DESIGN REQUIREMENTS - GENERAL

GENERAL DESIGN GUIDELINES
The following guidelines apply to all new construction (including entire new buildings as well as
remodels or additions to existing buildings) on the University of California at Davis (UCD)
Campus. Some projects, due to specific project budgetary, regulatory, or program constraints
may not be able to incorporate all of the guidelines listed below. Any questions as to applicability
of these guidelines should be directed to the University's Representative for clarification.

For broad campus goals and Architectural Design Guidelines please see:
http://www.ae.ucdavis.edu/projectsindesign/campus_standards.htm and click on “Architectural
Design Guidelines.” This guide was prepared in 2003 and provides historical background on the
development of the UC Davis campus, information on significant buildings and campus districts
as well as architectural and site furniture design guidelines.

Refer to all specific program requirements, Soils Reports (when furnished by the University), the
Long Range Development Plan (LRDP), the LRDP Environmental Impact Report (EIR), project
EIR, District Planning Guides, Architectural Design Guide and any other applicable guidelines in
designing buildings and site improvements on the UCD campus, as well as the following
requirements.

ACCESSIBILITY
Provide for disabled access to all sites and buildings as per the requirements of CCR Title 24 and
the Americans with Disabilities Act of 1990 (ADA) accessibility guidelines, using the most
stringent where the two conflict.

SUSTAINABLE MATERIALS, PRODUCTS, AND EQUIPMENT
Specify materials, products and equipment with the following attributes where they meet the
performance goals needed for the project:
1. Materials, products and equipment that have an inherent ability to serve their function
with minimal maintenance.
2. Materials, products or equipment that can be removed and re-used when they are no
longer needed for the project.
3. Materials, products or equipment that create no or minimal health risks to the people
who occupy, construct and maintain the project.
4. Materials, products or equipment that have significant post-industrial and post-consumer
recycled content.
5. Local/regional materials and equipment manufactured or having final assembly at a
facility within 500 miles of the Project.
6. Certified wood from manufacturers declaring conformance with Forest Stewardship
Council Guidelines for certified wood building components.
SITE UTILITIES
All significant Campus Core buildings shall be on campus central systems unless an exception is reviewed and approved by the University's Representative.

STORM DRAINAGE
Prevent concentrated roof storm water from flowing across pedestrian paths or walkways. Provide open clean-out areas at downspout/underground system junction.

Implement structural Best Management Practices (BMPs) that will prevent pollution or provide treatment of storm water runoff to reduce pollutants after construction of the project is completed. Post-construction programs are most effective when they stress (i) low impact design; (ii) source controls; and (iii) treatment controls.

Examples of BMPs for new development and redevelopment can be found in the California Stormwater Quality Association's Stormwater Best Management Practice Handbook for New Development and Redevelopment (www.cabmphandbooks.com).

If project site existing imperviousness is less than or equal to 50%, implement a stormwater management plan that:
1. Maintains annual groundwater recharge rates, promotes the use of nonstructural practices and infiltration, and captures and treats the volume from 90% of the average annual rainfall.
2. Addresses stream channel stability (e.g., prevents increases in critical erosive velocities during bankfull and near-bankfull storm events) and the frequency and magnitude of out-of-bank flooding (e.g., flow events that exceed the bankfull capacity of the channel and therefore must spill over into the floodplain)

OR

If the project site existing imperviousness is greater than 50%, implement a stormwater management plan that:
1. Maintains annual groundwater recharge rates, promotes the use of nonstructural practices and infiltration, and captures and treats the volume of runoff from 90% of the average annual rainfall for all proposed impervious areas, and
2. Results in a decrease of runoff by 25% of the annual stormwater load falling on existing imperviousness. This reduction can be accomplished through a variety of measures, including: increasing perviousness of site, implementing stormwater management practices (nonstructural and structural), capturing rainwater for reuse, or other measures.
3. Results in a decrease of runoff from the site by 50% of the annual stormwater load falling on the site and addresses channel stability and the frequency and magnitude of flooding from 100% of the newly added impervious surfaces. This reduction can be accomplished through a variety of measures, including: perviousness of site, stormwater
management practices (nonstructural and structural), capture of rainwater for reuse or other measures.

Semi-arid watersheds receive between 15 and 35 inches of rainfall per year. For this calculation, the volume of runoff from 90% of the average annual rainfall is equivalent to the runoff from 0.75 inches of rainfall; structural BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing field monitoring information. Structural practices are considered to meet these criteria if (1) they are designed in accordance with standards and specifications from a state of local program that has adopted these performance standards, or (2) there exists in-field performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership (TARP), Washington State Department of Ecology) for BMP monitoring.

LANDSCAPE
The design of each building complex should be sensitive to, and complementary of, any existing sensitive vegetation and mature specimen trees. Use water-conservative landscaping on the west and south campuses where domestic water is used for irrigation. Landscape, where appropriate, with native, drought resistant plants and use lawns only where needed for pedestrian traffic, activity areas, and recreation. Install efficient irrigation systems including centrally-controlled automatic irrigation systems and low-flow spray systems. Apply heavy applications of mulch to landscaped areas to reduce evaporation.

The landscape design shall provide for bicycle parking and circulation as well as for pedestrian circulation.

