with Paragraph 1.07 below.

- C. NEW CONSTRUCTION AND MAJOR RENOVATION PROJECTS: New construction and most major renovations shall demonstrate reductions in total energy use when compared to standard reference designs stipulated in Section C407 (“Total Building Performance”) of IECC 2012. Such projects (known as Category 1 projects at Brown) typically require LEED Silver ratings (minimum). LEED projects typically require energy modeling to compare baseline energy use with optional alternatives. Energy modeling which compares proposed designs to standard reference designs (or “baseline building performance”) shall meet the criteria established in Section C407.
  - D. EXEMPTIONS: Exemptions from the design analysis basis and guidelines established herein must be obtained by the Brown Project Manager through the Brown Energy and Environmental Director. Documentation must be provided to substantiate such exemptions. For example, achieving higher efficiency standards (above 25%) may sometimes not represent the least lifecycle cost. As another example, equipment which does not meet efficiency standards may be considered on the basis of reductions in carbon emissions, or on the basis of an increase in total building performance substantiated through energy modeling. Such exemption requests shall be brought to the attention of the Project Manager, who shall forward same to the Brown Energy and Environmental Director.
- 1.7 LIFECYCLE COST ANALYSES:
- A. Required for all projects where energy is consumed.
  - B. Lifecycle costs can be computed automatically in the “High Performance Design Report” using the factors listed directly below.
  - C. Lifecycle cost analyses shall be based on the following criteria:
    - 1. 8.5 percent or greater internal rate of return (this discount rate takes into consideration future price escalation and relatively low risk of energy efficiency in the design process).
    - 2. Project life, up to a maximum of 30 years. Equipment lives and maintenance costs shall be based upon ASHRAE Applications 2011 (Chapter 37) or ASHRAE Project 1237TRP – Equipment Life/Maintenance Cost Survey.
    - 3. In general, the following factors are required to establish life cycle cost (all factors included in the analysis should be documented for future reference):
      - a. Initial equipment cost
      - b. Rebates and incentives
      - c. Energy prices and their escalation rates
      - d. Annual energy use
      - e. Operation and maintenance costs (including water and chemicals)
      - f. Replacement costs during the individual lives of the equipment, which may or may not equal the project life.

D. For lifecycle cost analyses, the following Base Utility Rates are applicable (Escalation rates are different for different energy sources, and are provided in the “High Performance Design Report” which can be found with Brown University’s design standards.

1. Steam/HTHW (CHP): \$15 Per MMBTU
2. Chilled Water (From District plant): \$0.08 Per CPTH
3. Electricity with demand:\$0.13 Per KWH
4. Electricity without demand: \$0.11 Per KWH
5. Natural Gas: \$10 per MMBTU (Mid-Large Buildings)
6. Natural Gas: \$11 per MMBTU (Small Buildings)
7. Water and Sewer combined: \$11.90 per CCF
8. Water Only: \$4.40 per CCF
9. #2 Fuel Oil (non CHP): \$16 per MMBTU
10. #6 Fuel Oil (non CHP): \$19 per MMBTU

E. The following chart provides rates of return, based on simple payback and expected equipment life:

| Rates of Return Based on Simple Payback and Expected Equipment Life |       |                        |     |     |     |     |     |      |      |      |
|---|-------|------------------------|-----|-----|-----|-----|-----|------|------|------|
|   |       | Simple Payback (Years) |     |     |     |     |     |      |      |      |
|   |       | 1                      | 2   | 3   | 4   | 5   | 6   | 7    | 8    | 9    |
| ASHRAE Expected Equipment Life                                      | 5-yr  | 97%                    | 41% | 20% | 8%  | 0%  | -6% | -10% | -14% | -17% |
|   | 10-yr | 100%                   | 49% | 31% | 21% | 15% | 11% | 7%   | 4%   | 2%   |
|   | 15-yr | 100%                   | 50% | 33% | 24% | 18% | 14% | 11%  | 9.1% | 7%   |
|   | 20-yr | 100%                   | 50% | 33% | 25% | 19% | 16% | 13%  | 11%  | 9.2% |

Green highlighted cells identify range of years of simple payback associated with 8.5 percent or better rate of return. Yellow highlighted cells indicate return of less than 8.5 percent. Green indicates required implementation for New Construction and availability of additional funding for renovations or replacement of energy consuming equipment.

