

**\*\* DRAFT \*\***

**GUIDELINES**

**For the  
Design and Construction of Classrooms,  
Conference and Seminar Rooms,  
and other Presentation Spaces**

**at the**

**UNIVERSITY OF CALIFORNIA,  
SANTA CRUZ**

**April 2012**

UCSC Learning Technologies  
UCSC Physical Planning & Construction

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## INTRODUCTION

These guidelines have been developed for use by architects, engineers and designers as a tool for designing effective classrooms, conference and seminar rooms, videoconference rooms and other presentation spaces for the UCSC campus. They provide specific criteria for the design of new presentation spaces and alterations to existing presentation spaces, and as a means to evaluate the potential success of these alterations.

The Classroom Subcommittee approved the Classroom Guidelines on \_\_\_\_\_ and the Advisory Committee for Facilities (AFC) approved the final Classroom Guidelines on \_\_\_\_\_.

These guidelines are intended to help create a dialog during the early planning process and assist in determining the most important criteria that should be addressed during classroom design. They are not intended to establish rigid standards for the design, construction, and renovation of classrooms, nor are these guidelines intended to be a substitute for the development of specific program requirements.

These guidelines are meant to supplement the UCSC Campus Standards Handbook. For items not specifically addressed in these guidelines, the UCSC Campus Standards Handbook must be consulted.

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# **I. General Classroom Characteristics**

## **A. Types of Classrooms**

For the purposes of this document, classrooms and other presentation spaces are divided into four types:

- General purpose classrooms seating up to about 75 students.
- Large classrooms and lecture halls seating more than approximately 75 students.
- Special purpose classrooms including Computing Classrooms and classrooms for Distance Education.
- Conference and seminar rooms.

Specific characteristics of each type of room will be addressed in subsequent sections.

## **B. Locations of Classrooms**

- Classrooms should be located for easy access by students and equipment.
- Classrooms should be concentrated on the lower floors of buildings.
- The uses of adjacent spaces should be carefully chosen to avoid distracting noises and sounds. Classrooms should not be adjacent to mail rooms, reception areas, dining facilities, rest rooms, bicycle parking, loading docks, vending machines, elevators, mechanical equipment rooms and other similar noise-producing areas. Classroom walls should be designed to prevent sound intrusion from adjacent spaces.

## **C. Doorways, Corridors, and Traffic Flow near Classrooms**

- The flow of students should be the main factor in determining the size and location of classroom entrances. Building codes should not be the only criteria.
- The design of entrances, exits, stairs, corridors, and exterior paths should take into account the increased flow of between-class student traffic.
- Noise intrusion from corridors into the presentation spaces should be minimized.
- Where possible, classroom doors should be located at the sides and rear of the classroom rather than at the front so that students entering and exiting do not disrupt instruction.

## D. Classroom Dimensions and Orientation

### 1. Room Shape:

- Where possible, classrooms should be sized in a 2:3 or 3:4 width-to-length ratio. Excessively deep or wide classrooms should be avoided.
- Care should be taken to ensure that most seating falls within optimal viewing areas for projected images. The optimal viewing area for a given image lies within a 45 degree angle of the centerline of the projection screen.

### 2. Ceiling Height:

- The minimum ceiling height must accommodate appropriately sized projection screens placed high enough to allow viewing by students seated in the back of the room. The bottom of each screen should be at least 4 feet above the floor. See the chart below for common screen sizes and minimum ceiling heights.

Distance to Last Row of Seats	Minimum Screen Size (16:10 Aspect Ratio)	Minimum Ceiling Height
up to 15 feet	48" W x 30" H	8 feet
15-20 feet	70" W x 40" H	8 feet
20-25 feet	80" W x 50" H	8 feet
25-30 feet	96" W x 60" H	9 feet
30-35 feet	112" W x 70" H	10 feet
35-40 feet	128" W x 80" H	11 feet
40-45 feet	12' W x 7.5' H	11.5 feet
45-50 feet	13.5' W x 8.5' H	12.5 feet
50-55 feet	14.5' W x 9' H	13 feet
55-60 feet	16' W x 10' H	14 feet
60-70 feet	19' W x 12' H	16 feet
70-80 feet	22' W x 14' H	18 feet

Note: In large classrooms with projection booths, the top of the screens should be at approximately the same height as the projectors in the booth to prevent keystone distortion of the image.

### **3. Seating Distance:**

The front row of seats should be neither too far from nor too close to the projection screens. The front row of seats should not be so close as to require a viewing angle of more than 35 degrees from horizontal to see the top of the screen. Use the following guideline when calculating the distance from the projection screen to the first row of seats:

$$\text{Minimum distance to front row} = 2 \times \text{screen height}$$

For example, in a room with 6 foot image height the minimum distance to the front row should be 12 feet. Large classrooms with demonstration benches or rooms with large projection images will require greater distances from the screen to the first row of seating.

### **4. Teaching Area:**

The area where the instructor stands should be level with or below the area where students are seated. Raised platforms cause sight line problems and should be avoided whenever possible.

## **E. Doors**

- Where possible, doors should be located toward the rear of the classroom to minimize disruptions. Students should not enter at the front of the room as it interferes with instruction.
- Doors should have tinted view ports so people can see out before opening the door. Tinting will minimize light intrusion into the room.
- The use of an entry vestibule is desirable to control external noises as well as prevent daylight from spilling into the classroom during presentations.

## **F. Windows**

- Windows should have durable, easily operated treatments to allow darkening the room for presentations.
- In larger rooms, if windows are present, window treatments should be motorized, with low-voltage control interfaces to allow control via classroom media control systems.

## **G. Architectural Finishes and General Guidelines**

Architectural materials specified should be chosen primarily with durability, maintainability, and acoustical properties in mind.

## **H. Furniture**

- All fixed furniture (platforms, tables, fixed seating, etc.) should be permanently attached to the floor. All furniture should be selected for durability and be of a brand, model, and color that permits efficient repair, exchange, and replacement.
- All fixtures, cabinets, table and counter tops, and furniture should be covered with high pressure plastic laminate, unless selected surfaces must match existing materials in the room.
- Where required, an inventory of existing furniture and their proposed reuse shall be identified and spaces designed to accommodate this reuse.

## **I. Paint**

- UCSC Campus Standard colors must be used for all painted surfaces.
- Low VOC (Volatile Organic Compounds) paints shall be used. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. The quantities and types of low VOCs shall be documented in the Indoor Air Quality categories of LEED NC (New Construction) and CI (Commercial Interiors) submittals.