Heat Island Mitigation
Provide shade (within 5 years of landscape installation) and/or use light-colored/high-albedo materials with a Solar Reflectance Index (SRI) of at least 29 for at least 50% of the site's non-roof impervious surfaces, including parking areas, walkways, plazas, fire lanes, etc.; OR
Place a minimum of 50% of parking spaces underground or covered by structured parking. See Appendix for SRI calculation requirements.

Design Considerations for Existing Trees
All trees on campus are a prime natural asset and should be carefully protected. All new building should observe the following guidelines:
1. Whenever possible, avoid fill or excavations within the drip line of other species, to avoid suffocation and root cutting. Avoid placing utility lines through trees to be saved.
2. Establish finish grades on paving, footings etc., above the root system. The grade at the base of all trees should not be raised or lowered.
3. Limit root coverage to not more than 40 percent unless a loose permeable covering is used such as gravel, decomposed granite, etc.
4. Re-establish drainage systems around trees where natural drainage system has been disturbed. Finish grades should drain away from the tree.

General Planting Selection
1. Providing shady and sunny seating areas, colorful entries, and screening or buffers when necessary.
2. Plant sizes should be chosen to ensure long-term adaptability to specific site locations.
3. Coordinate proposed plant material with Grounds and Arboretum.
4. For planting guidelines (specifications for Nursery Tree Acceptance, Tree Planting Detail, Planting Procedures and Tree Spacing), refer to “Treescapes at UC Davis - A Landscape Management Plan for the Tree-Lined Corridors.”
5. In order to reduce the potential for criminal activity, plant sizes should not inhibit a clear line of vision for users.

Maintenance
1. Plant materials should be selected for ease of maintenance so as not to require substantial pruning, leaf and litter collection or pest control.
2. Avoid large deciduous trees in interior courtyards that require substantial leaf collection.
3. Plants should be drought tolerant and low water use types.

Lawn Areas
1. When lawn areas are required, provide a few larger areas of lawn, as opposed to many small individual patches of lawn, in order to minimize maintenance costs.
2. In layout of lawn areas and other specialized landscape areas, consider the ease of lawn mower or other maintenance equipment access to such areas.
3. Do not use decomposed granite or gravel at paths within developed areas adjacent to buildings where such materials can contaminate or migrate onto lawn or building entry systems.

PARKING/CIRCULATION
General Design
1. See Heat Island Mitigation section under the Landscaping section above for further requirements.
2. All parking areas near buildings on campus are to include a portion of the total spaces for handicapped parking as per the requirements of the DSA and CCR.
3. Parking should be convenient, but not obtrusive. Screening or buffering of parking areas is encouraged.
4. Pedestrian movement in and out of parking areas shall be incorporated into the landscape design.
5. Parking should not create an obstacle for pedestrians traveling through the campus core.
6. Parking and service areas shall be landscaped, retain existing trees where possible, conform to the topography, and be limited in size to decrease their visual impact.
7. All parking areas or clusters of areas 1 acre or larger shall either be provided with sedimentation/infiltration basins designed to capture the majority of suspended or emulsified contaminants.

8. Provide conduit stub-outs and pull strings for future installation of emergency phone and for ticket/permit dispensers.

9. Layout for parking should provide 5.4 parking spaces for every 10 occupants (staff, faculty and student) of the building.

10. Designate spaces for Disabled, Vendor/Diamond E, and Meter parking. Adequate signage shall be provided to identify designated spaces and identify the parking lot.

Minimum Parking Area Requirements
   1. Provide wheel stops (curb may be used as a wheel stop).
   2. Provide parking stalls with minimum dimensions of 8 feet-6 inches wide by 18 feet-0 inches long per space. Aisle width shall be a minimum 25 feet wide for 90 degree parking on both sides.
   3. Compact parking spaces are not normally provided.
   4. Motorcycle parking shall be provided as specified in the Detailed Project Program (DPP). When provided, motorcycle parking shall be on a concrete pad.

Vehicle/Bicycle/Pedestrian Circulation
   1. Two lane roads are to be 24 ft. wide minimum, with minimum 30 ft. radius at curves.
   2. Provide asphalt or concrete side paths of a width appropriate to its intended use. If asphalt is used, provide pressure treated pathway headers. Verify with the University’s Representative.
   3. Provide bicycle parking (to serve a minimum of 5% of the regular building occupancy) convenient to building entries and on the project site. Verify amount of bicycle parking with DPP.
   4. Provide for bicycle circulation from bike paths to bike parking to pedestrian path to building entry. Bicycle and pedestrian paths shall be separate when possible.

SITE LIGHTING & ELECTRICAL
The primary goals for campus lighting area safety, security and aesthetics: Only light areas where exterior lighting is clearly required for safety and security. Lighting used solely for aesthetic effects shall be used only to achieve campus wide way-finding goals.
   1. Safety involves minimizing conflicts with pedestrians, bicycles, and vehicles through channeling traffic to the safest paths and providing adequate sight lines and lighting levels.
   2. Security minimizes personal harm or property loss by achieving good visibility and by removing shadows along paths.
   3. Aesthetics in lighting refers to the appearance and place making qualities of the lighting design, both during the day and night.
WASTE COLLECTION
All buildings on campus shall include an outdoor enclosure area and pad for solid waste and recycling storage bins accessible by the campus solid waste and recycling collection trucks for periodic (usually daily) collections. All new buildings or building additions shall design convenient access locations to trash and recycling bins by building residents and Custodial personnel, as well as by Solid Waste and R4 Recycling collection trucks.

In design, consider convenience to users, isolation of odors and minimized visibility of trash bins. For example, avoid placement air intakes near trash location.

