01 81 13 Sustainable Design Requirements – Add Part .04

Add the following new subsection .04 in its entirety to Section 01 81 13 per the following. Remainder of section is unchanged.

01 81 13 Sustainable Design Requirements

.04 Owner's High-Performance Thermal Envelope Requirements

A. Summary: The following includes the University's supplemental requirements for high-performance thermal envelopes to optimize energy-efficiency and indoor thermal comfort. They are intended to provide supplemental details to be used with, not take the place of, the high-performance building design standards referenced elsewhere in this Section.
   1. Applies to thermal envelope of new construction and additions.
   2. Renewed facilities and/or renovations of spaces that retain the exterior façade for historic or other reasons shall include evaluations to improve the thermal envelope to meet this intent as much as cost effectively practical to achieve the lowest long-term life cycle cost.
   3. Any exceptions shall require approval by the OPP Project Manager, and exceptions by the OPP Project Manager shall require approval by one of the Associate Vice Presidents.
   4. Other aspects of the building envelope such as materials selection for longevity and minimum maintenance, moisture and pest protection, etc. are covered elsewhere.

B. Integrated Design Process: The envelope design shall be coordinated in an iterative, integrated process to:
   1. Meet the functional and aesthetic architectural objectives.
   2. Help achieve comfortable and pleasant indoor environmental conditions with effective combined use of passive elements.
   3. Be purposefully integrated with the HVAC and lighting systems to minimize dependence on non-renewable energy use and associated owning and operating costs for the life of the building.
   4. Avoid envelope decisions made in isolation that can directly lead to permanent, poor comfort conditions that require additional HVAC systems and non-renewable energy sources to compensate.

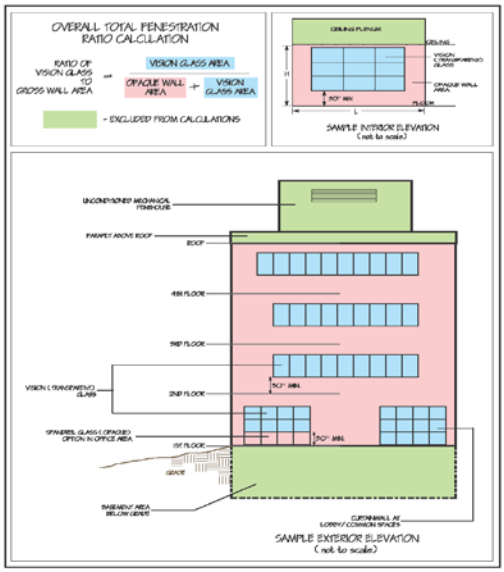
C. Optimize Passive Effectiveness of Envelope: Design the envelope with the, combination, arrangement, and thermal characteristics of envelope assemblies to achieve balance of aesthetics, vision glazing, effective daylighting, and passive energy conserving methods to provide a comfortable indoor environment to support the productivity and well-being of building occupants. The intent is to first passively minimize basic causes of local thermal discomfort. Then provide mechanical heating and cooling systems only as minimally needed to make up for otherwise unavoidable perimeter heat gain/loss. Use innovation, industry-

recognized high-performance building prescriptive compliance methods, and the University's Design and Construction Standards, and additional guidelines below.

1. Thermal performance of envelope assemblies shall comply with *ASHRAE Standard 189.1 Standard for the Design of High-Performance Green Buildings*: In general, comply with the prescriptive thermal performance requirements for the building envelope elements as defined in Chapter 7; Energy Efficiency.

2. Define superior continuous air, moisture and thermal barriers: Include clearly defined construction details and specifications of performance criteria to achieve and maintain superior integrity and interfaces of air infiltration, moisture intrusion, and thermal barrier assemblies. Avoid thermal bridging.

3. Fenestration Limitations: Comply with the following:
    a. In general, the area of vertical and skylight fenestration shall not exceed the percentages in the prescriptive option of *ASHRAE Standard 189.1*.
        i. Exclude from the ratio calculations the wall areas from unconditioned and semi-heated, unoccupied spaces. Refer to illustration below.



        ii. For renovations and additions, these percentages shall be based on the affected thermal wall or roof area within the boundary of the project scope, not on the total wall or roof area of an existing facility. In other words the total existing wall area of a building with a lower existing window to wall ratio cannot be multiplied by the maximum window to wall ratio in order to add a large new high percentage of glazed

areas. This applies similarly with skylights area and existing roofs. Only the assembly areas within the construction limits of the project shall be considered.

iii. If there is an agreed upon compelling justification for the proposed vertical or skylight fenestration areas to exceed the prescriptive limits, then see Design Phase Compliance Documentation, *Performance Rating Method* elsewhere in this section for more details.

b. Maintain a minimum of thirty (30) inches of an insulated assembly equal to the typical opaque wall assembly U-value from floor to window sill in all regularly occupied spaces such as offices, classrooms, laboratories, conference rooms, etc. This assembly may include curtain wall construction with various options of exterior opaque spandrel glass as part of pre-fabricated insulated composite panels or field installed insulation and wall finishes on interior surface.