## **J. Carpet:**

Floor carpet should be cut-pile, stain resistant, low-static carpet of the best institutional quality. Glue-down carpet or carpet tiles are acceptable. Carpet tiles are less desirable but allow selective replacement in high traffic areas. Carpet pads should not be used.

## **K. Acoustical Requirements**

Some sound absorption is desired in all classrooms, regardless of size. All rooms should have sufficient acoustical treatment for the size, shape and intended use of the room. Acoustical treatment should be distributed fairly evenly throughout the room, and should be sufficient to keep reverberation time below 0.9 seconds at 500 Hz. In general, larger rooms will require more specialized design to meet acoustical needs.

An acoustical engineer must be consulted for the design of large classrooms and lecture halls. In addition, small specialty classrooms, such as videoconferencing rooms or similar media intensive rooms, often have special surface treatment needs that may require design and review by an acoustical engineer.

## **L. Projection Screens**

- All classroom screens should have motorized enclosures recessed in ceilings, and have tab-tensioned fabric with matte white surfaces and opaque backing. Screen controls should include low-voltage interfaces to allow control via classroom media systems (contact closure, IP control or serial interfaces are acceptable).
- Screens should be positioned so that instructors can use part of the whiteboard while using the screen.

- Rooms of more than approximately 75 to 90 seats should have three screens.
- Screens should have toggle or maintain-type switches with limit switches on the screen motors. This frees the instructor from having to hold the switch the entire time the screen is moving.
- All screens should be 16:10 format.
- The lower edge of each screen should be at least four feet from the floor.
- Minimum image height should be 1/6 (one sixth) the distance to the farthest seat.

## **M. Whiteboards**

- All classrooms should have whiteboards across the front of the room. In larger rooms tiered sections are desirable.
- In all classrooms, whiteboard space should be provided that can be used when the projection screen is down and in use. The projection screen should be positioned so that one contiguous whiteboard section of at least eight feet in length is available when the screen is down.
- Whiteboard lights should be designed to avoid light spilling onto projection screens.

## **N. Floor Space and Seating Capacity**

For the design of new classrooms, allow 20 square feet per student for preliminary planning purposes. This will allow for seating, circulation, media equipment, lecture space, and sufficient space to meet accessibility standards within each classroom.

## **O. Seats**

- Provide left-handed desks for 10% of the seats.
- Fixed seating should be upholstered to provide acoustical absorption.

## **P. Other Fixtures**

- A large, easy to read AC-powered clock is desirable. The clock should be located where it can easily be seen by the presenter.
- All classrooms should be equipped with at least one manual pencil sharpener.

## **II. Small to Mid-sized Classrooms (up to 75 seats)**

### **A. Media Fixtures**

#### **1. Media Equipment Rack:**

A wall-mounted media rack is required near the teaching area at the front of the room (fig. 1). The media rack will be provided and installed by UCSC Learning Technologies, but infrastructure for the rack should be provided as follows:

- A quad AC power outlet should be located at the rack location, preferably inside the equipment rack.
- A Work Area Outlet (WAO) with 4 jacks for data connection is needed at the rack location, preferably inside the equipment rack.
- At least one 1.25-inch EMT conduit is needed between the media rack and the projector.
- At least one 1-inch conduit is needed between the media rack and each loudspeaker location.
- At least one 1-inch conduit is needed from the media rack to the Assistive Listening Device transmitter location.
- All media circuits should share the same ground to avoid ground loops in the sound system.

Fig. 1. Small classroom media rack on wall

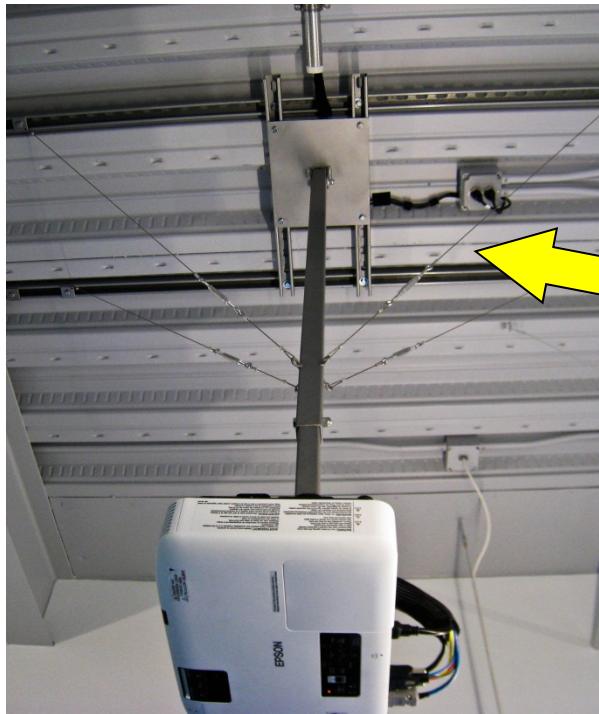


## **2. Video/Data Projectors:**

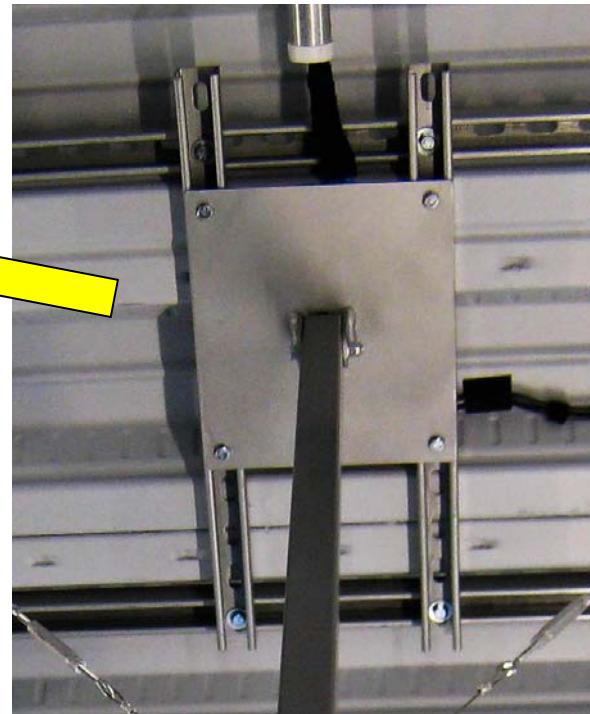
One or two ceiling mounted video/data projectors will be required, depending on size and shape of the room. Coordinate locations with Learning Technologies staff. At each video/data projector location, the following infrastructure is required:

- A quad AC power outlet
- A Work Area Outlet (WAO) with 2 jacks for data connection
- Structural support for a projector and mount weighing up to 30 pounds. Generally, two parallel pieces of unistrut, 4 to 6 feet long and 1 foot apart, mounted on the structural slab ceiling should be sufficient (fig. 2).
- A single 1.25-inch EMT conduit from the projector location to the media rack.