Screen bin locations, whether by planting, wood fencing concrete walls, etc., depending on particular program requirements. Include continuing accessibility (for instance, growth of maturing plants) in screening plans.

Provide a concrete pad under truck access capable of supporting over 20,000 lbs. Reinforce a 10 foot by 10 foot area beginning 5 feet in front to the bin. The concrete pad must be the same grade as the parking lot or access road.

Minimum clearances:
1. 18 feet driveway width for vehicle to turn into a driveway from the street.
2. 60 feet from front of bin enclosure to wall, parking or landscaping to accommodate collection truck backing and straightening operations.
3. 12 feet beyond the side of bin enclosure to accommodate a 3-point turn.
4. 23 feet overhead to accommodate emptying bins into collection vehicle.

Bins must be screened from view but accessible by custodial carts. Provide a designated outdoor space 96 inches by 36 inches with signage for recycling cart collections.

Gates: Avoid gates in residential areas where residents may be accessing the bins with their hands full. If gates must be included, plan to have as few gates as possible to open and close while servicing the area. Areas with gates shall have mechanical means to keep gates open.

Minimum Clearances:
1. 12 feet overhead to open bin lid for loading trash or cardboard.
2. 10 feet depth.
3. Width: Trucks are 8 feet wide plus mirrors. 12 feet clear width for a single bin. 22 feet for two bins plus 10 feet for each additional bin.

Provide lighting and hose bibb with backflow preventer and consider drainage at each bin location. Any bin receiving food waste must have a hose bibb and drainage. All drainage shall be to sewer, not storm drainage system.

Division 12 – Furnishings for trash and recycling receptors.
DESIGN REQUIREMENTS – BUILDING

ACCESS TO NATURAL LIGHT AND VIEWS
Design the building to maximize interior day-lighting. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high performance glazing and photo-integrated light sensors.

Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetrations) or achieve at least 25 foot candles using a computer simulation model in 75% of all regularly occupied areas. Provide daylight redirection and/or glare control devices to ensure daylight effectiveness. Exceptions for areas where tasks would be hindered by the use of daylight will be identified in the project program. See Appendix for calculation requirements.

Provide direct line of sight to vision glazing for building occupants in 90% of all regularly occupied areas (occupied by an individual for more than 4 hours daily). Exceptions will be identified in the project program. See Appendix for calculation requirements.

ACOUSTICS
All plumbing penetrations (bathroom, hydronic, etc.) in walls must be caulked airtight using specified acoustical caulk.

Where recessed fixtures of any type are installed (e.g., medicine cabinets, fire extinguishers, electric distribution panels, recessed water fountain, recessed bookcases, etc.) ensure that required acoustic wall construction extends behind these recessed elements.

Installation of noisemaking equipment (such as telephones, water fountains, etc.) is not allowed on walls of rooms requiring acoustic protection.

Use surface mounted rather than recessed lighting fixtures and fans, etc. at ceilings of rooms requiring acoustical protection in order to minimize sound transfer.

Space doors to rooms requiring acoustical protection so that neighboring rooms do not have directly adjoining doors and so that doors on opposite sides of corridors do not directly face each other. Stagger all doors. Do not place any doors to rooms requiring acoustical protection opposite stairwell or bathroom doors.

Provide a maximum gap of 1/2 inch at all door bottoms (less when possible).

Do not place bathrooms (public or private) or student lounges over rooms requiring acoustical protection (especially rooms having non-carpeted floors).

Separate studs with a structural, in-wall air gap; must isolate the jamb of all heavily used corridor doors from any adjacent rooms requiring acoustical isolation.
Mechanical equipment in spaces above or below rooms requiring acoustic isolation must be vibration isolated, including piping and conduits, from walls, floors and ceilings. See General Mechanical section for additional acoustic requirements.

HUMAN FACTORS
Buildings on campus should be designed with awareness and sensitivity for human interaction with the built environment. Design Professionals are to consider scale, way-finding, and adequate clearances. Walkway canopies, railings and similar work shall be designed to reflect their exposure to student use for consideration in restricting climbing, loading, etc.

INDOOR POLLUTANT REDUCTION AND CONTROL
Adhesives, sealants, sealant primers and aerosol adhesives used inside the exterior weatherproofing system must not exceed the following requirements:


Paints and coatings used on the interior of the building and applied on-site must not exceed the VOC limits and must not include any of the chemical components limited or restricted by the following standards:


Carpets systems must not exceed the target emissions factors of the Carpet and Rug Institute’s: Green Label and Green Label Plus Program and Testing Procedures.

Composite wood and agrifiber products, including core materials, must contain no added urea-formaldehyde resins. Adhesives used in field- and shop-fabricated assemblies containing these products must contain no urea-formaldehyde.

Pollutant Control
Design to minimize and control pollutant or biological contaminant entry into buildings and later cross-contamination of regularly occupied areas:

1. Employ permanent entryway systems (recessed walk-off mats or grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways.
2. Where hazardous gases or chemicals may be present or used (including garages, housekeeping/laundry areas, and copying/printing rooms), provide segregated areas with
deck to deck partitions with separate outside exhaust at a rate of at least 0.50 cubic feet per minute per square foot, no air re-circulation, and operated at a negative pressure compared with the surrounding spaces of at least an average of 5 Pa (0.02 inches of water gauge) and with a minimum of 1 Pa (0.004 inches of water) when the doors to the rooms are closed.

