TAB C-2

CAMPUS PLANNING AND URBAN DESIGN GUIDELINES

PROJECT-SPECIFIC

The Department of Campus and Facilities Planning (CFP) will provide urban planning input on facility design projects in the followings ways:

- Capital Projects

    - In coordination with Facilities Design and Construction (FDC), CFP will develop Design Guidelines for the project (e.g., massing, circulation, setbacks, etc.) and will review the project for consistency with the Comprehensive Campus plan, and/or any other applicable subarea or functional plans.

- Non-capital Projects

    - CFP will offer design input and interpretation of campus plans to A/E Consultants and FDC, but will not prepare Design Guidelines specifically for the project.

GENERAL

- The following guidelines have been derived from the University's adopted Comprehensive Campus Plan (CCP), and briefly summarize guidelines for the development of the campus, particularly where visual quality and urban design issues area concerned. Additional background on these guidelines can be found in the CCP Review Draft and Technical Background document, which is available at CFP. The Comprehensive Plan summary document may be viewed on the internet at: http://w3.arizona.edu/~cfp/ccp/ccp.htm

- The goal for campus aesthetics is to:

    ESTABLISH A SENSE OF AESTHETIC CONTINUITY CAMPUS-WIDE, BY DEVELOPING AND UTILIZING DESIGN VOCABULARIES AND GUIDELINES IN THE PRESERVATION AND REUSE OF EXISTING STRUCTURES AND OPEN SPACE AREAS, AS WELL AS IN THE DESIGN OF NEW FACILITIES AND OPEN SPACES.

- It should be noted that visual quality concerns cannot be entirely separated from Development and Infrastructure Guidelines, and that, in fact, both aesthetic and functional considerations are operative in any planning and design activity for the campus. These guidelines primarily focus, however, on the visual quality of the outdoor environment, including buildings and other structures, open spaces, and circulation routes.

BUILDINGS AND FACILITIES

- The guidelines outlined below should be employed in designing new buildings and facilities, and in reuse of and/or additions to existing buildings and facilities.

    - Orientation/Placement of Building On-site

        - The following considerations should be addressed in building siting and design: views, circulation, open space, on-site parking, future expansion, microclimate, and existing site features.

- Indoor-Outdoor Relationships

  - A more active relationship between interior and exterior space than has occurred in most existing facilities is a goal in the siting and design of new buildings and additions. This relationship is sought not only on the ground plane, but at other building levels as well.

- Scale and Massing

  - New facilities are generally becoming increasingly large and bulky. At the same time, these buildings must be compatible with existing buildings often at a smaller scale, and must be humanly scaled at the pedestrian level(s).

- Architectural Style

  - Within the Historic District, all new construction should be as compatible as possible with existing historic structures. This includes overall massing, fenestration, brickwork, and architectural detailing. The State of Arizona Historic Preservation Office will consult in any reuse of and additions to structures listed on the National Register.

  - In predominantly built-up areas already existing on campus, new construction should be architecturally compatible with the existing structures. While contemporary architectural styling is anticipated, appropriate massing, building materials, and detailing should contribute to a sense of visual unity. *Example: Pharmacy Building*

  - In new areas of campus development, (such as between Speedway and Mabel, and Sixth and Eighth Streets), a high standard of contemporary architectural excellence is required. The prevailing desert climate should have a major impact on architectural style.

- Building Materials

  - The selection of exterior building materials for permanent facilities should be based on long-term institutional durability and ease of maintenance; texture and textural variety; color palette; energy conservation considerations; cost and availability; and type and use of structure.

- Artwork and Graphics

  - Works of art should be integrated into the design of each building, especially in building entrance areas (indoor and outdoor) and other high-use common areas. This may include sculpture, murals, architectural relief, and/or pavement patterning.

- Strategic Buildings

  - Gateway buildings anchor strategic street intersections which mark entrances to the campus from public arterial streets. A gateway building functions as a highly visible facility, which structures the aesthetic experience of motorists in the vicinity of the gateway. In addition, the building is key to creating an identifiable campus area for the portion of campus with which it is associated. Particular care should be given to the siting of a gateway building in relation to its intersection, as well as to building design, landscaping, and lighting.

  - Landmark buildings anchor activity nodes or major open space areas. A landmark building is designed to be easily identifiable or visually significant, especially to pedestrians, because of its clear or unique form or massing; high figure - background contrast due to siting, scale, color, or architectural style; and/or its prominent spatial location. Special attention should be given to building design and massing, landscaping, and lighting. New landmark buildings should be designed to actively structure and enhance the usable open space they anchor. *Example: Old Main at Main Mall.*

- Parking Structures and Decks

  - The design guidelines for building and facilities set out above generally apply.
  - Because of the massiveness of parking structures, special consideration should be given to building materials, detailing, and landscaping.
  - Safety and security should be a primary design consideration, including the location and visibility of vertical circulation, night lighting, and graphics.

CAMPUS OPEN SPACE

- This section summarizes the guidelines which provide the basis for the design and review of landscaping and open space development plans. This is critical to achieving an overall campus character.

  - Overall Character - three typical conditions arise, each calling for a distinct design treatment.

    - For malls and corridor-type open spaces (usually involving street closures), as well as formal campus entrances: Refined, formal arrangement of landscape elements (plantings, seating, lighting, pavement treatment, and so on); characterized by predominantly symmetrical pattern and use of repeated elements. *Existing example: Main Mall. Proposed example: Highland Corridor*

    - For transition zones and campus gateways - informal arrangements of landscape elements, either in continuous meandering pattern for linear conditions, or clustered or grove-like pattern for entry/highlight conditions. *Existing example: Park Avenue Buffer. Proposed example: Speedway Boulevard landscaping treatment*

    - For intensively used plaza areas (activity nodes) - utilization of formal, repeated or patterned elements to identify major pathways and building entrances; in combination with informal patterns for seating and other usable open space areas. Introduction of level changes, usable lawn areas, and a variety of hard surfaces is encouraged. *Existing example: "Education Plaza". Proposed Examples: Sciences Concourse, Regents Square*

  - View Preservation **–** the predominant approach recommended in these guidelines is the creation and preservation of vistas into and within the campus, rather than outward toward the mountains.

    - Major vistas along campus streets and open space areas - these provide a linear view for pedestrians, visually organizing the open space and orienting the user; they also provide open space views from buildings facing the open space. Existing example: Main Mall. Proposed example: Cherry Corridor

    - View "windows" from arterial streets into campus - these include "windows" created by major openings between buildings (including widenings of open space corridors) and the two formal campus entrances along Campbell Avenue. *Existing example: A.H.S.C. Entrance. Proposed example: Olive-Fremont Windows on Speedway Boulevard*

  - Animation - to insure adequate animation of activity nodes and open space corridors, the following guidelines apply:

    - A variety of usable open spaces accommodating a range of activities is desirable.
    - For any open space, at least three types of seating should be provided.
    - Uses which draw people and people-watchers should be incorporated.
    - The use of participatory artworks and well designed water features is encouraged.
    - Major pedestrian routes should be incorporated.
    - Bicycle routes and/or major bicycle parking areas should be included.
    - Design elements should be employed to add color and festivity, and thus attract use.

- Development at multiple levels -- such as sunken plazas, under-and overpasses, mezzanines, balconies, and arcades -- is desirable to encourage people-watching, as well as to provide visual interest.

- Visual Continuity - the design elements in open space development include planting materials; seating; surface treatments; lighting; special features such as food pavilions, transit stops, and information kiosks; artwork; and associated buildings. Certain elements should be consistently employed on a campus-wide basis to provide visual continuity, harmony, and legibility:

  - Palette of theme plantings for repeated use, in particular canopy trees lining pedestrian and bicycle paths.
  - Common building materials and colors for campus architecture.
  - Comprehensive campus signage and graphics system. (Refer to UofA Sign Committee & 2/97 Signage Standards.)
  - Common surface treatments of pedestrian and bicycle paths.
  - Common lighting fixtures and supports.
  - For existing open spaces undergoing redevelopment, existing elements will be utilized to the extent possible. For new spaces, an overall character should be established which will be used as each new building and associated open areas are developed.