Fig. 2. Projector mounted to unistrut



Detail of attachment to unistrut



## **3. Loudspeakers:**

In smaller rooms not requiring voice reinforcement, provide a location for a pair of small loudspeakers on the front wall adjacent to the projection screen (one loudspeaker on each side of the screen). In larger rooms where voice reinforcement is desired, provide a location for a third loudspeaker for this purpose. This loudspeaker is typically center-mounted on the ceiling in front of the first row of seats.

**4. Assistive Listening Device (ALD):**

Provide a location for an Assistive Listening Transmitter. The location of this device is not critical but should be mounted high on a wall, preferably near the media rack.

Note: The design and location of loudspeaker systems and the ALD depend on specific requirements of each room. UCSC ITS/Learning Technologies staff can work with architects on the final design of these locations.

**B. Power Outlets**

Several AC power outlets should be located on the front wall of the room and at various locations around the room so instructors can plug in transparency projectors and other portable equipment.

**C. Floor Box**

A floor box at the teaching station with power and data connections and at least one 1.25-inch conduit to the media equipment rack is desirable.

### **III. Large Classrooms and Lecture Halls (over 75 seats)**

#### **A. General Characteristics**

Classrooms with a seating capacity greater than 75 should incorporate the following design features to aid in acoustics and viewing of instructional materials:

- Whiteboards should be divided into two or three sections. Outer sections may be angled to help reflect sound to the rear of the classroom and to reduce the acuteness of viewing angle for viewers on the opposite end of front row seats. The typical angle is 15° to 30°. Wider rooms will require greater angles for the outer whiteboards.
- The front side walls to the immediate left and right of the whiteboards may be angled to help provide useful sound reflection to the rear of the classroom.
- The ceiling surface above the whiteboard should be sloped to help reflect sound to the rear of the classroom. The required angle for reflections to the rear of the classroom may be created with a saw-toothed surface rather than with an unbroken planar surface.
- In large classrooms with projection booths, the top of the screens should be at about the same height as the projectors in the booth to prevent keystone distortion of the image.
- Acoustical treatment should be sufficient to maintain reverberation times below 0.9 seconds at 500 Hz. Acoustical treatments should be distributed fairly evenly around the room. Acoustically “live” and “dead” zones should be avoided.
- Ceilings should be acoustically nonabsorbent.
- The front portion of the room’s ceiling should be sloped to assist in projecting early sound reflections to rear seats.
- Fixed seating is suggested. Fixed seating enables the use of a sloped floor and/or risers toward the rear of the room, allows more seating per assignable square foot and provides improved sight lines.
- If a flat floor is dictated by physical or budgetary constraints, rear risers should be installed. If only a one-step riser height is possible, this should be broken up into two or three smaller steps spread across several rows.
- When fixed seating is used, it should be upholstered for acoustical absorption. The floor surface under the seating should have a hard finish such as sealed concrete or sheet vinyl. Side aisles should be floor carpeted for acoustical damping and reverberation control.

## B. Infrastructure for Media

Rooms above approximately 75 seats will include a lectern, a media rack and loudspeakers (to be provided and installed by UCSC Learning Technologies). The media rack will be located in a closet or projection booth. Infrastructure needed for this media equipment should be provided as follows:

- At least two 2-inch EMT conduits are needed between the lectern and the media equipment rack.
- At least two 1.25-inch EMT conduits are needed between the media rack and each projector.
- At least one 1-inch conduit is needed between the media rack and each loudspeaker location.
- At least one 1-inch conduit is needed between the media rack and the Assistive Listening Device (ALD) transmitter location.
- At least one 1-inch conduit from the media rack to the location of low voltage light and screen controls is needed to facilitate control of that equipment by the media system.
- The media equipment rack should have its own dedicated AC circuit.
- The lectern should have its own dedicated AC circuit.
- All audio, video, and control electrical circuits should be fed from "clean" legs from the transformer free of high inductive loads. There should be no elevator motors, compressor motors, blower motors, etc. on the side of the power transformer that feeds the media equipment.
- Adequate structural support is needed at loudspeaker locations.
- Adequate structural support is needed at locations of data projectors.
- Adequate structural support is needed at locations of flat-screen monitors, if required.
- Design and location of loudspeakers and ALD depend on specific requirements of each room. UCSC ITS/Learning Technologies staff will work with the architect on final design of these locations.