- 1) Example One:
  - Expected Equipment Life = 15 years
  - Estimated Simple Payback = 5 years

- The table above indicates the rate of return is 18 percent. 18 percent is greater than the threshold of 8.5 percent so efficiency improvements should be adopted.

2) Example Two:

- Expected Equipment Life = 10 years
- Estimated Simple Payback = 8 years
- The table above indicates the rate of return is 4 percent. 4 percent is less than the threshold of 8.5 percent. Non-monetary benefits or other positive aspects of feature should be reviewed and an exemption can be sought, if applicable.

F. Simple Payback Based on Rates of Return and Expected Equipment Life: The following chart denotes the system payback in years, based on annual rates of return and expected equipment life:

| Simple Payback (Years) Based on Rates of Return and Expected Equipment Life  |       |                |      |      |     |      |     |     |     |     |
|--|-------|----------------|------|------|-----|------|-----|-----|-----|-----|
|  |       | Rate of Return |      |      |     |      |     |     |     |     |
|  |       | 5%             | 6%   | 7%   | 8%  | 8.5% | 10% | 12% | 24% | 32% |
| ASHRAE Expected Equipment Life   | 5-yr  | 4.3            | 4.2  | 4.1  | 4.0 | 3.9  | 3.8 | 3.6 | 2.7 | 2.3 |
|  | 10-yr | 7.7            | 7.4  | 7.0  | 6.7 | 6.6  | 6.1 | 5.7 | 3.7 | 2.9 |
|  | 15-yr | 10.4           | 9.7  | 9.1  | 8.6 | 8.3  | 7.6 | 6.8 | 4.0 | 3.1 |
|  | 20-yr | 12.5           | 11.5 | 10.6 | 9.8 | 9.5  | 8.5 | 7.5 | 4.1 | 3.1 |
| Note: Highlighted cells show maximum simple payback equivalent to 8.5% minimum rate of return (aka internal rate of return, discount rate, hurdle rate, etc) |       |                |      |      |     |      |     |     |     |     |

1.8 HIGH PERFORMANCE DESIGN REQUIREMENTS

A. Provide designs and performance criteria which exceed the applicable minimum requirements stipulated in IECC 2012 by a minimum of 25%, and up to 50%, for the following components, systems, or equipment:

| COMPONENT<br>SYSTEM OR<br>EQUIPMENT        | CRITERIA              | -----IECC 2012----- |                     |
|--|-----------------------|---------------------|---------------------|
|  |                       | RELATED<br>SECTION  | ASSOCIATED<br>TABLE |
| Thermal Resistance<br>Of Building Envelope | R-Value               | C402                | C402.2              |
| Building Fenestration                      | U-Value               | C402                | C402.3              |
| Unitary A/C and<br>Condensing Units        | EER or COP            | C403                | C403.2.3 (1)        |
| Unitary Heat Pumps                         | EER or COP            | C403                | C403.2.3 (2)        |
| Packaged Terminal A/C<br>and Heat Pumps    | EER or COP            | C403                | C403.2.3 (3)        |
| Furnaces and<br>Unit Heaters               | Efficiency            | C403                | C403.2.3 (4)        |
| Boilers                                    | Efficiency            | C403                | C403.2.3 (5)        |
| Condensing Units                           | EER or COP            | C403                | C403.2.3 (6)        |
| Chillers                                   | EER or kw/ton         | C403                | C403.2.3 (7)        |
| Cooling Towers                             | gpm or Btuh<br>per HP | C403                | C403.2.3 (8)        |
| Water Heating<br>Equipment                 | Efficiency            | C404                | C404.2              |
| Lighting                                   | watts/ft <sup>2</sup> | C405                | C405.5.2 (1) or(2)  |

1.9 UNIVERSAL PROJECT REQUIREMENTS:

A. The following universal project requirements are to be incorporated into all building projects in accordance with Section 01 17 71 “Contract Record Documents and Turnover Requirements”:

1. Operating and Maintenance (O&M) Manuals (Section 01\_17\_73): O&M manuals are required for every project, unless specifically declined by the Brown Project Manager. Manuals shall include:
  - a. Final approved submittal data
  - b. As-built documentation and record drawings