- Crime Preventive Design **-** the principles of crime preventive design and defensible space should be utilized in the planning and design of outdoor space, particularly for major pedestrian paths and usable open spaces. This means design which discourages criminal activity and encourages visual surveillance by campus users as well as campus police and security.

  - Sufficient night lighting must be provided along major pedestrian routes, in activity nodes, in parking areas and structures, and at major building entrances. The installation of emergency telephones in strategic locations should also be considered.
  - Landscaping and walls should be designed to maintain visibility between heavily trafficked areas, and not as screens for potential intruders.
  - Where possible, elevation differences, view "windows," and vistas should be used to encourage surveillance between intensely used pedestrian areas, and between pedestrian areas and well trafficked streets.
  - Design which encourages development of identifiable open space "territories" with which people associate themselves and neighboring users, is desirable. This is especially appropriate in campus residential communities.

- Screening **–** shall consist of screen plantings, walls or fences, berms or elevation differentials, or a combination of these measures. For most situations, screening should be a minimum of five feet in height. The following new facilities should be screened from view:

  - trash collection areas
  - delivery/loading areas
  - outdoor storage areas
  - major above grade utility installations
  - most surface parking lots

- Landscaping - at the outset of design of any facility or open space, a thorough site survey should locate and identify all existing on-site plantings. Healthy specimen trees and palms should be preserved "in situ" to the extent possible. If this is not possible, relocation should be considered in preference to demolition. A theme plant palette should be established, listing plants for repeated use on campus to further establish a sense of landscaping consistency. The following characteristics are desirable for plantings on campus:

  - low water requirements/drought tolerant;
  - non-allergenic;

    - ease of maintenance -- preference for non-deciduous species dropping no fruit, clean species requiring little pruning;
    - non-invasive root systems;
    - pest and disease resistant.
    - There are certain exceptions to all of the above, depending on location, use, and historical value.

- Barrier Free Design - pedestrian routes and usable open spaces should be designed and landscaped to permit access and use by physically handicapped persons. Buildings, parking facilities and grade-separated crossings must be accessible to the physically disabled as well.

- Campus Legibility - equally important as campus signage in orienting people is the "legibility" of the campus -- the capacity of the campus to provide users visual clues as to their location and direction of movement. A number of proposals embodied in the Plan are designed to enhance and augment the legibility of the campus for both the campus community and visitors:

    - Creation of distinct development use clusters or districts.
    - Redevelopment and development of identifiable activity nodes of usable open space (plazas, malls).
    - Use of landmark buildings to further distinguish activity nodes.
    - Further development of transition zones which provide a distinct campus edge along arterial streets and planning area boundaries.
    - Creation of campus gateways, in part defined by gateway buildings.
    - Enhancement and development of linear pedestrian corridors, most with major vistas to be preserved.
    - Use of campus theme plantings and campus color and materials palettes to provide a consistent, coherent "background" for special features (above).
    - Preservation of the historic district and wall of the campus.

CAMPUS TRANSITION ZONES

- The goal for University interfaces with non-University uses is as follows:

  TREAT FUNCTIONAL AND AESTHETIC INTERFACES WITH NEIGHBORING COMMERCIAL AND RESIDENTIAL AREAS AND WITH CITY STREETS AS SENSITIVELY AS POSSIBLE.

    - Arterial Streets - the following generally summarizes the guidelines applicable to city arterial streets. The purpose of the guidelines is to provide a high quality visual experience to motorists passing the University, as well as to cooperate with the city in maximizing the safety and efficiency of arterial streets. Treatment of the arterial street "transition zone" is incorporated into these guidelines.

        - Building design:

            - Limit building heights in proximity to the street to 4 to 5 stories. Step back any structures immediately adjacent to street if possible.
            - Present a pleasant facade to the street, not an apparent "backside" of the building.

        - Street treatment:

            - Provide a continuous landscaped buffer along the street, retaining a sidewalk parallel to but not necessarily abutting the roadway.
            - Further develop the existing landscaping pattern, if any, or establish a new pattern.
            - Accommodate underground utilities.
            - Encourage city to retain or install landscaped median.
            - Provide directional graphics as needed.

        - Visual access:

            - Retain formal campus entrances.

    - Provide designated campus gateways.
    - Develop the proposed "windows" into the campus.

  - Auto circulation:

    - Close local streets as proposed in a timely manner, in cooperation with the city and adjacent neighborhoods.
    - Encourage Suntran to provide service at transit stops and terminals.
    - Work with the city in the design of arterial street widenings, grade-separated pedestrian/bicycle crossings, University parking structures, and intersection signalizations.

- Neighborhood Interface **-** in the Comprehensive Campus Plan, transition zones or buffers are indicated along the campus planning area boundary, adjacent to local streets and neighborhoods. These guidelines apply to the treatment of the transition zone or buffer, providing as sensitive a relationship by the campus to its neighbors as possible.

  - Timing

    - Recognize that development can occur at the current edge of the campus, versus at the campus boundary at full build-out. Therefore, some development may appear intrusive or insensitive to neighbors during the interim period. There also may be awkward circulation patterns on a temporary basis.
    - Screen new parking lots designated "permanent" or to be in place more than three years, with landscaping and/or walls or fences.
    - Implement the continuous buffer treatment (see below) as opportunities arise.

  - Uses

    - Place uses at the planning area boundary which are as compatible as possible with neighboring uses.
    - Maintain uses to a standard that is consistent with and will not detract from the overall appearance of the neighborhood.
    - The most appropriate uses are day-time oriented, creating no nuisances or disruption to neighbors, in particular the location of greenhouses in a "precinct" in the southwest quadrant of campus at Eighth Street and Park Avenue. E*xamples:* office uses, research facilities with no unusual noise or radiation concerns, such as greenhouses.
    - Adult or graduate student housing is preferred to undergraduate housing.
    - Recreational facilities are appropriate if spillover noise and lighting can be controlled or night use limited to specified hours, and/or public neighborhood usage provided.

  - Mitigation of Possible Nuisances **-** the following are potential nuisances to neighbors, and should be mitigated to the extent possible during design:

    - Auto traffic volume and noise (see below).
    - Street parking (see below).
    - Spillover lighting.
    - Spillover noise.
    - Pedestrian traffic in high volumes.
    - Night usage.
    - Fumes or odors.
    - Shadow patterns (solar accessibility).
    - Run-off/drainage.
    - Criminal activity and vandalism.

- Auto Circulation and Parking
    - Provide routes internal to the campus to accommodate most University traffic.
    - Provide access to University buildings from internal campus streets; remove existing driveways entering local neighborhood streets where and when feasible.
    - Limit access to residential neighborhoods from the campus to selected streets, while closing most local streets within the campus planning area. Minimize parking impacts associated with the loss of on-street parking, such as the proposed closure of Fifth Street and Tyndall Avenue.
    - Cooperate with the city and neighborhoods in implementing the residential parking permit programs where necessary and the metering of street parking.
    - As a goal, bring all University-related vehicles into the campus parking system (including daily fees, metering, and annual permits).
    - Support city and neighborhood efforts in the installation of appropriate traffic control devices outside the Planning Area which has the net effect of reducing University related traffic impacts.

- Visual Quality
    - Building design:
        - Limit building heights at the campus perimeter to 2 to 3 stories.
        - Encourage the use of "step-back" designs (going from one or two stories, then up as further away from the boundary), especially adjacent to single-family residential areas.
        - Screen outdoor storage, refuse collection, and loading/delivery areas from view.
        - Where feasible, break up bulky structures into smaller masses and/or orient the long sides of buildings perpendicular to (not parallel to) neighborhood boundaries.
        - Consider the use of berming to reduce the perceived height of buildings.
    - Landscaped buffer:
        - Provide a minimum building and parking lot setback of 25 feet from the local street right-of-way for all new permanent construction.
        - Develop the setback as a continuous landscaped buffer, incorporating screen plantings; berms, walls, or elevation changes where feasible; a sidewalk a minimum of 5 feet in width; and night lighting.
        - Coordinate design of the perimeter landscape buffer with appropriate neighborhood constituencies, and be sensitive to existing historical streetscape elements.
        - Where campus streets intersect local neighborhood streets, plant the University street corners with more intensive and/or accent plantings.
    - Adjacency to uses to be retained:
        - For new construction, provide a minimum building and parking lot setback of 10 feet from the property line of uses designated for retention in the area plans.
        - Develop the setback as a landscaped strip, with screen plantings and/or walls, fences, or berms.