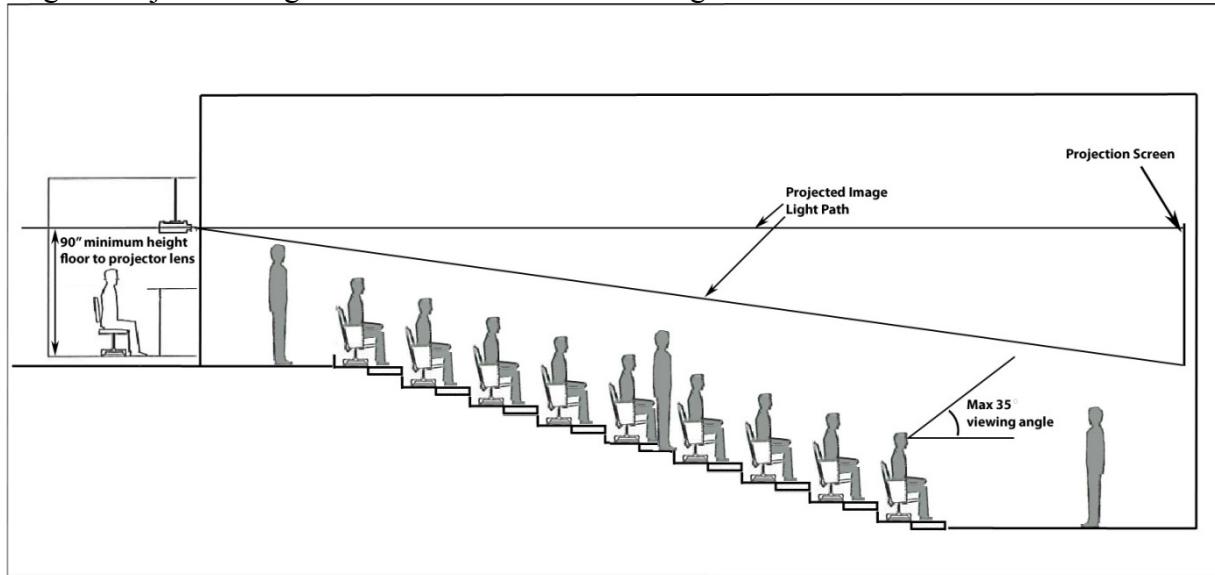
## C. Classroom Projection Booths

Larger classrooms require a booth in the rear of the room to house video/data projectors, portable projectors as needed, a rack containing media equipment and associated items. The projection booth provides an area separate from the classroom that isolates projector noise, facilitates equipment operation and maintenance without interrupting classes and provides a secure location for valuable equipment. Because of its limited size, careful design of the projection room is critical to efficient use of this space.

### 1. General Booth Design Criteria

- a. The projection booth should be adequately sized for its intended use. Width should allow all projectors to be on centerlines of their respective screens. Depth should be sufficient to allow workers to move about and access equipment without interfering with normal operation. Projection equipment will be located adjacent to the window into the classroom, so space should be provided behind the projectors for operation and maintenance staff to work.
- b. To minimize light intrusion, the projection booth door should not open to the exterior of the building, nor should it be positioned in such a way as to allow sunlight to enter the booth and classroom.
- c. A single projection window shall be installed providing good visibility for the operator and flexible locations for the projectors.
  - The glass should be optical quality or select water white seamless glass, without any visual imperfections. The single layer of glass should be installed with gasket seals to help control sound between booth and audience. The use of double pane glass is not acceptable.
  - The window should be as high and as wide as practical. The window must be wide enough to allow for projection on the perpendicular centerlines of each screen. The window should be set high enough to enable the projected images to pass over the heads of the audience including students walking in front of the booth at the back of the classroom (fig. 3).
  - To prevent acoustical reverberation in the classroom, the glass should be tilted. If the front of the glass (audience side) can be cleaned without special equipment, then the top of the glass should tilt into the booth.

Fig. 3. Projected image relative to screen and viewing audience



- d. The booth lighting system should be capable of providing dimmable work lights to illuminate the work space during programs and a high illumination level during maintenance and set-up. This may require separate lighting systems.
- e. Space shall be provided in a convenient maintenance location for a media equipment rack. The rack should be positioned to allow maintenance access to the rear of the equipment.
- f. The projection booth floor, window and counter height should be designed to allow easy operation of equipment, viewing of lecture area and quick movement of people and carts from one part of booth to another.
- g. Video/data projectors should be mounted in the projection booth rather than the classroom in order to isolate noise, facilitate maintenance access and provide increased security against theft and vandalism. Video/data projectors should be mounted to the booth ceiling on the perpendicular center lines of their respective screens.
- h. Each projector location should be provided with a quad AC receptacle capable of providing up to 1000 watts of power.
- i. Counter space 30 inches deep should be provided along the full length of the window. The counter should be able to support portable items weighing up to 50 pounds. Electrical outlets should be provided at or just above counter height every 6 inches along the full length of the counter.

- j. Storage space should be provided for miscellaneous equipment, spare lamps, cables and supplies.
- k. A fire extinguisher should be installed as approved by the UCSC Campus Fire Marshal.
- l. A pass-through opening should be provided between the booth and the classroom to allow the passage of cables during special events. This opening should be equipped with doors at both ends. The door on the classroom end should be lockable.

## **IV. Special Purpose Classrooms**

While most classrooms adequately serve the general pedagogical needs of the campus, some types of instruction require special facilities that address unique needs. These special purpose classrooms include those used for computer-based instruction and those used for videoconferencing-based distance learning. These classrooms have specific needs in addition to those addressed elsewhere in this document.

### **A. Computing Classrooms**

Computing classrooms are teaching spaces with a large installation of computers such that each student has a computer for use in the class. These classrooms can range from what look like traditional classrooms with rows of student computers to highly flexible collaborative spaces where almost nothing in the room is fixed.

The design requirements for computing classrooms often vary significantly depending upon the pedagogical approach and other factors the room is intended to support. The following are a series of standards and areas for consideration in designing or remodeling a computing classroom.

#### **1. General Room Requirements:**

- A ground floor location is preferred
- Access from the building exterior is strongly preferred
- If access to the room is from the interior of the building only, the building must be accessible during open hours (may be 24/7)
- Air conditioning may be needed (sufficient to maintain 72°F during use)
- Enhanced sound control is desirable, including carpet and acoustical ceilings
- Computer-lab-rated carpeting (28 oz., 1.8 kv) is desired for acoustics and dust control
- Exposed structural beams should have soundproofing installed
- No sinks, restroom or other sources of water should exist in the room

#### **2. Media Equipment:**

- One or more ceiling-mounted projectors (with structural support, electricity and network outlets in ceiling)
- A media presentation system including wireless microphones, loudspeakers, control system, instructor's workstations, etc.

#### **3. Lighting:**

- Separate lighting controls are needed at teaching, workstation, and consultant areas
- An independent light source is needed for the consultant area
- The ability to completely darken the room is required.

#### **4. Furniture And Room Layout:**

The type and layout of the furniture has a major impact on the usability of the room for its intended purpose. Requirements for desks, chairs and other furniture may vary widely depending on the needs of a particular space. Furniture must be selected for the specific room in consultation with the service providers for the computing classroom.

For a row-based layout the following standards apply:

- Wheelchair accessible (see Wheelchair Accessibility below)
- Projection screen(s) mounted on the front wall (screens should not block the whiteboard)
- a large whiteboard on the front wall
- An instructor station at front, with a minimum 5 feet from the white board to the front row of computers
- An area for a consultant, near the wall, adjacent to an entry door with clear view of the entire room
- space for a printer in a non-disruptive area with sufficient room and placement to accommodate traffic flow to and from the printer
- 4 feet between fronts and backs of tables (when aisles between rows face the same direction)
- 5 feet between tables back-to-back (when aisles between rows face away from each other)
- 3.5 feet of lateral workspace per station
- Table rows should be no longer than 12 feet
- 5 feet width of main aisles

## **5. Wheelchair Accessibility**

For public areas with fixed seating or workstations, at least 5% (but not less than one) must meet the requirements for wheelchair accessibility. For a computing classroom, that would mean the following:

- The height of the table or counter is between 28 inches and 34 inches from the floor.
- The knee clearance under the table or counter is at least 27 inches high, 30 inches wide and 19 inches deep.
- There is a minimum clear space of 30 inches x 48 inches at the workstation for the wheelchair user to maneuver.
- The workstation adjoins an accessible route (typically an aisle that is at least 36 inches wide).