3. Provide containment drains plumbed for appropriate disposal of hazardous liquid wastes in places where water and chemical concentrate mixing occurs for maintenance, or laboratory purposes.

4. Provide regularly occupied areas of the building with new air filtration media prior to occupancy that provides a Minimum Efficiency Reporting Value (MERV) of 13 or better.

5. For fireplaces or wood-burning appliances, require low-emitting EPA certified wood-burning appliances, or residential natural-gas fireplaces.

LACTATION ROOMS
Lactation rooms are required in every major new campus building unless waived by UCD Child Care & Family Services for small buildings, special uses or occupancies, etc.

MAINTENANCE
Locate and specify windows, when possible, to enable convenient window cleaning by occupants and maintenance personnel. Pivoting windows or easily accessible windows for cleaning are desirable.

Custodial Equipment Rooms shall be strategically located on all floors throughout the building for the storage of custodial cleaning equipment. Locate to avoid moving equipment long distances. Minimum size: 55 sq. ft. provide one room per 20,000 gross sq. ft. Typical equipment and sizes are:

1. Mopping cart -2 feet by 6 feet
2. Trash cart (6 bushel) - 2 feet by 3 feet
3. Vacuum; carpet (upright) - 3 feet by 1 foot
4. Floor machine (buffer) -2 feet by 4 feet+
5. Hi speed buffer 2 feet x 4 feet
6. Shelving - 1 foot deep by at least 15 lineal feet of adjustable shelving.

Custodial Wet Closets shall be strategically located on all floors throughout the building; they may be designed in conjunction with Custodial Equipment Rooms. Minimum size: 70 sq. ft. and designed as follows:

1. 32-inch by 32-inch or 30-inch by 24-inch floor basin with approximately 4-inch curb height.
2. Hot and cold water outlet with attached hose (and wall clip) for filling buckets, etc.
3. Three or more dry mop and dust mop hooks or clips on wall away from basin.
4. Pad/brush holder.
5. Space for equipment as follows: Step ladder - 1 foot by 2 feet, vacuum - 2 feet by 3 feet, and carpet extractor - 3 feet by 7 feet.
6. Shelving - 1 foot deep by at least 15 lineal feet of adjustable shelving.
7. Electric receptacle, grounding type located approximately 2 feet above the floor and near the corridor door.

8. Mop rack. Rack is fabricated of a one-piece channel of No. 20 gauge, type 304L, 18-8 alloy stainless steel with horizontal edges returning 1/2 inch to the wall. Surface of rack is polished to a No. 4 satin finish. Mop holders are riveted to rack at 10-inch intervals. A pivoting serrate runner cam holds in fixed position. Mounting suggestion - 70 inches from top of finished floor to bottom of rack.

Custodial Storage Rooms shall be one room per building for bulk storage of custodial supplies; may require limited shelving and shall be near the loading dock and an elevator. Minimum size: 100 sq. ft. The Custodial Storage Room will not be required if the Custodial Equipment Room and Custodial Wet Rooms are each greater than 90 sq. ft.

Additional requirements for custodial spaces are as follows:
1. Doors shall swing out and shall be large enough to permit free movement of boxes and equipment.
2. Custodial Wet Closets shall have exposed concrete or painted drywall ceiling, hardened smooth concrete floor and washable hard smooth finish on concrete block walls. Provide glazed tile walls at basin.
3. Finishes in other custodial spaces shall be similar to those for Custodial Wet Closets.
4. Provide adequate ventilation.
5. Lighting shall meet Illuminating Engineering Society of North America (IES) guidelines with no exposed lamps. No rooms shall contain telephone switchgear, elevator panels, electrical panels, metering devices or similar equipment.

LABORATORIES
Per campus policy, laboratory buildings shall include a separate employee eating area. Incorporate this requirement into the building design.
DESIGN REQUIREMENTS - STRUCTURAL

Building floor and roof loads shall be designed to exceed code minimums. Verify with the University’s Representative for specific design criteria.

SECURING NON STRUCTURAL ELEMENTS

Falling hazards from non-structural building elements including equipment, fixtures, ceilings, furniture, and other contents should be abated, to the extent practical. This includes the following guidelines:

1. Free-standing bookshelves, cabinets, and equipment shall be anchored according to Uniform Building Code (as modified by applicable California State Codes), Chapter 16 Structural Design Requirements and 25 Gypsum Board and Plaster.
2. Shelves shall have doors, or restraints to keep items from falling. For bookshelves, the restraint should extend at least one-half inch above the shelf. For chemicals and in other laboratory areas, the restraint should extend at least two inches above the shelf. Where glass chemical containers will be stored, the restraint material should be of a nonmetallic or a rubber coated metallic material.
3. Sliding or swinging cabinet doors shall have mechanical latches.
4. Compressed gas cylinders shall be restrained using approved brackets with two metal straps or chains that have been firmly attached to walls. When using chains, one should be located approximately 8 inches from the floor and the second should be located approximately 34 inches from the floor.
5. Flexible utility connections shall be used for fume hoods and other equipment.
ENERGY EFFICIENCY
In order to comply with the UC Policy on Green Building and Clean Energy, new buildings will be designed to achieve a minimum standard of LEED 2.1 “Silver” rating and outperform the requirements of Title 24 by 20%.

Alternatives involving increased construction costs shall be economically evaluated to determine pay back period. In determining the pay back period, data concerning energy costs and energy cost escalation rates will be furnished by the University. Data furnished by the University and all assumptions used in the evaluation shall be clearly stated.