TAB C-3

LABORATORY PLANNING AND DESIGN CRITERIA

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NOTE

- These criteria are intended to apply to both new construction and renovation projects. Obviously, minor renovation projects will not be expected to comply with broad scope criteria, such as redesigning the entire building to satisfy the "modular planning" goal. Wherever these criteria can be reasonably applied to renovation projects with a resulting improvement in the lab environment and without excessive cost penalties, the University desires to do so.

- **General Laboratory Planning and Design Precepts**

  - Utilize a central core for special spaces, shared spaces, and building service areas
  - Array laboratories around the perimeter of the building
  - Locate offices and circulation spaces between the core and the perimeter labs

    - Separate office spaces from the labs
    - Maintain adjacency and visibility to labs
    - Provide a hierarchy of office spaces

      - Faculty
      - Graduate students
      - Research technicians

  - Provide a variety of informal gathering spaces, with tack and marker boards in each

    - Eddy spaces in corridors (in addition to lab door recesses)
    - Lounges
    - Break rooms

  - Consider providing clean and "dirty" corridors

    - Clean corridors are restricted to people circulation
    - "Dirty" corridors can not be considered as secondary means of egress
    - "Dirty" corridors provide:

      - Utility distribution
      - Air distribution systems
      - Lab equipment (refrigerators, etc)
      - Building equipment (compressors, air pumps, etc)
      - Circulation route for sensitive items

  - Air pressurization hierarchies are critical
  - Ensure adequate space provisions for major equipment

    - Restrict size of main corridor (code minimum?) to prohibit placement of equipment
    - Utilize a hierarchy of equipment spaces:

      - Shared group spaces in the core
      - Floor space allowance in the "dirty" corridor
      - Open floor and/or space in each lab
      - Available floor space for cart parking
      - Bench top space for analytical equipment (as appropriate)

  - Recess outswinging lab doors off the corridor
  - Ensure adequate provisions for bulk storage

    - Provide storage for all types of materials required:

      - Dry goods
      - Chemicals
      - Bottled gasses

    - Utilize a hierarchy of distributed storage spaces:

- General building storage
- Floor closets
- Lab closets
- Millwork cabinets
- Open and/or closed shelving

- Design bulk storage areas with appropriate fire resistance ratings for materials and quantities

  - Bulk chemical storage facilities should have these characteristics:

    - Perimeter location
    - Vented room
    - 2-hour fire resistant construction
    - Consider including “blow out” panel

  - More than 10 gallons (in the aggregate) of class I chemicals must be stored in a cabinet

    - Provide adequate floor space in chemical storage rooms for individual cabinets

- **Flexible Laboratory Planning**

  - Plan lab facilities with a distributed hierarchy of shell space for future build-out

    - Floor shells and/or wing shells, as appropriate
    - One or more module shells
    - Semi-custom shells
    - Special shells

  - Provide complete utility service into each shell
  - Plan laboratories as "generic" spaces
  - Accommodate different categories of generic labs

    - Wet
    - Dry
    - Teaching
    - Research
    - Biology
    - Chemistry
    - Biochemistry
    - Electronic
    - Geology
    - Physics

  - Accommodate "exceptions" and unique conditions in separated custom-purpose spaces

    - Animal holding
    - Biohazard activities
    - Cold rooms (storage or working)
    - Electron microscope
    - Environmental
    - Laser
    - Radioisotope activities
    - Tissue culture activities

- Consider use of "semi-custom" spaces (in modular increments) to provide flexible and/or adaptable space for activities which present unforeseen requirements

- Provide connecting doors between homogenous lab categories (may be used as secondary egress when part of a rated area separation assembly)

- Design lab infrastructure with flexibility to accommodate different categories of labs and/or future design changes without a need to revise the infrastructure systems

  - Piped utility distribution
  - Waste and vent systems
  - Air management
  - Power supply

- Ensure that all equipment and appurtenances maintain the flexibility established in the basic planning and design

  - Modular benches, wall cabinets, shelving
  - Removable benches to allow increasing equipment floor space
  - Coordinate lab top seams with joints in casework
  - Allowance for items such as cylinder racks

- **Modular Laboratory Planning**

  - Design labs using a planning module
  - Module selection should incorporate the following determinants:

    - Building structure (and vibration considerations)
    - Typical bench needs and sizes for each lab category
    - ADA access requirements
    - Ceiling panel modules
    - Epoxy top modules

  - 10'-6" seems to accommodate lab activities and ADA requirements
  - Maintain consistent modular planning throughout the facility

    - Lab "length" is multiple of lab "width"
    - Special use, exception, semi-custom areas
    - Offices

  - Provide for unique "in-lab" needs within the module or multiple modules
  - Provide complete array of utility stubs to each module, even if not always distributed

- **Handicapped Accessibility in Laboratories**

  - Design typical lab benches to be 34" high
  - Provide sit-down handicapped accessible workstation in each lab
  - Appurtenances for each HC station will vary with the category of lab, but in general should include

    - Bench at approximately 30" high
    - Hood
    - Sink with wrist blade faucet handles
    - Lab gasses with wrist blade cock handles
    - Power
    - Storage facilities

        - Writing surfaces

    - Appurtenances must be within regulation-specified reach distances
    - Investigate whether sit-down writing surfaces available to all lab users could be designed to accommodate an HC station when needed
    - Investigate whether removable benches and/or equipment could be designed to allow retrofit for HC accessibility

- **Planning and Design for Laboratory Safety**

    - Resolve lab exiting issues

        - Investigate a design scheme which utilizes "lab suites" thereby allowing individual lab doors to be left open while preventing true corridor doors from being blocked open
        - Investigate providing magnetic hold open / pneumatic closer devices on lab/corridor doors

    - Chemicals management

        - More than 10 gallons (in the aggregate) of class I chemicals must be stored in a cabinet
        - Provide acid, solvent, and/or flammable storage cabinets for supply chemicals as appropriate in each lab

            - Under hood or free standing as required by quantity to be stored
            - Properly vented
            - Cabinets should be compartmented to allow segregation of chemicals

        - Provide space for storage of waste chemical containers

    - Utilize chemical fume hoods only for lab processes, not for storage

    - Utilize canopy hoods and/or snorkels to remove heat only

        - Autoclaves
        - Dishwashers
        - Certain analytical equipment

    - Provide emergency showers with "hands free" eyewash in corridors

        - Locate within 50 feet of each lab door
        - Do not provide showers in labs
        - Do not provide a drain
        - Provide a local warning alarm for water flow

    - Provide flexible hose eyewash at each major bench sink

    - Provide adequate space, outside traffic areas, for waste handling

        - Provide secured storage/space for sensitive waste
        - Provide vented storage/space for hazardous waste (maximum 5 gallon container)
        - Utilize a distributed hierarchy of waste spaces

            - Building
            - Floor
            - Individual labs

- Waste categories include

    - Ordinary trash
    - Recycled paper
    - Other recyclables
    - Broken glass (secured)
    - Waste chemicals (secured, vented)
    - Red bag (secured)
    - Orange bag (secured)
    - Radio-hazard (secured)

- Provide a separate break away from labs. Provide space for microwave, refrigerator, coffee pot, sink, etc.