- c. HVAC Manuals, including the following:
    - i. General
    - ii. Installation
    - iii. Servicing
    - iv. Parts
    - v. Warranty information
  - d. Control Information, including as appropriate:
    - i. Drawings, including schematics
    - ii. Sequences of Operations
    - iii. Exact locations of concealed sensors
    - iv. Design setpoints
    - v. Valve schedules
    - vi. Wiring Diagrams
2. Air Balance Report (if applicable):
- a. An air balance report is required for all HVAC systems to include design values, actual values, and deviations.
  - b. Utilize and adjust VFDs to provide load response flexibility and to simplify balancing requirements.
  - c. Balancing is not considered complete until temperature and humidity requirements are met consistently.
  - d. The project engineer shall determine level of air balance required (i.e. permitted deviations from design) in conjunction with Brown FM (Facilities Management) personnel.
  - e. Air flows shall meet applicable occupancy or equipment requirements.
3. Hydronic Balance Report (if applicable):
- a. A hydronic balance report is required for all waterside HVAC systems to include design values, actual values, and deviations.
  - b. Utilize and adjust VFDs to provide load response flexibility and to simplify balancing requirements.
  - c. Balancing is not considered complete until flow and pressure requirements are met consistently.
  - d. The project engineer shall determine location of gauges and sensors to facilitate system testing and monitoring in conjunction with Brown FM personnel. At a minimum, provide pressure gauges of suitable range before and after pumps and coils.
4. Commissioning:
- a. Full project commissioning is required for all new construction, major renovations, and retrofit projects involving energy consuming equipment. Input and output control points, and programming logic, shall be verified as part of project commissioning. Calibration of field devices shall be verified as part of project commissioning.
  - b. Commissioning should be performed by an independent third-party but the Project Manager can elect to pursue an alternative approach if more appropriate to project scope and requirements. Commissioning agent should generally be involved throughout the planning, design, and construction process to include the following phases:

- i. Commissioning Team Development
- ii. Planning and Predesign
- iii. Design Phase - Submittal/Progress Review
- iv. Construction Phase
- v. Acceptance Phase - Verification of Performance  
(Functional Performance Testing)
- vi. Warranty Phase

1.10 GENERAL DESIGN GUIDELINES:

A. The following general design guidelines and principles are to be incorporated into all building projects:

1. Minimize External Loads – Improve building envelope, provide slightly positive building pressure.
2. Minimize Internal Loads (Major Equipment) – Power Systems, Computer Systems, Switching Equipment, System Support Equipment.
3. Minimize Internal Loads (Supplemental Equipment/Systems) – Lighting, Kitchen, Office Equipment, Plug Loads, Water/Sewer.
4. Optimize Air Conditioning Equipment and Systems – Maximize efficiency of Air Handling Units, Unitary Equipment, Computer Room Equipment and layout, and associated control strategies.
5. Minimize System Losses – Insure that ductwork and piping systems are completely sealed and thoroughly insulated.
6. Maximize Efficiency of Central Plant Equipment – Boilers, Chillers, Pumps, and Controls.
7. Meet ventilation requirements in ASHRAE 62.1 (2010).
8. Optimize Infrastructure Improvement Process – Cogeneration, Thermal Energy Storage, Redundancy Requirements.
9. Ensure Continued Performance Through Requirements for Metering, Training, O&M Manuals, Test/Adjust/Balance (TAB), and Commissioning.

1.11 AIR HANDLING UNIT (AHU) DESIGN GUIDELINES:

A. Building AHU design and system performance shall be enhanced via the following:

1. Installing VFDs which track static pressure requirements in all central AHU systems.

2. Providing VAV boxes to meet present zoning requirements and adaptability for future equipment and space utilization needs.
3. Matching control setpoints with equipment requirements, standards and occupancy requirements including use of dual setpoints (occupied/unoccupied) and/or separate areas for personnel conditioning.
4. Minimizing maintenance requirements and maximizing service accessibility.
5. Sizing AHU coils and air flow ability to allow for higher Supply Air temperatures and still provide acceptable conditions – allowing greater use of air-side or water-side economizer operation.
6. Maximize use of heat recovery systems, especially for 100% outside air systems.
7. Provide for full economizer capability in conjunction with an adequately sized/controlled relief fan (exceptions for systems served by water-side economizer).
8. Provide low leakage dampers.