To ensure that as many life cycle cost-effective measures as possible be installed in all new construction and remodeling projects, every attempt should be made to ensure that all energy conservation measures with a simple payback period of less than 10 years are installed. The design process shall include attention to energy efficiency for systems not addressed by Title 24.

The Executive Design Professional is encouraged to suggest alternative designs to reduce both energy use and demand. Alternative design suggestions could include, but are not limited to:

1. Revised building orientation
2. Revised construction materials
3. Increased insulation
4. Use of variable air volume (VAV) HVAC systems vs. constant volume systems
5. More effective use of outdoor air in HVAC systems
6. Revised piping configurations to reduce pumping costs
7. More efficient building and heat recovery equipment selections
8. More sophisticated equipment control strategies
9. High efficiency motors in long run time applications
10. More efficient lighting systems

TITLE 24 EXEMPT BUILDINGS
Buildings or systems that are exempt from Title 24 requirements (e.g. process loads for labs and medical research, animal buildings and hospital spaces, etc.) are to be at least 20 percent more efficient than a standard design for that type of space or system.

The design of an exempt building must include a computer simulation analysis of a standard base case, exempt building with standard design and an analysis for the upgraded building design which will include many of the measures described in the following paragraph, plus ideas from the Design Professional Consultants. The result of the analysis is that the upgraded building must use at least 20 percent less energy than the standard exempt building. Some typical measures that could be used for the upgraded design are: VAV supply and exhaust; VAV fume hoods; heat recovery and/or indirect evaporative cooling and other measures.

Every project is to be evaluated with the University Representative to determine the limits of construction and extent of life cycle cost effective measures to be installed. For remodeling
projects Title 24 documentation should only be provided for systems that are replaced or upgraded.

INFRASTRUCTURE BENEFITS
Although not specifically addressed in Title 24, load management plays an important factor in keeping UC Davis' utility bills low. Many energy efficiency measures such as heat recovery and thermal ice storage reduce loading on the campus chilled water system, steam system and electrical distribution system. Contact University's Representative to determine the value of the infrastructure benefits that are to be used in life cycle cost analysis.

ENERGY CONSERVATION MEASURES
The following list identifies energy conservation measures that the Design Professional should consider implementing in order to reach the campus energy conservation goal.

BUILDING ENVELOPE
A1  Minimum roof insulation levels of U-0.050.
A2  Minimum wall insulation levels of U-0.100.
A3  Windows with no exterior shading shall have a visible transmittance to shading coefficient ratio greater than 1.1 (VT/SC > 1.1).
A4  For all spaces where humidification and/or dehumidification are required and outside air requirements are low (e.g. main frame computer rooms), provide a vapor barrier around the entire controlled space. Include detailing of pipe and conduit penetrations of vapor barriers.
A5  Optimize building orientation
A6  Upgrade roof insulation from U=0.050 to U=0.033
A7  Upgrade wall insulation from U=0.100 to U=0.050
A8  Day-lighting to minimize artificial light
A9  Double glazed windows
A10 Thermal breaks in windows
A11 High performance glazing (low SC, high VT) (with shading)

CHILLERS
B1  Thermal storage (TES) or natural gas fired cooling for remote buildings
B2  Limit air-cooled chiller to 30 tons
B3  Limit air-cooled chiller to 150 tons w/ TES
B4  Limit evaporative cooled chiller to 150 tons
B5  Provide energy efficiency option

COOLING TOWERS
C1  FRP, coke bottle shaped, propeller tower
C2  Close approach temperature (4-7 degrees)
C3  Oversized w/ low fan power (<0.03 kW/ton)
C4  2 speed motor for fans 1 HP and up
C5  VFD for fans 15 HP and up
BOILERS
D1  Modulating or high/low fire
D2  Factory insulated to R-6 or better
D3  Energy efficiency options
D4  Pulse boiler

PUMPS
E1  Provide lead/lag pumping for VFD systems requiring (i.e., split 1- 100 percent pump into 2- 60 percent lead/lag pumps).
E2  Optimize selection to minimize HP
E3  Suction diffuser on base mounted pumps
E4  Lead/lag variable water volume for small systems

HYDRONIC SYSTEMS
F1  For pumping systems that are approximately 10 HP and larger, provide variable water volume (VWV) pumping systems for chilled water, hot water, heat recovery and possibly other types of water systems. Chilled water systems using chillers are to be separated into a primary-secondary system so that the chillers may operate at constant volume.
F2  For chilled water systems connected to the central plant, the chilled water delta T should be maximized as much as possible to minimize the flow of chilled water from the central loop and to improve performance for future thermal energy storage systems. The minimum acceptable and desired coil leaving water temperatures (LWT) and chilled water coil delta T's are shown below.