## **6. Chairs**

Requirements may vary, but generally chairs should be ergonomic, height-adjustable via a lever (not via rotation), non-reclining, with casters

## **7. Electrical Power:**

- At least 2.5 outlets per workstation (to accommodate peripherals)
- Conduits run in tables if necessary (no power strips)
- Power requirements per workstation (CPU + monitor):

- Startup: 390 W
- Continuous: 165W

## **8. Network/wiring**

- Gigabit Ethernet (twisted pair category 6 wiring) to each workstation
- 1.5 jacks per workstation to accommodate additional equipment and changes in room layout
- Wireless network coverage in all of the room

## **9. Security:**

- An intrusion alarm system connected to campus dispatch with a perimeter alarm (doors and windows) and motion detectors.
- Electronic locks on main door
- If there are doors other than the main electronically locked door, they should be easily securable by student employees with minimal training required.

## **B. Videoconference Classrooms**

The goal of a videoconferencing classroom is to enable students and instructors at two locations separated by distance to share the same experience as if they were all in the same room.

Effectively achieving this goal requires careful design of both classrooms with an eye toward transmitting sound and images that are as realistic as possible while minimizing distracting noises, echoes and reverberation.

Ambient sound and noise control is essential. Application of acoustically absorbent treatments is a required component of a successful videoconference classroom. Noise intrusion and room reverberation must be kept to a minimum. Careful design to achieve acceptable reverberation and ambient noise control should be coordinated with representatives of UCSC Learning Technologies.

In addition to the typical array of classroom media equipment, a videoconference classroom includes the following features:

- Tables with chairs.
- Far-end displays: Large flat-panel displays show people at the far end of the conference. This can be either the instructor or the students, depending on where the instructor is. One display is placed at the front of the classroom for students to view, and another is placed at the rear for the instructor to view. While sizing the display to make the images appear life-size is not practical, larger displays will enhance effective interaction between instructors and students.
- Main display: The main display will usually show course materials at both sites, such as a computer display or document camera.

- Enhanced lighting control: In addition to the usual lighting controls, lighting the instructor for good viewing by cameras is necessary. Careful design of the instructor lighting will enhance camera images without disturbing the instructor with glare from the lights.
- Microphones: Placement of microphones must be designed to effectively pick up the instructor's voice and student questions and comments. The instructor microphone (in addition to a wireless lapel microphone) is typically ceiling-mounted in the teaching area. The student microphones are typically table-mounted (one for each student or pair of students).
- Control room: A control room at the rear of the classroom is required. This control room should be accessible without having to go through the classroom. A window with shades or drapes between the control room and the classroom is necessary. The control room should be quiet so that the operator can adequately hear and adjust the sounds being transmitted and received. Design of the control room should prevent light from intruding into the classroom.

## V. Conference and Seminar Room Characteristics

Experience shows that UCSC departments will probably install media equipment in many conference rooms shortly after building construction is complete. Installing infrastructure to support that equipment during construction allows for a much cleaner and less costly finished product than retrofitting it later. With this in mind, the following features should be installed in all conference rooms during construction:

- At least one (1) 8 foot x 4 foot white board (or provision for one to be added later).
- Power and data outlets on all walls.
- At the likely future location for a ceiling-mounted video projector, provide the following:
  - a quad power outlet sufficient to provide up to 1000 watts of power
  - a data jack
  - structural support for a projector weighing up to 30 pounds. Two parallel pieces of unistrut 12-16 inches apart and 4-6 feet long are adequate for structural support.  
Coordinate the design and location with Learning Technologies staff.
- A pull-down or electric projection screen (or provision for one to be added later). Electric screens are preferred for durability. Coordinate the location with Learning Technologies staff.
- At the location for a small wall mounted media control panel, provide
  - a recessed 4-gang electrical box to house a media controller
  - a single 1-inch conduit to the projector location.  
Coordinate the location for the media controller and projector with Learning Technologies staff.
- A floor box in the center of the room with at least two power and data jacks for table use.
- Lighting should be designed to minimize spillage on the projection screen. Ambient light on projection screen should not exceed 5 foot-candles.
- If the room will be used for videoconferencing, acoustically absorbing materials on walls and ceiling to minimize reverberation should be provided. Dimmable angled ceiling lighting fixtures should also be provided to illuminate attendees for the camera while keeping light off the projection screen.

## **VI. Classroom Mechanical Systems**

### **A. Heating, Ventilating & Air Conditioning (HVAC)**

1. Air handlers (including heating and ventilating units) serving classrooms shall be equipped with economizer cycle controls to allow for cooling with outdoor air.
2. All classroom HVAC systems shall be designed to provide outdoor air for ventilation as called out in ASHRAE Standard 62.1-2010; "Ventilation for Acceptable Indoor Air Quality" and CAC Title 24, Part 6. In cases where the two standards differ the more stringent shall be followed.
3. Classroom thermostats shall be equipped with tamper-proof covers.
4. Start / stop control of classroom HVAC systems shall be provided by the campus Building Management System controlled from the Central Heat Plant. The system will allow the HVAC schedule to be custom adjusted to match the occupied class schedule, which varies by quarter.
5. Classroom systems shall use the following criteria as the basis of design:
  - a. Indoor air temperatures:

70° F (winter)  
75° F (summer, for rooms with air conditioning)

For rooms without air conditioning, provide a ventilation rate sufficient to maintain the indoor temperature within 10 degrees of outdoor air temperature under summer design conditions.
  - b. Outdoor air temperatures:

32° F (winter)  
88° F (summer dry bulb)  
66° F (mean coincidence summer wet bulb)
6. Diffuser locations shall be selected to distribute supply air uniformly in the classroom at occupant level velocities as recommended by applicable ASHRAE design standards. Diffusers shall be selected based on design air volume and a maximum sound rating of NC-25. Supply diffusers shall be equipped with opposed blade dampers. Balancing dampers shall be provided at duct work branch connections. For large lecture halls, under floor distribution for displacement ventilation should be considered. Diffusers for underfloor systems shall be designed so as to not collect debris and for also for easy custodial cleaning.
7. Projection booths should be equipped with separate HVAC systems or zoned

independently of the classroom.