- Provide vision lite in every lab/corridor door

- Provide a fire extinguisher rated for materials being used in lab on a hook in each lab room

- Alarm systems

    - Provide mini-horn/strobe units in environmental rooms and in labs
    - Do not provide smoke detectors in corridors

- Biosafety levels

    - Not all laboratories present a biohazard condition requiring primary and/or secondary barriers
    - Hazards are classified by biosafety level, and required physical barriers are described
    - Biosafety level 1

        - Handwashing sink

    - Biosafety level 2

        - Class I or II biosafety cabinets may be required
        - Waste decontamination facilities

    - Biosafety level 3

        - Class I or II biosafety cabinets are required
        - Glove boxes may be required
        - Access control to the laboratory
        - Specialized mechanical ventilation

    - Biosafety level 4

        - Class III biosafety cabinets are required (or personal pressure suit)
        - Separate building or completely isolated zone
        - Specialized mechanical ventilation and waste management systems to contain hazards

- **Laboratory Casework**

    - Provide wood casework

        - Natural finish, not plastic laminate
        - Except where matching existing metal
        - Except in areas requiring impervious surfaces

        - Animal care areas
        - Biohazard areas
        - Radioisotope areas
        - Chemical storage rooms

    - Include utility chase behind wall/peninsula/island base cabinets
    - Demonstrate functional useability of corner area where two base cabinets intersect
    - Provide removable access panels at knee spaces and sink cabinets

        - Rear stretcher at knee space should be continuous

    - Provide pull out writing tablet in casework, using drawer glides
    - Provide heavy duty full extension drawer glides (100 pounds minimum)
    - Provide pre-fabricated specialty chemical and flammable storage cabinets where required

- Laboratory bench tops

    - Epoxy resin tops at all wet or semi-wet areas
    - Acid resistant plastic laminate at dry areas
    - Provide dished top at all major lab sinks
    - Provide lip at all sinks in labs
    - Locate seams in tops coincident with seams in benches to allow for modifications
    - Use light colored tops if lighting efficiency can be demonstrated

- Wall / peninsula / island reagent shelving (above lab benches)

    - Custom fabricated using unistrut-type system (not stock item)
    - Extend unistrut from floor through bench top to structure above

        - Seal penetration with epoxy seaming material
        - Do not use a "wrapped splash"
        - Earthquake lip (12" or 18" clear dimension)
        - Acid resistant plastic laminate on wood substrate

            - Do not use an epoxy paint or clear finish

        - Do not install reagent shelving above sinks

    - Enclosed wall reagent cabinet (above lab benches)

        - 12" clear dimension
        - Glass or opaque doors as requested by User
        - Do not install wall cabinets above sinks

    - Wall shelving (non-reagent)

        - Must have backing in wall
        - Clear finish wood
        - Heavy duty adjustable kv-type brackets
        - End caps
        - Use unistrut-type reagent shelves for extra deep wall shelving
        - Install top-most shelf 24” minimum below ceiling
        - Do not install wall shelving above sink

- **Laboratory Equipment and Appurtenances**
    - Provide a 3'-6" minimum single leaf at each lab/corridor door
    - Discuss fume hood selection with UA Facilities Design & Construction
        - Investigate special user requirements
            - Laminar flow clean hoods
            - Radioisotope hoods
            - Perchloric acid hoods
            - Biosafety cabinets
    - Laminar flow clean hoods
        - Used only to protect process (not to protect operator)
        - Not exhausted
    - Radioisotope hoods
        - Special purpose fume hood with hepa-filtered exhaust discharge
        - Generally uses slightly higher face velocity than conventional fume hoods (125 fpm)
        - Requires welded stainless steel exhaust duct system
        - Can be open or gas-tight (glove box)
    - Perchloric acid hoods
        - Straight exhaust duct run (no horizontal offsets) is mandatory
        - Requires automatic wash down system
            - Timer-controlled for washing once per week
            - Discharge must be carried to the lab waste system
        - Requires welded stainless steel exhaust duct system
    - Biosafety cabinets
        - Identify specific type of hood required, based on User process
            - Class I biosafety cabinet: 100 fpm, single pass air, out through hepa filter
            - Class II-A biosafety cabinet: 100 fpm, 70% recirculated through hepa, 30% exhaust to room through hepa
            - Class II-B1 biosafety cabinet: 100 fpm, 30% recirculated through hepa, 70% exhausted to exterior through hepa
            - Class II-B2 biosafety cabinet: 100 fpm, 100% exhausted to exterior through hepa
            - Class II-B3 biosafety cabinet: 100 fpm, 100% exhausted to exterior through hepa, plena under negative pressure to room
            - Class III biosafety cabinet: gas-tight cabinet, supply through hepa, exhaust through 2 hepa
        - Biosafety cabinet exhausts may be manifolded together, but not with chemical fume hoods
    - Exhaust hood control
        - Chemical fume hoods may not be User controllable, must be on 24 hours

        - Also includes radioisotope and perchloric acid hoods
        - Consider off-hours setback and vav systems, for energy conservation

    - Interior recirculation ("supply") fans of biosafety cabinets may be User controllable

        - Must be interlocked with hood and/or general exhaust fans to ensure that operator safety and room pressure are not compromised
        - Applies to all class II biosafety cabinets, only

    - Provide tank farm with chains, not dividers, when required

        - Design to be near the door, for ease of service
        - Utilize University-standard tank manifold

    - Provide wall space for UA-standard towel and soap dispensers at each lab sink
    - Provide tack surfaces and writing boards in all labs
    - Carefully coordinate all equipment specifications

        - Fixed or moveable, must specify details
        - Sizes and floor space allowances

    - Use electric autoclaves instead of steam

- **Laboratory Finishes**

    - Floor finishes

        - Available choices

            - Vinyl composition tile is appropriate for most labs
            - Epoxy sealer is also appropriate for most labs, including chemistry
            - Seamless vinyl provides a "pan" in very wet areas
            - Seamless vinyl is cleanable for biology labs

        - Continue flooring under casework
        - Seal toekick of all benches (to prohibit water penetration)
        - Use topset cove base at toekicks

    - Provide epoxy wall paint in all wet labs

        - Also on ceilings, if hard surface

    - Ceilings

        - Available options

            - Suspended acoustical tile ceilings are acceptable in most laboratories
            - No ceiling is an option where appropriate
            - Provide hard ceilings only where required by lab activity

    - Provide a sealed sleeve with a lip at all floor penetrations

- **Laboratory Utility Service and Distribution**

    - Utilities distribution

    - Overhead, in corridor ceiling
    - Valve on each utility stub, in corridor
    - Drop on wall surface or freestanding to each lab bench
    - Distribute to positions in utility space at rear of casework
        - Make joints in horizontal piping only at removable panels
    - Visible and accessible
    - Consider special delivery systems where appropriate
        - Lab gas "pedestal" or "drop pods"
        - Electric "drop cords"

- Utilities on bench tops
    - Place turrets toward rear of bench
    - Use turrets with angled discharge to enhance hose management
- Utilities racked on reagent shelf
    - Generally avoid (hoses get in the way)
    - If doing so, rack on unistrut verticals, not shelf
    - If doing so, maintain 22" clear height above bench top
- Piped utilities
    - distribute to benches and hoods
        - controls must be outside hoods
- building provides central
    - potable water
    - ro water
        - Provide special (di) polish at individual labs
    - Natural gas
        - Some Users prefer bench top cylinders for gas service
    - Compressed air
        - Confirm if required
    - Building does not provide central
        - Vacuum
        - Hot water
        - Specialty gasses
        - Provide in individual lab as needed
    - Use building chilled water wherever possible for process

        - Provide heat exchanger between building and process
        - Recirculate chilled water (do not use "single pass")
        - Where demand is excessive, varies from building system, or need is critical

            - Use stand alone chiller
            - Consider placing chiller on emergency power system

- Waste system and piping

    - Do not use acid neutralization systems (building or stand-alone)
    - Separate lab waste from domestic waste

        - Utilize separate piping system to exterior of building
        - Provide sampling manhole for lab waste piping
        - Combine lab and domestic waste piping after sampling manhole

    - Use acid-resistant piping system for lab waste

- Lab sinks

    - Confirm with User need for large/deep sinks
    - Plan major sinks at ends of benches, in base cabinet
    - Use gooseneck faucets with wrist blades at all sinks
    - Cup sinks are not routinely needed on benches or in hoods

        - Install only is specifically required
        - Always provide lip
        - In hoods, sink must be at rear to avoid trap being in under-hood storage cabinet

- Do not use plastic di faucet

    - Aluminum faucet (with plastic piping) is acceptable

        - Self-closing
        - Easily replaceable

- Floor drains

    - Use only when required to discharge condensate or other similar non-hazardous material

    - Must be lipped and guarded

- Electrical & telecommunications typically required

    - Provide an adequate number and arrangement of circuits
    - Provide an adequate number and arrangement of 120v receptacles
    - Provide an adequate number and arrangement of 208v receptacles
    - Provide wiremold electrical distribution above all lab benches

        - Double raceway
        - Install quantity of receptacles as required by User process
        - Receptacles above bench must have gfci protection *within 5' of water source*
        - Install of data jacks as required by User in second raceway

    - Label each receptacle's circuit

        - Alternate circuits in each lab and in each wiremold run
        - Provide wall phone jacks where required. Do not provide data jacks at wall phone jacks.
        - Provide date jacks along benches where required.