<table>
<thead>
<tr>
<th>CHW Coil Design</th>
<th>Coil LWT</th>
<th>Coil CHW Delta T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>62 degrees</td>
<td>16 degrees</td>
</tr>
<tr>
<td>Desired (Required &gt;= 10HP AHU)</td>
<td>66 degrees</td>
<td>18-20 degrees</td>
</tr>
</tbody>
</table>
F3  For heating hot water systems, use 180-degree hot water supply temperature for coil sizing. Hot water system delta T should be maximized to reduce pump and pipe sizing. Typically, a 40 to 60 degree delta T should be used for air handling coils and a 30 to 40 degree delta T should be used for reheat coils when 180-degree hot water system is used.
F4  For hydronic systems where variable water volume (VWV) is used, provide the following:
   • Install modulating 2-way valves with tight shut-off rated to close against a differential pressure of 1-1/2 times pump head.
   • Provide one 3-way valve (or end-of-line needle valves) on heating hot water systems.
   • Locate differential pressure sensor at hydraulically most remote coil.
   • If hydraulically most remote coil is variable, provide multiple differential pressure sensors and use a low signal selector to send proper signal to variable frequency drive.
• Limit total bypass gpm through 3-way valves to 1.5 gpm per pump horsepower by installing balance valve in the bypass of all 3-way valves.

F5  For constant or variable flow water systems, provide 2-way control valves for all reheat and recool coils except as noted above.
F6  In coil schedule, identify the control valve Cv value.
F7  Identify control valve Cv
F8  Reverse return piping or pipe looping
F9  Pot feeders in parallel with pumps
F10 Limit pressure drop to 2 feet H2O per 100 feet

AIR HANDLERS
G1  Provide a variable frequency drive (VFD) for VAV systems with motors 15 HP and larger.
G2  Provide a variable frequency drive (VFD) for constant volume systems with motors 25 HP and larger and that utilize 65 percent efficient and greater filtering.
G3  Chilled water, hot water, direct expansion, heat recovery, terminal and other coils are to be sized at a life cycle cost effective face velocity and pressure drop. Maximum desired face velocities and air pressure drops are identified below:

<table>
<thead>
<tr>
<th>System Type</th>
<th>Operating Hours</th>
<th>Desired Max. Coil Face Velocity (fpm)</th>
<th>Max. Coil Wet Air Pressure Drop (H2O)</th>
<th>Hot Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CHW &amp; DX around</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>24h/d, 7d/w</td>
<td>350</td>
<td>0.45</td>
<td>0.30</td>
</tr>
<tr>
<td>Constant</td>
<td>10h/d, 5d/w</td>
<td>400</td>
<td>0.50</td>
<td>0.35</td>
</tr>
<tr>
<td>Variable</td>
<td>24h/d, 7d/w</td>
<td>400</td>
<td>0.50</td>
<td>0.35</td>
</tr>
<tr>
<td>Variable</td>
<td>10h/d, 5d/w</td>
<td>450</td>
<td>0.55</td>
<td>0.40</td>
</tr>
</tbody>
</table>

G4  Optimize selection to minimize fan HP
G5  VFD for VAV systems 3 HP to 10 HP
G6  Casing insulation of R-8 or greater
G7  Low leakage dampers
G8  Low pressure drop sound attenuation
G9  Limit air handler size to 25,000 cfm

AIR FILTERS
H1  For air handlers approximately 7.5 HP and larger, provide low pressure drop, UL-approved air filters similar to the following:

<table>
<thead>
<tr>
<th>Filter Efficiency</th>
<th>Similar to</th>
<th>Desired Maximum Face Velocity (fpm)</th>
<th>Maximum Initial Pressure Drop (H2O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 percent</td>
<td>LUWA FP75</td>
<td>400</td>
<td>0.17</td>
</tr>
<tr>
<td>65 percent</td>
<td>LUWA FP75</td>
<td>400</td>
<td>0.17</td>
</tr>
</tbody>
</table>
85 percent  LUWA FP85  400  0.19
95 percent  LUWA FP95  375  0.23
99.97 percent HEPA  FARR   250  0.65
99.99 percent HEPA  FARR   200  0.65

VAV AND CV BOXES
I1  For VAV systems, unless calculations indicate otherwise, set minimum air flow for
cooling and for heating to 40 percent of the maximum air flow value, or 0.70 cfm
per square foot, whichever is less.
I2  The maximum air pressure drop (PD) of a bare box shall be 0.07 inches. For 1 row
coil add 0.10 inches max. PD and for 2 row coil add 0.15 inches to 0.20 inches PD.

DUCTWORK
J1  SMACNA smoke and bubble tests indicate that splitters, extractors, scoops and 90-
dergree branch taps have high pressure drops and should be avoided. Smoke tests
also indicate that the fittings in the following table have low pressure drops and are
the fittings of choice for SA, RA and EA branch ducts. Please show or require these
fittings in specs.
PREFERRED BRANCH TAKE-OFFS

<table>
<thead>
<tr>
<th>Duct Branch</th>
<th>Preferred</th>
<th>SMACNA Figure *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangular to Rectangular</td>
<td>Shoe</td>
<td>14-14.N or W</td>
</tr>
<tr>
<td>Rectangular to Round</td>
<td>Conical</td>
<td>14-14.M or V</td>
</tr>
<tr>
<td>Round to Round</td>
<td>Wye</td>
<td>14-14.B, C or J</td>
</tr>
</tbody>
</table>


J2  Require random (or complete) duct leakage testing in all ducts rated at (1 or) 2
inches of water and greater.
J3  Use ducted transfer air from corridors as supply air for bathrooms and janitors
closets
J4  To improve IAQ, use high SA, low RA
J5  To improve IAQ, use induction type diffusers
J6  Maximize the use of round duct
J7  Provide duct looping (or gridding)
J8  Limit pressure drop to 0.07 inches H2O per 100 feet
J9  Provide minimum R-6 insulation for supply ducts

EXHAUST FANS
K1  Optimize selection to minimize fan HP
K2  Provide 5 to 10 diameters straight duct into fan
K3  Use propeller fans for low delta P applications

PACKAGE UNITS and SPLIT SYSTEMS
L1  Select high SEER equipment
L2  Provide slightly oversized evaporator coil
L3  For multi-compressor systems, intertwine coils
HEAT RECOVERY AND INDIRECT EVAPORATIVE COOLING

M1 Heat recovery and/or indirect evaporative cooling systems shall be provided for all 100 percent outside air systems and shall be evaluated for systems using high outside air flow rates.