8. Classroom HVAC systems shall not produce room noise in excess of NC-25 (LEED NC\_2009\_45dBA).<sup>1</sup>
9. For small classrooms, ventilation may be enhanced by windows that open. Air movement may be desirable to avoid the feeling of air stagnation in a completely enclosed room.
10. In areas where heat-generating media equipment will be located, such as projection booths, media equipment closets and cabinets, ventilation and/or cooling must be provided to lengthen the life of the equipment. Areas requiring 24/7 cooling for electronic equipment such as media equipment and server rooms should be provided with standalone HVAC (typically split system Dx cooling).
11. Santa Cruz has a mild summer climate. In general, most cooling loads can be accommodated through the use of outdoor air ventilation. The use of air (refrigeration cycle cooling) conditioning is discouraged for most applications on the UCSC campus. In situations where meeting the design cooling load with outdoor ventilation only will either be more energy intensive or will be impractical due to high distribution velocities, oversized fans, large oversized ductwork, large air intake louvers, or high system noise, the use of air conditioning will be considered, on a case by case basis. Provide the University with considerations related to this issue early in the design process so that an informed decision can be made on including impacts to scope and budget.
12. Provide demand-controlled ventilation for all classrooms exceeding 10 people per the requirements of CAC Title 24, Part 6. Exception 1 under Section 121 (c) 3. C. for continually occupied classrooms shall not be applied. All UCSC classrooms be designed for an intermittent occupancy.
13. All classroom HVAC equipment shall be fully networked and controlled by the campus Building Management System (BMS). The BMS shall be Tridium-based matching the campus standards. The system shall provide monitoring and alarms via a graphical front end interface remotely located at the campus watch stander's station at the Fackler Cogeneration Plant. Consult UCSC for most recent standards on this system.
14. Classroom HVAC systems shall be in compliance with the most recent UCSC satiability guidelines which include: exceeding Title 24 energy standards by 30%, achieving a Leeds rating of Silver or higher and striving to minimize (net zero if possible) greenhouse

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<sup>1</sup> Noise Coefficient

- Jet takeoff (200 feet) 120 dBA Construction Site 110 dBA Intolerable Shout (5 feet) 100 dBA Heavy truck (50 feet) 90 dBA Very noisy
- Urban street 80 dBA
- Automobile interior 70 dBA Noisy Normal conversation (3 feet) 60 dBA Office, classroom 50 dBA Moderate Living room 40 dBA
- Bedroom at night 30 dBA Quiet

gas production for source energy being consumed. Innovation in this area is strongly encouraged.

## VII. Classroom Lighting Systems

### A. Guiding Concepts

Classrooms require lighting that can produce enough brightness for note-taking and reading. Lighting systems also should provide for illumination on whiteboards, demonstration areas, and other work surfaces. Control of illumination, especially control of light spillage onto the projection screen, is extremely important in rooms where media equipment is used.

Lighting fixtures and lamps should be specified for minimum light intrusion onto projection screens and for energy efficiency, low heat generation, and easy maintenance. General guidelines for the selection of light fixtures include the use of recessed lamps in sharp-cutoff luminaires to provide controlled lighting with minimal light spill on projection screens and to avoid shining light directly in the viewers' eyes. The use of incandescent lamps should be minimized to reduce maintenance, conserve energy, and reduce heat generation.

The fixtures near the front of the room still must have the capability to be turned completely off to darken the area around the projection screen.

### B. General Requirements

1. All lighting controls should be clustered, clearly labeled and simple to use. Lighting controls should not be overly complex (fig. 4).
2. Lighting controls should be conveniently located at the front of the room near the teaching station and in the projection booth (if provided).
3. Aisle lights should be provided for safety.
4. All fluorescent light fixtures should have electronic ballasts for noise control.
5. Dimmers must not hum or inject electrical noise into audio systems.
6. Lighting controls should be placed at every entrance to control enough lights so that instructors can see to cross the room to the main switches.
7. For classrooms with entrance vestibules, the switches should be inside the classroom itself, not in the vestibule.

### C. Lighting Zones

All classrooms should have lighting zones as follows:

1. One zone should control the classroom's general-use fluorescent lights to provide full brightness for general activities without spilling on projection screen.
2. One zone should control low level lights for note taking. These lights should not shine on the screens.
3. One zone should control whiteboard lights to illuminate the writing surface at the front of the room. In rooms with multiple screens, whiteboard lights above each screen should be separately controllable.

4. The instructor should be able to completely darken the room for presentations.
5. Optionally, a zone can control spotlights that highlight the instructor and demonstration area. This zone can be further divided into two zones, one for the instructor's area and one for the demonstration area.

## D. Lighting Levels

Classroom lighting should generally provide the following lighting levels:

- Full Lighting: **25-50 Foot-Candles**
- Note-Taking Lighting: **2 Foot-Candles at the Desktop**

## E. Controls

- Lighting controls should be grouped in the same area with screen and media controls near the teaching station.
- Low voltages interfaces should be provided to allow control from the media system.
- Controls should be positioned in compliance with accessibility standards.
- If the room is equipped with a projection booth, all these functions should also be duplicated in the booth.

Fig. 4 Lighting Control examples

### Good Controls:

This panel presents the instructor with a simple set of choices.



### Bad Controls:

This panel presents the instructor with an overly complex array of choices.



## **VIII. Classroom Electrical Systems**

All electrical equipment, including contactors, lighting fixtures, dimmers, etc., should be of selected brands, models, and specifications to conform to campus standards (see UCSC Campus Standards Handbook).

### **A. Conduit**

1. All conduit should be of continuous EMT, electrical metallic tubing (conduit) type material where possible.
2. In areas and situations where EMT is not possible, junction boxes or flexible conduit should be installed only by prior approval of the University Building Official.
3. Junction boxes should not be located in hidden or inaccessible corners.
4. All conduit should be at least  $\frac{3}{4}$  inch inside diameter or larger. Larger conduit is generally installed to ensure space for future expansion.
5. Low voltage cables (e.g. audio, video, and control cables) are all required to run in a separate conduit from any AC wiring.
6. All conduit and electrical circuits should have the same ground reference.