    - Lighting

        - Place general fixtures to eliminate shadows from work surfaces
        - Do not rely on general fixtures for the complete lighting environment
        - Provide task lighting above lab benches and other work surfaces

            - Utilize 2-tube fixtures with shades to minimize glare

        - Evaluate color and reflectivity of finishes and bench tops as part of lighting design
        - Provide emergency lighting in each lab room or distinct space

- **Laboratory Air Management Technology**

    - Preferred system

        - Building ahu to supply make up air to labs
        - Lab fan coil units to remove sensible cooling load of lab equipment
        - Investigate manifold and vav exhaust system if project has many hoods

            - Use multiple fans in manifolded system

                - To allow programmed maintenance

    - Basic system design issues

        - Provide pressure hierarchy between lab spaces

            - Provide capability to measure velocity and pressure downstream of terminal boxes

        - Provide exhaust discharge velocity of 3000 - 3500 fpm

            - Provide bypass on manifold vav systems at roof

        - Provide filtration or scrubbing for hazardous emissions

    - Temperature control

        - St individual room thermostats at 75°F, ± 2°F

    - Humidity control – discuss with UA FDC

    - Filtration requirements

        - Provide minimum 4" deep 30% efficiency filter banks in 100% outside air systems

    - Design exhaust systems for materials being removed

        - Heavier or lighter than air
        - Concentrations and processes
        - Discuss design hood face velocity with UA FDC
        - Limit use of canopies and snorkels to heat removal

- Ductwork materials
  - Spiral 316L stainless steel shall be used for fume hood applications
  - PVC coated galvanized may be used on manifold vav systems applications
    - Clearly specify strict construction controls
  - Welded 316L stainless steel must be used for perchloric acid hoods
- Design exhaust system for noise reduction
  - Duct size, design, and route
  - Fan selection and location
  - Low pressure drop hood
- Specify appropriate vent conduits for storage cabinets
  - Explosive / flammable
  - Vapors

TAB C-5

CUSTODIAL PLANNING AND DESIGN

Custodial Services are inherent to the operations of buildings and proper service areas must be considered with all other areas during the programming and planning stages of each building.

Universally accepted standards have yet to be set for custodial closets and storerooms. Certain criteria however, for size, shape, location, and special appurtenances, have been developed which are compatible with present cleaning procedures and today's cleaning equipment.

Comprehensive custodian operations encompass three major areas:

- Custodial Closets
- Custodian Storage Areas
- Trash Disposal Systems

- CUSTODIAN CLOSETS

  Should be planned to function primarily as the workrooms of men and women responsible for cleaning the interior surfaces of the building. The University of Arizona has developed the following criteria for custodian closets:

  - Size should be a **minimum** of 80 – 100 square fee, with 7-8 foot minimum width.
  - Recessed light fixtures (to allow for clearance of long broom and mop handles) providing 75 F.C. light.
  - Adequate ventilation.
  - Pegs for storage of rotary brushes.
  - Hangers for wet mops over the sink.
  - Hangers and wall space for dust mops and brooms.
  - Hard surface walls impervious to water.
  - Shelves in closet to accommodate supplies in case lots, and to allow for storage of liquids in original 5 or 6 gallon containers.
  - A 36" wide door that swings out, not into the room.
  - Hot and cold water outlets not less than 24" above a floor type basin. Basin curb should be 6" minimum above the floor.
  - A grounded 20 Amp. Duplex outlet in open wall space, not behind shelves, for recharging battery operated equipment.

  Location of custodian closets is very important. They should be centrally located with no area in a building more than 150 feet in walking distance from a "wet" closet. Each closet should not serve in excess of 15,000 square feet.

  Buildings should have custodian closets on every floor. Good locations for secondary custodian closets are:

  - Close to elevators
  - Close to main pedestrian areas
  - Between two restrooms

  Criteria For Vertical Transportation

  - There should be an elevator in every multi-storied building.
  - The elevator should land on every floor including the basement.

- The elevator should be available to custodian and maintenance personnel.

It is considered poor planning to locate a custodian closet:

- At the dead end of a corridor. A situation such as this results in many unnecessary steps for the custodian.
- On a stair landing. A stair-landing closet would cause the custodian to always carry utensils and equipment up and down stairs.
- Inside another room (unless that closet serves only that room).
- Under stairs. Low ceilings and narrow dimensions are hard to ventilate.
- In narrow spaces. The custodian must move his equipment into the hall to utilize a narrow room. Square shaped closets are most efficient.

Telephone switching gear, elevator controls, electric panels or other service functions are not compatible with custodian operations, and should not be located inside custodian closets. Openings to pipe chases or mechanical equipment areas should not be located inside custodian closets.

- LARGE STORAGE ROOMS
  - Every large building should have a storeroom for custodian equipment, bulk supplies and custodian lockers. Buildings larger than 150,000 sq.ft. should contain two such rooms. Storage areas should be designed specifically for custodian storage, <u>not for dual usage.</u> Planning should be done in consultation with those who will be responsible for maintaining the building.
  - Dock or elevator facilities must be provided.
  - Doors should be no less than 36" wide and open out. Storage areas should contain a minimum of 144 square feet. 12' x 12' are good dimensions.

- TRASH DISPOSAL
  - Disposal of the trash and garbage produced by every cleaning operation is an integral part of a comprehensive program. The University of Arizona's Physical Plant utilizes compaction and physical removal by truck for all trash and garbage. A properly sized, fire-resistant trash room shall be planned into each new campus building. Where debris from kitchens and dining halls, or where animal matter is involved, refrigerated trash storage rooms shall be provided.

- SUMMARY
  - Proper custodian closets, carefully planned and sized storage rooms or custodial supplies, and consideration of refuse collection and disposal requirements, are prime ingredients in any efficient housekeeping program.

TAB C-6

KEYLESS ACCESS AND SECURITY SYSTEM GUIDELINE

The University of Arizona has implemented a Keyless Access and Security System program to provide a cost effective, efficient, and maintainable means of providing and managing access into campus buildings for the university community, contractors and visitors. The focus of the system is to address issues of loss prevention, personal safety, and convenience through the use of this standardized technology. The system utilizes the University's CatCard as the "key" since it is universally deployed to all campus constituencies.

The principle focus of the program addresses **building perimeter access points.** Most University facilities are unlocked during normal (and sometimes extended) business hours, during which time keys are not required to enter the building. However, when the buildings are supposed to be closed and locked, it is the program's intent to provide entry through the use of the University of Arizona CatCard rather than with the use of a physical key.