M2 Provide lead/lag pumping

M3 Additional pre-cooling using cooling tower

M4 Additional pre-cooling by spraying exhaust air coil

FUME HOODS

N1 Variable air volume hoods

N2 Gang hoods onto exhaust plenum w/ multiple fans

N3 Size ducts per Industrial Ventilation, 21st edition

DOMESTIC and INDUSTRIAL HOT WATER

O1 Size recirculating pumps for a 10-degree temperature drop

O2 Specify low flow showerheads w/o flow restrictors

O3 Minimum R-16 insulation for packaged water heaters

O4 Minimum R-16 insulation for storage tank

COMPRESSED AIR AND VACUUM PUMP SYSTEMS

P1 Main/standby equipment is not allowed except for buildings that are considered critical by UC Davis. Lead/lag systems are desired for systems requiring 10 HP compressors/pumps and larger (i.e., split 1- 10 HP compressor/pump into 2- 5 HP or 2- 7.5 HP lead/lag compressor/pumps).

P2 Provide intercooled and aftercooled, 2 stage compressors/ pumps for all systems 5 HP and larger.

P3 Do not reject compressor heat into the chilled water system.

P4 Do not provide once through cooling water systems.

P5 Heat recovery into DHW or runaround systems

MECHANICAL/ELECTRICAL

Q1 All motors 1 HP and over that are used at least 1,000 hours per year are to be premium efficiency per requirements NEMA MG-1, Table 12-6D Nominal Efficiency for ODP and TEFC Motors:

<table>
<thead>
<tr>
<th>HP</th>
<th>eff</th>
<th>HP</th>
<th>eff</th>
<th>HP</th>
<th>eff</th>
<th>HP</th>
<th>eff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85.5</td>
<td>5</td>
<td>89.5</td>
<td>20</td>
<td>92.4</td>
<td>50</td>
<td>94.1</td>
</tr>
<tr>
<td>1.5</td>
<td>86.5</td>
<td>7.5</td>
<td>91.0</td>
<td>25</td>
<td>93.6</td>
<td>60</td>
<td>94.5</td>
</tr>
<tr>
<td>2</td>
<td>86.5</td>
<td>10</td>
<td>91.0</td>
<td>30</td>
<td>93.6</td>
<td>75</td>
<td>95.0</td>
</tr>
<tr>
<td>3</td>
<td>89.5</td>
<td>15</td>
<td>92.4</td>
<td>40</td>
<td>94.1</td>
<td>100</td>
<td>95.4</td>
</tr>
</tbody>
</table>

Q2 No shaded pole motors on fractional horsepower motors 1/20 HP and larger.

Q3 For variable frequency drives (VFD’s) provide adequate protection from current harmonic distortion, typically a 3 percent input line filter or isolation transformer.
Q4 For rooms that are provided with dedicated air handlers (e.g., lecture halls, gymnasiums etc.), provide occupancy sensor control of fluorescent lighting systems and air handlers. For small air handlers, cycle fan to maintain thermostat setpoint when not occupied. For larger air handlers, set fan to low speed (approximately 20 Hz) when not occupied.

Q5 For intermittently occupied spaces with their own air handlers (e.g., lecture halls and gymnasiums), provide ASHRAE 62-1989 approved demand ventilation control of outside air dampers. If CO2 sensors are used, then modulate OSA dampers to maintain 600 to 700 ppm of CO2 during occupied periods. The minimum OSA rate is to be 0.15 cfm/person during occupied periods. The maximum OSA rate is to be 100%.

Q6 Provide power factor correction at MCC's or motors

Q7 Provide proper K-rated transformers

Q8 Provide 80 C or 115 C rise transformers (interior, dry type, natural convection)

Q9 Provide Pipe all grease fittings to locations that can be easily maintained

Q10 Shaft grounding of motors

GLAZING

Use appropriate glazing systems to minimize reflected glare to adjacent buildings or public areas. The use of projections and roof overhangs is recommended over windows in sunny locations (especially south and west orientations). The length of the projection shall be calculated to provide solar gain in winter and shading in the summer. Horizontal shutters, fixed awnings or other architectural devices may also provide this function.

LIGHTING

Fluorescent fixtures equipped with energy saving lamps and ballasts.
The University's Representative must approve in writing the use of incandescent fixtures. Zone lighting or task lighting shall be utilized whenever energy efficiency can be improved by these measures.