### **B. Circuits**

1. All circuits powering audio, video, and control electronics should be fed from "clean" legs from the transformer free of high inductive loads. There should be no elevator motors, compressor motors, blower motors, etc. on the side of the power transformer that feeds the media equipment.
2. All electrical control circuits should come to a single location.
  - This location should be large enough for the lighting contactor cabinet.
  - The location should be convenient for maintenance and secure from vandalism.
  - If possible this location should be isolated from the classroom to eliminate repair and contactor noise.
3. Utility AC outlets on separate circuits from the media equipment should be provided inside the classroom for overhead projectors, portable media equipment, laptop computers, vacuum cleaners, etc.
  - There should be at least one duplex outlet on each wall, as well as on the front, classroom side, of the projection booth.
  - In larger rooms which have fixed seating on risers, an outlet should be provided in the face of the first riser (centered in the room), and on the face of a riser midway back in the middle of seating (centered in the room).
  - There should be at least one duplex outlet approximately every ten feet along the front wall of the classroom, on the underside of any teaching tables and on any fixed lecterns.

- There should be one duplex outlet approximately 12 feet in front of the center of each projection screen for portable projection equipment. These outlets may need to be in recessed floor boxes.
  - Unless otherwise specified, power and audio/video outlets shall not be surface-mounted on the floor to avoid the intrusion of water and debris. Outlets shall be mounted on the rear stage wall and/or the front stage wall or other vertical surfaces (such as the risers of tier seating). If this is not possible, outlets should be placed in recessed floor boxes which allow covers to close flush with the floor surface when cables are connected.
  - Outlets should be distributed in the student seating area equal to 10% of the number of seats for powering assistive technologies and charging portable electronic devices.
4. A dedicated circuit with quad outlet should be provided for the media equipment, in a location coordinated with Learning Technologies. The number and locations of outlets will increase with the size of the room. Consult Learning Technologies for specific requirements pertaining to outlet quantities for media equipment.
  5. Video Projection - Provide a quad 120V outlet in the ceiling at each video projector location.

## **IX. Classroom Signal Cabling, Cable Television, Telephone and Data Network Outlets**

### **A. Conduit Specifications for Media Wiring**

1. Conduit is required between locations of media equipment rack, the teaching station, loudspeakers, Assistive Listening Device (ALD), and each projector or other display device. Sizing will depend on media needs specific to each room and should be coordinated with Learning Technologies representatives. See earlier chapters on room characteristics for details.
  - a. In rooms above approximately 75 seats, provide a floor box at the teaching station with at least two 2 inch conduits to the media equipment rack. Provide at least two 2 inch conduits between the media equipment rack and the projectors or other display devices. Provide one inch conduits between the media equipment rack and each loudspeaker location as well as to the ALD.

### **B. Data Network Outlet Locations**

Work Area Outlets (WAO) for data network connection should be located at each of the following locations:

1. WAO with at least two jacks at each of at least two locations at the front of the classroom
2. WAO with at least two jacks at each video projector
3. WAO with at least one jack at each wireless network access point
4. WAO with at least four jacks in the projection booth
5. WAO with at least four jacks at the media equipment rack
6. WAO with at least four jacks at the lectern
7. WAO with at least two jacks on each wall of the room.

### **C. Wireless Network Access Points**

Wireless network access is required in all new classrooms. Required coverage density varies according to classroom size, usage and limitations of current wireless technology. The number and placement of wireless access points, as well as the infrastructure needed to support wireless access points, should be determined in consultation with University representatives. For further information on infrastructure for wireless network equipment, refer to Division 27 of the Campus Standards.

### **D. Telephone Network Outlet Locations**

Wall phones should be located in the following locations:

1. In the projection booth
2. The front of the room near the lighting and media equipment controls
3. The phone at the front of the room should have a handset cable long enough to reach to the lectern.

4. Phones should have switches to turn off ringers.

## **E. Cable Television (CATV)**

The University is transitioning television service to an IP delivery model. All television service in future construction will travel via the data network.

## X. Classroom Media Systems

**Note:** Classroom media presentation systems will be designed and installed by UCSC Learning Technologies, with the following exceptions:

- Projection screens are provided and installed during construction of new facilities as part of the construction contract.
- In large classrooms and lecture halls where a separate speech reinforcement system would be necessary (using either a distributed loudspeaker system or a loudspeaker array), design of the speech reinforcement system should be included in the design of the room, and installation of the loudspeakers should be considered part of the construction contract.

### A. Guiding Concepts

Instructional presentation technology is an essential, integrated part of many classes. Because new buildings will serve for many years, classrooms should be designed for flexibility, to accommodate both current technology and technology of the future.

While most classroom media equipment is generally provided by the University, provisions and infrastructure to accommodate the equipment should be considered within the overall design of the classroom. All media equipment, whether provided by the University or by contractors, should conform to the following guidelines, and to the media package specifications provided later in this document.

Projection screens should be provided with:

- a tab-tensioned, matte white surface
- a 16:10 aspect ratio
- a quiet motor
- automatic stop settings
- controls at the front of the classroom, clustered with lighting controls near the teaching area. For rooms with projection booths, controls should be placed in the booth as well.
- a low-voltage control interface to allow integration with the media control system. Acceptable interface technologies include contact closure, RS-232/422 and IP (provided a network jack is available at the screen location).

### B. Media Packages

UCSC has defined standard "Media Packages" of presentation media equipment for classrooms and other presentation spaces:

- **Media Package 1-** for conference and seminar rooms
- **Media Package 2-** for classrooms seating up to about 75 students
- **Media Package 3-** for classrooms seating more than about 75 students

Note: These are targets that have been adopted by the campus. Individual circumstances may require some modification to these specifications. Media Packages are developed and refined with the following principles in mind:

- **Ease of Use.** Media systems are designed to be intuitive and simple to use.
- **Uniformity.** Operation and layout of media systems should be consistent from classroom to classroom.
- **Self-Service Operation.** Faculty will be expected to independently use any media equipment installed in the classrooms.
- **Use of Off-The-Shelf Technology.** Equipment must be commercially available and easily interchangeable to permit maximum 'up time' of classrooms.
- **Upgradeability.** Systems must allow for future technology to be integrated as new products and concepts become available.
- **Reliability and Serviceability.** The media packages and their individual components must allow for high reliability and fast repair.