   i. Note: This is primarily a thermal comfort issue to help avoid colder vertical surfaces near occupant's lower extremities and to allow wall space for installation and proper operation of perimeter heating systems and recognizing that glazing below 30" does not count for daylighting glazing area.

   ii. Lobby, entry and other transient, non-assigned spaces may be excluded.

c. Limit the amount of vision/daylight vertical glazing of the interior wall surface area of perimeter walls of fully conditioned, regularly occupied spaces as required to meet ASHRAE 55 thermal comfort design criteria.

   i. Large glazed areas can significantly affect comfort of nearby occupants, even with high performance glazing. Discomfort results from poor Mean Radiant Temperature, asymmetric thermal radiation effects, and uncomfortable drafts due to convection and/or air infiltration at window frame, storefront or curtainwall assemblies. By careful, integrated design of the envelope, strategic size and location of glazing, and the HVAC system, it can be possible to reduce or eliminate the need for the installation and operation of dedicated perimeter radiant heating systems typically required to offset these effects.

   ii. Lobby, entry and other transient, non-assigned spaces may be excluded.

4. Specify high-performance glazing: Optimally select glazing performance for each orientation to achieve the following:

   a. At a minimum, comply with the prescriptive thermal performance requirements for the building envelope elements as defined in *ASHRAE Standard 189.1* Chapter 7; Energy Efficiency.

b. Options for U-value, Solar Heat Gain Coefficient and Visual Light Transmittance and spectrally selective tints or coatings that are better than those prescribed by ASHRAE 189.1 shall be considered where advantageous to obtain lowest total cost of ownership and included as Energy Conservation Measure alternate bids.
c. Comply with requirements in 08 50 00 WINDOWS.
d. If the project specifically intends to properly optimize effective passive solar heating, south facing windows glazing may have a higher SHGC if fully integrated with properly designed exterior shading devices.

5. Integrate permanent projections for effective exterior solar shading: Combine use of insets, overhangs, horizontal or vertical fins, and light shelves applied with respect to building orientation and seasonal sun angles of site to minimize solar heat gain during cooling season, allow beneficial solar gain in heating season, and minimize discomfort caused by glare.
    a. At a minimum, comply with prescriptive requirements in ASHRAE Standard 189.1for Permanent Projections on east, south, and west fenestration.
    b. A combination of vertical and horizontal shading is more effective than just horizontal shading on the east and west facades of buildings because the sun is low in the sky early in the morning and late afternoon.
    c. Note: Internal shading devices shall be considered only for glare control, not as equivalent alternatives to external shading for HVAC load reduction.
    d. Custom patterns of opaque reflective finishes on the exterior surfaces of glazing (i.e. “fritting”) shall not be considered a direct substitute for true shading projections. It is not as effective, is difficult or nearly impossible to match exact color with respect to fading of adjacent glazing, and from experience has been extremely expensive to replace because of requiring custom orders and set-up charges.

6. Design for effective, integrated daylighting: Combine strategic fenestration placement, interior light shelves applied on predominately southern exposures and other glare control methods such as louvers, blinds, fins and shades achieve beneficial indirect daylight and to avoid high contrast levels that cause visual discomfort. Integrate daylight harvesting with interior lighting design and controls. Refer to 26 51 00 INTERIOR LIGHTING.
    a. Horizontal blinds are more effective on predominately south facing exposures.
    b. Vertical blinds are more effective on predominately east and west facing exposures.

7. Integrate Natural Ventilation Option with HVAC Systems and controls: If operable windows are included to allow for natural ventilation, then coordinate HVAC system zoning and controls to automatically turn off associated HVAC equipment when windows are opened either automatically or manually.
    a. Automatic Ventilation Mode: If and when outside air conditions are determined to be able to provide satisfactory indoor comfort, windows shall be automatically opened and the associated HVAC system shall be off when in natural ventilation mode.
    b. Manual: If windows are manually operable and intended for natural ventilation, use sensors and control strategies to interlock HVAC system to zone controls to be off when windows are opened.

8. Comply with ASHRAE 55 Thermal Environmental Conditions for Human Occupancy: The thermal envelope shall be optimized to passively assist in achieving the following comfort criteria.
    a. ASHRAE 55-2010, Section 5.2, Method for Determining Acceptable Thermal Conditions in Occupied Spaces:
        i. Operative Temperature (average air temperature and Mean Radiant Temperature);
        ii. Allowable Radiant Temperature Asymmetry;
        iii. Allowable Vertical Air Temperature Difference;
        iv. Allowable Range of Floor Temperature.
    b. Perform calculations and analysis for representative spaces and make iterations to thermal envelope first and then lastly to the HVAC systems as necessary to comply.
    c. Design Professional shall submit formal compliance documentation to indicate how the integrated thermal envelope and HVAC design complies with these requirements in accordance with ASHRAE 55, Chapter 6: Compliance.