INTERIOR LIGHTING

R1 Lighting levels for campus spaces are based on IES standards. If not shown below, consult IES lighting handbook. Maintained lighting levels are to be designed as follows:

<table>
<thead>
<tr>
<th>Type of Occupancy</th>
<th>Illumination Level in Foot-Candles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td></td>
</tr>
<tr>
<td>Assembly Only</td>
<td>15</td>
</tr>
<tr>
<td>Study Hall</td>
<td>50</td>
</tr>
<tr>
<td>Classroom Space</td>
<td></td>
</tr>
<tr>
<td>Regular classroom work</td>
<td>50</td>
</tr>
<tr>
<td>Drafting rooms (manual)</td>
<td>100</td>
</tr>
<tr>
<td>Corridors (see also- Emergency)</td>
<td></td>
</tr>
<tr>
<td>Office, Classroom Buildings Intersections</td>
<td>10** 20</td>
</tr>
</tbody>
</table>
Student Housing .................................................. 10**

Dormitory Rooms
Prolonged Study .................................................. 50
Lounge/Lobbies ................................................... 10
Kitchen (w/o task light) ........................................ 50
Kitchen (with task light) .................................... 30

Emergency Lighting
Corridors ............................................................. 1 min, 3 ave, 10 max **
Stairwells ............................................................. 1 min, 3 ave, 10 max **

Gymnasiums
Assembly ............................................................. 15
Recreation, Practice ............................................. 30**
Exhibits, Matches ............................................... 50**
Kitchen, Commercial ......................................... 75

Laboratories
General .................................................................... 65
Close Work (task lighting) ..................................... 100

Lecture Rooms
General ............................................................... 35
Special, Demonstration, Exhibit (task lighting) ....... 100
Chalkboards, Markerboards (task lighting) .......... 100

Libraries
Reading Rooms, Carrels ........................................ 50
Stacks (active) ...................................................... 20*
Book Repair and Bindings ................................... 50
Check in and out, catalogs, card files ................... 50

Lounges
Study (with task light) .......................................... 30
Study (w/o task light) ........................................... 50
Non-Study ........................................................... 20

Offices
Designing, detailed drafting (task lighting) .......... 100
Accounting, bookkeeping, business machines ....... 50
General, reading, transcribing, filing, mail sorting ... 50
General (w/ task lighting and user coordination) .... 30
Computer Rooms (VDT's) ...................................... 30 - 50 ***
Conference Rooms ............................................... 30

Recreation
Basketball (regulation) ........................................... 50**
Basketball (recreation) ........................................... 30**
Restrooms ............................................................. 15**
Service Areas (Mechanical, Electrical Rooms) ...... 20**
Stairwells (see also- Emergency) ......................... 10**
* vertical FC at a work plane height of 30"
** work plane height of 0"
*** see IES standard RP-24

R2 All general lighting fixtures to include high efficacy F32T8 lamps and electronic ballasts where applicable. Suggested minimum ballast product quality requirements are:
- Ballast shall have a 3 year manufacturer's warranty and shall have been on the commercial market for a minimum of two years.
- Ballast shall be UL listed class P and sound rated A.
- Ballast must be instant start and parallel wired, solid state, not hybrid.
- Ballast shall maintain light regulation of +/- 10 percent with +/- 10 percent input voltage variation.
- Current total harmonic distortion shall be less than 10 percent.
- Flicker shall be 15 percent or less with any lamp suitable for the ballast.
- Ballast shall be designed to withstand line transients per IEEE 587, category A.
- Ballast shall operate at 20 kHz or greater.

R3 Specify 3500 kelvin for F32T8 lamp color. If color rendering is important consider specifying a minimum CRI of 80.

R4 Emergency EXIT signs are to be the LED type. Maximum wattage per sign shall be less than 7 watts and the minimum warranty shall be 5 years. Signs are to be painted white and use green LED’s.

R5 The use of standard incandescent lighting (e.g., A-lamps, R-40’s, PAR-38’s etc.) shall be minimized (including closets). If a high color rendering lamp or point source of light is necessary, consider the use of 130-volt halogen lamps. Wherever appropriate, the use of hard-wired compact fluorescent shall be maximized.

R6 In rooms where incandescent lighting and fluorescent lighting are provided for different uses, provide an interlock so that only one type of light source can be used at one time.

R7 Occupancy sensors are to be provided in all common bathrooms (2 water closets or more with connected load of 150 watts or more) lecture halls and classrooms. Specify ceiling mounted, ultrasonic type sensors. Locate sensors so that they will “see” inside bathroom stalls, but will not “see” outside the room. Provide standard wall switches in classrooms and in bathrooms that have windows so that the lights may be turned off manually. Light switches are not required in bathrooms with no windows. In bathrooms, provide 1-PL fixture near door that is not controlled by the occupancy sensor but is controlled only by the switch.

R8 For buildings that utilize DDC for HVAC control, integrate the Title 24 required light sweeping system into the DDC controls system, where feasible.

R9 In enclosed stairwells, provide adequate day-lighting for emergency egress if possible and put any stairwell lighting on photocell control.

R10 Maximize use of 3 and 4 lamp ballasts

R11 Wall mounted occupancy sensors in private offices

R12 15 minute twist timer for bulletin board lighting
R13  4 hour twist timer for janitor closets

EXTERIOR LIGHTING
S1  In general, all exterior lighting is to be high-pressure sodium. Metal halide is acceptable if good color rendition is necessary. Fluorescent or compact fluorescent is acceptable for small areas.
S2  Provide two switched conductors to each exterior fixture. One switched conductor is to be on a timeclock, (dusk to 11 PM), the other switched conductor is to be on photocell (dusk to dawn) or astronomic clock. Conductors should be located such that any fixture can be changed from one conductor to the other with minimal effort.

EMERGENCY POWER
T1  Design system for load shedding capabilities
T2  Autostart and transfer generator using EMCS system
T3  Emergency generator alarms shall be interfaced with the campus remote monitoring system.