## C. Media Lectern

Large rooms containing Media Package 3 systems include a media lectern (fig. 5). The media lectern combines all items that an instructor needs to teach a class in one compact piece of furniture. The media lectern:

- Serves as a lectern and a work surface
- Includes a media control system touch panel, providing a central point of control and monitoring of the media presentation system.
- Contains media system components that are secure against theft but also easily accessible and ready for use so the instructor does not have to turn away from the audience.
- Includes folding shelves providing work areas for instructors in wheelchairs and space for the document cameras.
- Has power outlets and cables to connect an instructor's laptop computer to the media system and to the Internet.
- Includes an access hatch on the side facing the audience that provides quick and easy technician access to the rear of the media equipment for maintenance, and the inside is sufficiently deep and roomy to allow for easy connection and maintenance of equipment.
- Measures 48 inches wide by 30 inches deep.
- Sits fixed in place over a shallow open floor box, which provides access to conduits for signal cables and electrical power for its equipment. The floor box is typically 12 x 16 x

4 inches, and open on top. The media lectern bottom has a large opening to allow passage of cables.

Learning Technologies works with a particular manufacturer who has helped us develop the design and builds each piece for us. Although the pictured media lectern has an oak exterior, we can custom order whatever exterior surface is desired by the architects.

Fig. 5. Large Classroom Lectern:



## **IX. Access for Persons with Disabilities**

All classrooms must be designed to comply with:

- The latest Title 24 of the California Code of Regulations—Chapter 11, and
- American with Disabilities Act Accessibility Titles I, II and III (28 CFR Part 36 Appendix A and 28 CFR Part 35).

### **A. Access Compliance**

When designing a classroom space, consideration should be given to individuals with disabilities. Some examples include:

- Wheelchair users who need a surface on which they can write;
- Those who have service animals need a place for the animal to stay that doesn't interfere with other students' ability to get to / from their seat;
- Those who use sign language interpreters need a light setting available so they can see the interpreter during films;
- Those who use remote real-time captioning need a wireless network connection so they can see the transcript of what their instructor is saying as a remote captioner types it;
- Those who need assistive listening devices;
- Those who need handrails to negotiate any kind of step; and
- Those with some cardiopulmonary medical problems need fresh or clean recirculated air.

### **B. General Requirements**

#### **1. Seating requirements**

- In all assembly places where seating is provided, there shall be spaces for persons using wheelchairs and semi-ambulant persons.
- Accessible seating or accommodation shall be provided in a variety of locations.
- At least one companion fixed seat must be provided next to each wheelchair location.
- Each wheelchair area shall adjoin an accessible route which shall also serve as a means of egress in case of emergency.
- 1%, but no less than 1, of all fixed seats shall be aisle seats with either removable or folding armrests on the aisle side.

#### **2. Assistive listening systems and devices (ALDs)**

- Assembly areas, conference and meeting rooms shall provide ALDs for persons with hearing impairments.
- The minimum number of personal receivers required is 4% of the total number of seats, but no less than 2 seats.
- At least 25% of the receivers must be compatible with hearing aids.

- Permanent and Portable Systems. Permanent installed systems are required if:
    - The area has an audio-amplification system, AND
    - The area has fixed seating.
3. Access to instructor area
- Raised areas for instructors shall have an accessible path of travel from the classroom area.
  - All controls and operating mechanisms (e.g., switches to lower screens, operate media, etc.) shall be within the required reach ranges as detailed in Title 24 of the ADA.

## **XII. Sustainability and LEED**

### **A. Sustainability Guidelines and Principles**

Considerations must be made during the planning and design of classrooms and computer labs for students, faculty and general public based on UCSC Physical Design Framework (March 2010), UCSC Sustainability Assessment 2007 and the most current LEED rating system. The construction or alteration of any building must comply with the University of California Sustainable Practices Policy (August 2011) for New Construction, Commercial Interiors and Existing Buildings. New construction shall achieve a minimum of LEED-NC ‘Silver’ and strive to achieve certification of LEED-NC ‘Gold’ or higher.

Requirements:

1. Provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms, computer labs and conference areas) to promote their productivity, comfort & well-being.
2. Provide a high level of thermal comfort system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms, computer labs and conference areas) to promote their productivity, comfort & well-being.
3. Provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the buildings.
4. Provide classrooms that are quiet so that the teachers can speak to the class without straining their voices and students can effectively communicate with each other and the instructor.
  - a. Meet the reverberation time (RT) requirements of ANSI Standard S12.60-2002, Acoustical Performance Criteria, in all core learning spaces.
  - b. For small core learning spaces (less than 20,000 C.F) ceiling areas (excluding lights, diffusers & grilles) must have noise reduction coefficient (NRC) of 0.70 or higher. Alternatively, a combined area of ceiling and other interior surfaces equal to or less than the ceiling area (excluding lights, diffusers and grilles) must be NCR 0.07 or less.
  - c. For large core learning spaces (equal to or less than 20,000 C.F), confirm via ANSI Standard S12.60-2002 that the RT is 1.5 sec or less.
5. Reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers & occupants.

- a. Architectural paint and coating applied to interior walls and ceilings must not exceed the volatile organic compound [VOC] content limits established in Green Seal Standard GS-11, Paints, 1st Edition, 5-20-93.
- b. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2<sup>nd</sup> Edition, 1-7-97.
- c. Clear wood finishes, floor coatings, stains, primers, sealers and shellacs applied to interior elements must not exceed the VOC content limits established for those coating types in South Coast Air Quality Management District. (SCAQMD) Rule 113, Architectural Coatings, rules in effect on 1-1-04.
- d. All carpet installed in the building interior must meet the testing and product requirement of the Carpet & Rug Institute Green Label Plus Program.
- e. All carpet cushion installed in the building interior must meet the requirement the Carpet & Rug Institute Green Label program.
- f. All carpet adhesive must meet the requirement of IEQc4.: Adhesive & Sealants which includes a volatile organic compound [VOC] limit f 50 g/L.
- g. All hard surface flooring must meet the requirements of the FLOORSCORE standard (current as of the date of this rating system, or more stringent version) as shown with testing by an independent 3<sup>rd</sup> party.
- h. FLOORSCORE alternative 100% non-carpet finished flooring with FLOORSCORE certified must equal 25% of finish floor area.
- i. All flooring elements installed in the building interior must meet the testing & product requirements of the CA Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.
- j. All gypsum board, insulation, acoustical ceiling systems & wall covering installed in the building interior must meet the testing & product requirements of the CA Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.
- k. Furniture & seating must be GREENGUARD Children & Schools certified.

## **XIII. Security and Surveillance**

UCSC is currently evaluating security needs for classrooms. At a minimum, classroom entry doors should be equipped with card access locks. Consult current UCSC Campus Standards (<http://ppc.ucsc.edu/standards>) for acceptable models.

For further security information, refer to Division 28 of the Campus Standards.