1.12 MOTORS AND ELECTRICAL SYSTEM DESIGN GUIDELINES:

- A. All motors shall be specified to be premium efficiency. Motors for use with VFDs shall be rated for inverter-duty in accordance with NEMA MG-1 Part 31.
- B. VFDs shall be required for all of the following applications:
  1. Secondary Pumps.
  2. Cooling Tower Fans
  3. Air Handling Unit Fans
  4. Relief Fans associated with AHUs for Economizer Operation
  5. Booster Pumps
  6. Chilled Water and Hot Water Circulating Pumps
  7. Large Exhaust Fans
- C. VFDs should also be considered as options to improve overall system efficiency subject to lifecycle cost analysis for the following:
  1. Chillers.
  2. Primary Pumps.

3. Air Cooled Condenser Fans – Grouped.
4. Computer Room Air Conditioning Units.

D. Additional Motor/Electrical Considerations and Opportunities

1. Utilize electrical filters/line protection as necessary to protect VFDs and other distribution system components.
2. Consider over sizing electrical distribution where practical, to reduce line losses (maximum voltage drop 2% at design load for feeders, 3% for branches)
3. Utilize high efficiency transformers (NEMA TP-S).
4. Utilize power factor correction equipment locally and/or at service entrance to reduce distribution system losses and utility costs.
5. Metering to be provided and connected to campus metering system where applicable.

1.13 CHILLER SYSTEM DESIGN GUIDELINES:

A. General Guidance

1. Select most efficient chiller type for each project by comparing life cycle costs for various options.
2. Consider over-sizing chiller condenser and cooling tower to improve efficiency/reduce peak horsepower requirements.
3. Compare chiller selections based on the estimated load profile for the facility to provide an indication how the design performance compares with expected operating conditions.
4. Provide the load profiles for chillers in the design package.
5. Provide for chilled and condensed water temperature reset based on outside air wet bulb temperature

B. Chiller Plant Design

1. Provide summary tables of code specifications for each piece of equipment and the actual equipment selections.
2. For multiple chiller installations, provide energy modeling and calculations to determine annual operating cost. Provide specific operating sequences to maximize energy savings to the controls

contractor, including:

- a. Cooling tower operating specifications and curve
- b. Condenser and chiller flow rates.
- c. Chiller loading and control sequences.
- d. Economizer operation and control sequences. Select optimal chilled water setpoint possible for system (include consideration of economizer capability). Include waterside economizer for all chiller plant designs unless not lifecycle cost effective (analysis should include consideration of factors such as facilities with minimal air-side economizer potential and year-round cooling requirements).

#### 1.14 CONTROLS GUIDELINES:

##### A. General Guidance

1. System graphics shall be provided for all new construction and major renovation projects.
2. Metering software, where available and applicable to the facility, to be provided.
3. Major facility renovations should include facility energy metering and tracking capability

B. Controls should be designed to facilitate “Continuous Commissioning” and therefore controls shall provide long-term retention and trend capabilities for historical data.

C. Design specifications shall require the following minimum control algorithms to include the following:

1. Demand Control Ventilation with CO<sub>2</sub> sensors, excluding research labs and animal care areas
2. Include scheduling of building ventilation systems for vacation periods in addition to routine occupied and unoccupied time periods
3. Discharge Air Temperature Reset.
4. Cold Deck Temperature Reset with Humidity Override (select the zone with the greatest cooling requirements to establish the minimum cold deck temperature differential which will satisfy requirements).
5. Enthalpy-based economizer operation
6. Night Setback, excluding research labs and animal care facilities.
7. Optimum Start-Stop

8. Chiller Optimization (select the chiller or chillers required to meet the load so as to minimize energy requirements)
9. Chilled Water Temperature Reset- (chilled water supply temperature shall be reset based on outdoor air enthalpy).
10. Condenser Water Temperature Reset
11. Standby control for conference rooms, classrooms, seminar rooms, and lecture halls: utilize standby setpoints and either BAS vendor furnished combined temperature sensor/occupancy sensor or lighting interlock to place rooms to standby mode when building is occupied but room is unoccupied.