In order to equip new university building with this system, project consultants will need to provide a design and produce construction documents that have the following accommodations for a keyless access and security system:

- **RISER** - A riser for the building's Keyless Access/Security System. This riser is required to be stacked vertically within a building to permit the Keyless Access/Security System to be wired from floor to floor
- **HEAD END EQUIPMENT** - Space and some utilities for the Keyless Access/Security System head end equipment directly adjacent to the riser. This particular equipment exists on only one floor of the building. This equipment also needs to be provided with three duplex 120VAC electrical outlets and one voice/data jack.
- **FIELD DOOR CONTROLLER PANELS** - Space and power for Keyless Access field door controller panels at various locations throughout the building as determined by the keyless access system design. These panels will require hardwired, 120VAC power.
- **RACEWAYS** - Conduit and junction boxes will need to be provided for routing certain portions of the Keyless Access/Security System local area network. Not all of the keyless access and security system wiring is required to be located in conduit. In very general terms, conduit is required between the equipment that is installed on walls up to accessible, above ceiling space or the building's cable tray.
- **DOOR HARDWARE** – Designated doors will have hardware that needs to interface and/or be controlled by the Keyless Access system. Doors that have keyless access hardware requirements may either have their hardware specified and provided under the general construction contract (for example – in the door hardware package) or have their hardware provided by Amer-X as part of the Keyless Access/Security System installation.
- **DOOR FRAMES** - Doorframes - pre-prepared from the manufacturer that can easily accommodate the addition of equipment for electronic operation. These frames typically include a handy box at the top of the doorjamb and a latch strike mud pocket that is deep enough for an electronic strike.

  Consultant shall coordinate door frame requirements during the design phase of a project.

All the Keyless Access/Security System wiring is low voltage; only the head end equipment and field door controller panels require 120VAC. As such, most of the wiring is not required to be located in conduit. The Keyless Access/Security System is not required to be provided with emergency power; each building's system is provided with sufficient battery backup to provide at least four hours of standby operation. In the event a particular installation calls for longer standby power capability, the 120VAC power could be on an emergency circuit. The building Keyless Access/Security System communicates with the main server through phone and data lines; no connection to a hardwired network is necessary.

The following information is intended to explain the detailed requirements of each portion of the Keyless Access/Security System infrastructure that will need to be provided by under the general construction contract.

RISER

- A minimum 2” riser for each major wing of the building. The riser must serve every occupied floor of a building.
- One 12”x12”x4” box at each floor (see Notes below).
- A 1” conduit from the riser box to the building’s cable tray

  Notes:
  - A building may only have one riser, but larger, more complex buildings may have more than one.
  - Amer-X will provide the riser boxes for each floor of the building

HEAD END EQUIPMENT

Security Control Panel

- One *16”x16”x4”* box for security control panel (see Notes below)
- One, duplex 12OVAC receptacle for panel power. This receptacle is not required to be on emergency circuit. The circuit for this receptacle is not required to be dedicated.
- One, voice/data jack with an RJ31X jack. The data side of this jack is used by the keyless access system panel.

  Notes:
  - Installation of security system wiring and the phone line cord between control panel and voice/data jack is provided by Amer-X.
  - 12OVAC-24VDC transformer and transformer cover for the power receptacle will be provided and installed by Amer-X.
  - Amer-X receives the box for security panel from the equipment manufacturer. Amer-X will provide this box to the electrical contractor for installation during building construction.

Keyless Panel and Network Connection

- One *16”x22”x6”* box for keyless access panel and net connection (see Notes below)
- Two, duplex 12OVAC receptacles - one for keyless access panel power, one for the network connection power. This receptacle is not required to be on emergency circuit. The circuit for this receptacle is not required to be dedicated.
- One, voice/data jack with an RJ31X jack. The voice side of this jack is used by the security system panel.

  Notes:
  - Installation of keyless access system wiring and the network connection cord between control panel and voice/data jack is provided by Amer-X.
  - 12OVAC-24VDC transformers and transformer covers for the power receptacles will be provided and installed by Amer-X.
  - Amer-X receives the box for keyless access panel from the equipment manufacturer. Amer-X will provide this box to the electrical contractor for installation during building construction.

FIELD DOOR CONTROLLER PANELS

Depending on the number and location of controlled doors, keyless access field door controller panels will need to be installed at various locations in the building. At each of these locations, the following equipment is required:

- One *16”x22”x6”* box for the field door controller panel (see Notes below)
- 12OVAC power hardwired into the box. This circuit is not required to be dedicated or on emergency power.

Notes:

- The panels can be installed above ceilings, in equipment rooms, or other similar areas.
- The *16"x22"x6"* holds the largest field controller panel. This size box may not be installed at every location, but space should be provided to accommodate the "worst case" box.
- Amer-X receives the boxes for the field controller panels the equipment manufacturer. Amer-X will provide these boxes to the electrical contractor for installation during building construction.

RACEWAYS

All of a building's perimeter access points will need to be provided with wiring pathway that will permit the doors to be controlled electronically. Each building perimeter access point shall be provided with the following equipment:

- Door Contacts
- Electronic Locking (either electric strikes or latches, or magnetic locks)
- Request to Exit Device

In addition, certain, designated building entries (as determined by the Keyless Access/Security System design) shall be provided with the following additional keyless access equipment:

- Card reader
- PIN pad

Raceways will need to be provided from accessible, above-ceiling spaces to this equipment at each door where this equipment is located.

Notes

- If magnetic locks are used on a door, a keyed bypass switch will be required. This is an additional piece of equipment that will also require conduit to the accessible, above-ceiling space.
- For storefront-type entries, the Keyless Access/Security System wiring can be routed through the storefront mullions. This is a field installation coordination issue that Amer-X addresses with the storefront installers during construction.
- For all glass entries, a post or bollard will be required to mount some of the keyless access equipment (card reader, PIN pads). This type of installation requires greater consideration during the project's design phase.

DOOR HARDWARE

Electronic locking requires special hardware for the doors designated to be controlled by the Keyless Access/Security System. In general terms, there are three types of electronic locking hardware: electric strikes, electric latches, and magnet locks. Until the building's design reaches a point where the door types are well defined, it cannot be determined which type of electronic locking hardware will be used. However, the following should be considered:

- Magnetic locks are generally the most costly way to electronically lock a door. They should only be used when the other two alternatives are not feasible (i.e. double doors that require panic hardware and cannot have a mullion).
- Electric strikes can be installed in almost all doorframes or mullions and are the most economical way to electronically lock a door.
- Electronic latches are typically used where the door is required to remain positively latched (i.e. fire doors) in the event of a Keyless Access/Security System failure.

DOOR FRAMES

Installation of electronic locking on doors is facilitated by having doorframes pre-prepared from the manufacturer for electronic hardware and controls. This entails the following

- A handy box provided at the top of the door frame, located 6 inches off the latch side of the frame

KEYLESS ACCESS/SECURITY SYSTEM INSTALLATION

As the University's sole source, keyless access and security systems vendor, Amer-X performs the following installation tasks associated with the keyless access and security system:

- Installation of head end and field panels in boxes installed by the electrical contractor
- Installation of 24VDC transformers and transformer covers on duplex receptacles installed by the electrical contractor
- Connection of power source to panels
- Connection of phone/data lines to jacks installed by the electrical contractor
- Coordination with construction trades, such as window and door installers, to facilitate installation of peripheral devices
- Installation of peripheral devices (door contacts, card readers, PIN pads, electric strikes, etc.)
- Installation of the low voltage Keyless Access/Security System wiring - both in conduits provided by electrical contractor (in walls and vertically through the building) and the data loop local area network wiring between panels and devices (routed similar to telecommunication lines through above ceiling spaces).

DESIGN PHASE INVOLVEMENT

Please refer to the following process descriptions and flow chart for how Amer-X should be involved in the design process.

DESIGN PHASE INVOLVEMENT, PROCESS AND FLOW CHART

Schematic Design

- Consultant, User group, and Amer-X meet
- Introduction of keyless access/security system
- Review building layout, functions, different building constituencies, and expected building operation. See Note (1) below.