D. Envelope Energy Component Compliance Documentation: Refer to basic requirements in Part .02, Paragraph C. Building Envelope Energy Component, above.
    1. *Prescriptive Method*: The Building Envelope Energy Compliance Report shall include the following, in tabular form:
        a. General project information including project name and location, contact information of Design Professional, and climate zone of reference design standard/code.
        b. Mandatory Provisions checklist
        c. Opaque Surfaces Performance Summary: For each space conditioning category, summarize each opaque surface assembly including the thermal performance of proposed and prescriptive budget criteria values (max U/ min R, values, high reflectance/ emittance factors, and surface areas). Provide line item breakdowns for each building elevation.

d. Fenestration Performance Summary: For each space conditioning category, summarize windows and skylights including the thermal performance of proposed and prescriptive budget criteria values (max U/ min R, values, SHGF, infiltration rates, external shading projection factors, and surface areas). Provide summaries for each building elevation.
e. Window to Wall Ratios Summary: include Gross Wall Area and Window Area and Window to Wall Ratio, per elevation and total.
f. Skylight to Roof Ratio Summary: include Gross Roof Area, Skylight Area and Ratio.
g. Overall Floor areas: include area summaries of each space conditioning category: Non-Residential Conditioned space, Residential Conditioned space, Semi-heated space, and the total of all of the above.

2. *Performance Rating Method:* If using this option, perform a quantitative analysis as early as possible in the design process to develop the envelope as a distinct component that meets the requirements defined in this Section. Submit the analysis to document energy reduction achieved as part of the Building Envelope Compliance Report prior to any official design approvals.
   a. The analysis shall include preliminary, simplified heating and cooling energy calculations of the Building Envelope Energy Component to show quantified energy reduction between proposed Design and prescriptive budget envelope model.
   b. As stated earlier, any trade-off must be considered within the building envelope energy component itself.

3. LEED Requirements: On projects that require a whole building Energy Simulation Model, submit the final certified Compliance Report of Optimizing Energy Performance, signed and sealed by the Design Professional. Report shall include summaries of comparisons of the Design Building of each of the ASHRAE 90.1 Energy Components and the total to the budget (baseline) model.

E. Quality Assurance: Project Specifications shall include the following quality assurance requirements:
   1. Contractor shall coordinate and schedule all test and inspection requirements with Owner's Commissioning Agent and/or testing agency.
   2. Field Quality Control:
      a. Mockups (for new construction): Before beginning installation of thermal, air, and moisture barriers, contractor shall build mockups of exterior wall assembly shown on Drawings, of size no less than 150 sq. ft., incorporating backup wall construction, external cladding, window, door frame and sill, insulation, and flashing to demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of thermal, air and

moisture barrier membranes. Include junction with roofing membrane, building corner condition, and foundation wall intersection. Coordinate construction of mockup to permit inspection by Owner's testing agency of components before external insulation and cladding is installed.

b. Inspections: Materials and installation are subject to inspection for compliance with requirements.
c. Tests: Testing to be performed will be determined by Owner's testing agency as follows:
    i. Qualitative Testing: Air barrier assemblies shall be tested for evidence of air leakage according to current ASTM E1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
    ii. Infrared thermal imaging shall be performed on the completed building envelope during the first heating and cooling season and reports submitted by Owner's Commissioning/Testing Agency. Areas showing "hot/cold spots" of unacceptable thermal losses shall be investigated and repaired

3. Remediation: Deficient air, moisture and thermal barrier components shall be investigated, removed and replaced and retested for compliance until satisfactory at no additional cost to the University.

F. Building Enclosure Commissioning (BECx): When Building Enclosure (Envelope) Commissioning is included in the project scope, a qualified independent Commissioning Agency with specialized building envelope expertise shall be engaged to perform building enclosure (envelope) commissioning and associated inspections, tests, measurements and verification to ensure all performance requirements are being met.
    1. Industry Guidelines: Comply with the current versions of the following:
        a. *ASHRAE Guideline 0*, The Commissioning Process.
        b. *National Institute of Building Sciences (NIBS) Guideline 3*, Building Enclosure Commissioning Process.
    2. BECx Qualifications: Building Enclosure Commissioning specialist shall provide documentation of qualifications required by NIBS Guideline 3.
    3. Additional resources:
        a. AIA Best Practices: Building Enclosure Commissioning: An Introduction
        b. U.S. Green Building Council: Building Envelope Commissioning
        c. Whole Building Design Guide: Building Commissioning

Delete the following section 01 83 00 Facility Shell Performance in its entirety.

~~**01 83 00 Facility Shell Performance**~~

~~A. Reserved for future use.~~

END of revision

Update Commentary:

Section was added primarily for the following reasons:

1. *To define supplemental Owner Requirements intended to achieve high performance of building envelope and integration with HVAC and lighting systems.*
2. *To define the Design, Submission, Commissioning and Quality Control requirements pertaining to the building envelope to assure high quality, high performance of those components and assemblies.*
3. *Note the following special points:*
    a. *Envelope component must be equal to or better than performance prescribed by the combination of the High-Performance Building Design Standards cited in Part 2 of this section.*
    b. *Avoid sources of local thermal discomfort*
    c. *Limitations of exterior glazed areas.*
    d. *Submission and approval requirements of Building Envelope Compliance Report that summarizes the key performance characteristics of the envelope assemblies*
    e. *Building Envelope commissioning and field quality control.*