#### 1.15 GENERAL TEMPERATURE GUIDELINES

- A. Brown University recommends the following temperature guidelines for conditioned, interior building spaces:

|                 | COOLING | HEATING |
|-----------------|---------|---------|
| Occupied Mode   | 74°F    | 70°F    |
| Unoccupied Mode | 82°F    | 62°F    |
| Standby         | 77°F    | 67°F    |

- B. The zero energy bandwidth between occupied heating and cooling modes shall be 4.0°F except as described in 1.15/C
- C. These guidelines do not apply to research spaces or animal care facilities, which may have other specific requirements which may additionally include humidification.

#### 1.16 LIGHTING SYSTEM DESIGN GUIDELINES:

- A. Fixtures shall be listed as DLC Premium
- B. Maximize use of automatic lighting controls in accordance with Section C405 of IECC 2012 to include:
1. Day-Night-Weekend Scheduling
  2. Occupancy Sensors
  3. Daylighting Sensors
  4. Automatic Time Switches in permitted areas.
- C. Select light-colored ceilings and walls to encourage reflection and distribution of light throughout space.
- D. Optimize ballast and lamp efficiency.

- E. Design interior and exterior lighting levels in accordance with Section C405 of IECC 2012

1.17 BUILDING ENVELOPE DESIGN GUIDELINES:

1. Design building thermal envelope in accordance with Section C402 of IECC 2012.
2. Optimize roofing insulation and/or reflective coating
3. Optimization of glazing as a percentage of building exterior.
4. Glazing and window treatment configuration appropriate to climate and site specific conditions.
5. Provide vestibules on buildings higher than four stories.
6. Optimize use of solar energy.
7. Optimize weather stripping of existing windows and doors to maximize reduction of infiltration rate. Examples include weather stripping, insulation, and caulking of non-operational window joints.

1.18 COMFORT HEATING SYSTEMS:

- A. Each facility should be evaluated to determine the degree to which comfort heating, comfort humidification, and process humidification is required.
  1. Comfort heating should be designed to minimize potential for simultaneous heating/cooling.
  2. Utilize heat recovery whenever possible.
  3. Optimize comfort heating system based on location and expected usage requirements:
    - a. Condensing boilers are preferred where they may be used effectively.
    - b. Heat recovery from the condenser side of water-cooled systems should be evaluated if a building is expected to have concurrent boiler and chiller operation. In accordance with ASHRAE 90.1 (2010), condenser heat recovery is required if the system meets the following requirements: facility is expected to operate 24 hours per day, heat rejection capacity of water cooled system exceeds 500 tons and design service heating loads exceed 1,000,000 Btu/hr.
    - c. In renovation projects, existing-to-remain steam and hot water radiators and convectors which are connected to single-zone heating systems shall be equipped with Thermostatic Radiator Valves (TRV's) to regulate temperature and prevent over- and under-heating. TRV shall be provided with capability to set and lock maximum and minimum temperature limits.
    - d. Hot Water Systems: Provide controls and programming to implement

hot water reset based on outdoor air temperature.

1.19 PLUMBING EQUIPMENT AND SYSTEM DESIGN GUIDELINES:

- A. Where local utilities allow for sewer credits, meter make-up water and blow-down water for cooling towers or irrigation water.
- B. Utilize low flow devices in faucets and shower heads.
- C. Utilize dual-flush toilets and low water use urinals.
- D. Utilize grey water for irrigation and plumbing, where possible.
- F. Evaluate rainwater harvesting and reuse.
- G. Evaluate instantaneous point of use water heaters versus building-wide hot water distribution.
- H. Evaluate the use of automatic sensor-based faucets.
- I. Evaluate the use of other reduced-water consumption and sustainable technologies.
- J. Condensing gas-fired water heaters are preferred.

1.20 PROJECT INCENTIVE ANALYSIS:

- A. Project incentives are an important component to the completion of energy efficiency projects.
- B. Review utility, local, state, and federal sources for potential incentives and report incentives to energy and environmental office.
- C. Incentives can provide funding for:
  - 1. Energy Analysis
  - 2. Design
  - 3. Equipment
  - 4. Construction
  - 5. Commissioning
- D. Additional incentives may be found in analyzing the tax implications of the project.
- E. In addition, by evaluating incentive programs, the design team may make changes to the proposed design to take advantage of funding options. These changes may result in an overall improved design.
- F. The project manager shall have overall responsibility that all rebates, incentives or other requirements are completed in a timely manner.

End of Section