Design Development

- Amer-X develops preliminary system design and budget. Submits copy to Project Coordinator, Consultant, and User group
- Consultant, User group, and Amer-X meet. Review preliminary design with user and consultant. Make modifications/deletions/additions as determined by refined understanding of building operations
- Amer-X develops final system design and budget. Submit copy to Project Coordinator, Consultant, and User group. Provides standard door details, riser diagram, door hardware requirements to consultants

Construction Documents

- Amer-X verifies coordination of consultant documentation with final system design

Construction Phase

- Electrical Contractor installs pathways (riser and door conduit) according to specifications
- Door contractor preps doors and jambs for equipment, according to specifications
- University establishes purchase order with Amer-X for system installation
- Amer-X coordinates field device installations with affected contractors

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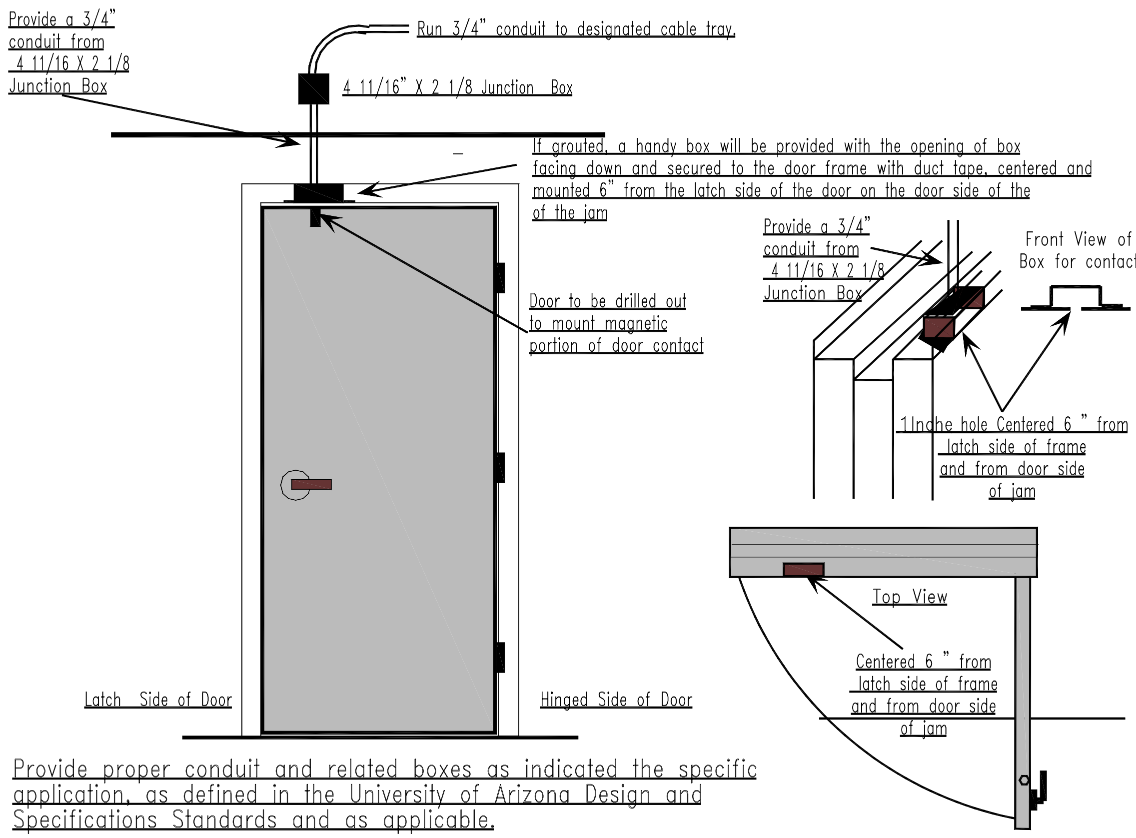
Schematic Design Note (1):

Amer-X meets with consultants and user group(s) after schematic design to introduce the keyless access/security system program, and describe the system's capabilities and options. This is where the dialog on how the users expect the building to operate from an access point of view begins. A review of the functions that take place in the building, the different user groups/constituencies, and any special concerns about asset protection, special activities (cash handling, pharmaceutical storage, etc.) and access management should also take place at this time.

User groups will be asked to think about how they need and/or want the building to be accessed
    During normal business hours
    After normal business hours
    For special events
User Groups will also be asked to think about who they need and/or want to be able to access the building when the building is:
    Normally open
    Supposed to be closed

University of Arizona Security System Door Details and Illustrations
Single Exterior Door

All wire runs not in conduit must be supported from approved hangers, installed not less than 3 ft on center



Provide proper conduit and related boxes as indicated the specific application, as defined in the University of Arizona Design and Specifications Standards and as applicable.

Keyless Access Security Cable	Wire Size	Approvals	Belden Cable Number or Equal
Security Data Loop	18/2	UL, NEC, Type CMP,CL2P	6300 FE

Door Details and Illustrations
Single Exterior Door
Security System Only

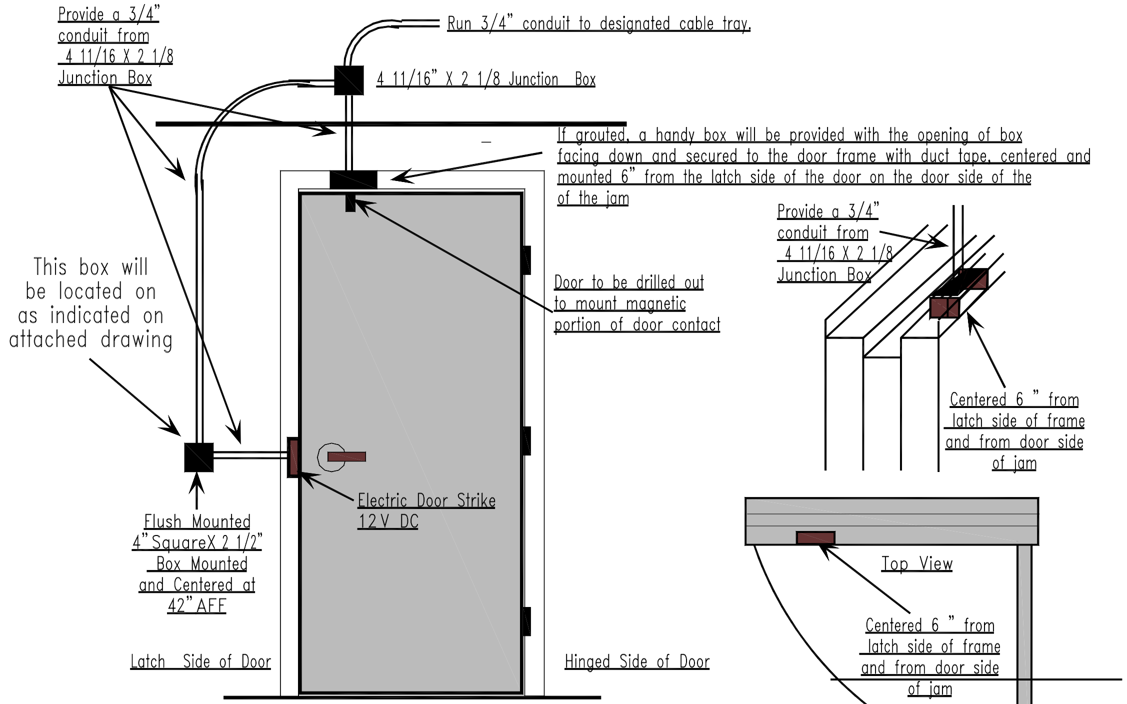
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS

STANDARD DETAIL:
SINGLE EXTERIOR DOOR, SECURITY SYSTEM ONLY

DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6-D1	
ACAD: C6-D1		

University of Arizona Keyless Access Security Systems Door Details and Illustrations
Single Exterior Door

All wire runs not in conduit must be supported from approved hangers, installed not less than 3 ft on center



Provide proper conduit and related boxes as indicated the specific application, as defined in the University of Arizona Design and Specifications Standards and as applicable.

Keyless Access Security Cable	Wire Size	Approvals	Belden Cable Number or Equal
Keypad	22/12 Shielded	UL, NEC, Type CMP,CL2P	6509 FE
Card Reader	18/6 Shielded	UL, NEC, Type CMP,CL2P	6304 FE
Electric Strike	18/2	UL, NEC, Type CMP,CL2P	6300 UE
Magnetic Lock	18/2	UL, NEC, Type CMP,CL2P	6300 UE
Door Contact	22/4	UL, NEC, Type CMP,CL2P	6502 UE
485 Data Loop	24/2	UL, NEC, Type CMP,CL2P	6600 FE
Security Data Loop	18/2	UL, NEC, Type CMP,CL2P	6300 FE

Door Details and Illustrations
Single Exterior Door

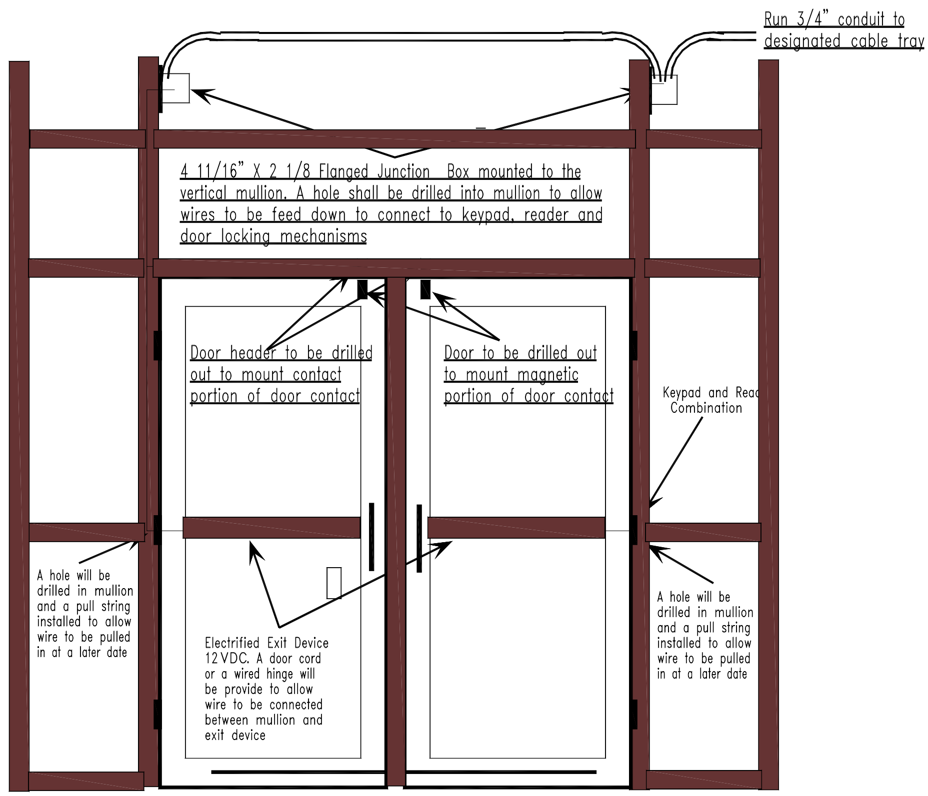
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS

STANDARD DETAIL:
SINGLE EXTERIOR DOOR, ACCESS AND SECURITY

DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6-D2	
ACAD: C6-D2		

University of Arizona Keyless Access Security Systems Door Details and Illustrations
Double Exterior Door with Mullion

All wire runs not in conduit must be supported from approved hangers, installed not less than 3 ft on center



Provide proper conduit and related boxes as indicated the specific application, as defined in the University of Arizona Design and Specifications Standards and as applicable.

Keyless Access Security Cable	Wire Size	Approvals	Belden Cable Number or Equal
Keypad	22/12 Shielded	UL, NEC, Type CMP,CL2P	6509 FE
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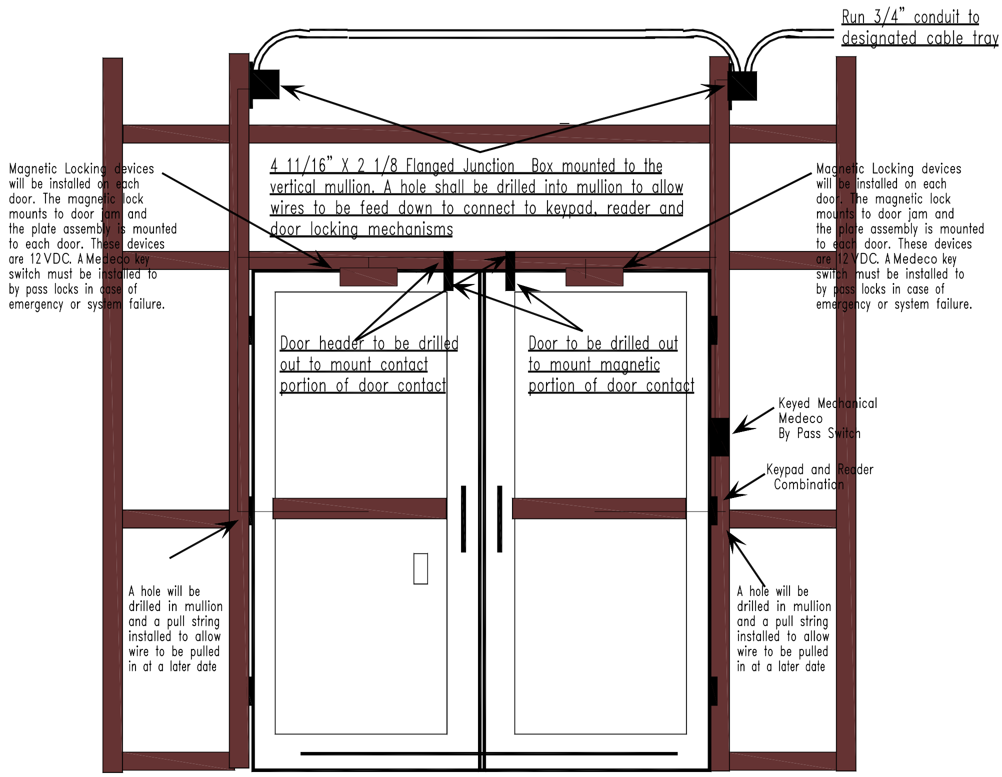
Magnetic Lock	18/2	UL, NEC, Type CMP,CL2P	6300 UE
Door Contact	22/4	UL, NEC, Type CMP,CL2P	6502 UE
485 Data Loop	24/2	UL, NEC, Type CMP,CL2P	6600 FE
Security Data Loop	18/2	UL, NEC, Type CMP,CL2P	6300 FE

Door Details and Illustrations Double Exterior Door with Mullion

UNIVERSITY OF ARIZONA MANUAL OF DESIGN SPECIFICATION STANDARDS		
STANDARD DETAIL: DOUBLE EXTERIOR DOOR WITH MULLION		
DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6–D3	
ACAD: C6–D3		

University of Arizona Keyless Access Security Systems Door Details and Illustrations
Double Exterior Door with Magnet Locking Devices

All wire runs not in conduit must be supported from approved hangers, installed not less than 3 ft on center



Provide proper conduit and related boxes as indicated the specific application, as defined in the University of Arizona Design and Specifications Standards and as applicable.

Keyless Access Security Cable	Wire Size	Approvals	Belden Cable Number or Equal
Keypad	22/12 Shielded	UL, NEC, Type CMP,CL2P	6509 FE
Card Reader	18/6 Shielded	UL, NEC, Type CMP,CL2P	6304 FE
Electric Strike	18/2	UL, NEC, Type CMP,CL2P	6300 UE
Magnetic Lock	18/2	UL, NEC, Type CMP,CL2P	6300 UE
Door Contact	22/4	UL, NEC, Type CMP,CL2P	6502 UE
485 Data Loop	24/2	UL, NEC, Type CMP,CL2P	6600 FE
Security Data Loop	18/2	UL, NEC, Type CMP,CL2P	6300 FE

Door Details and Illustrations
Double Exterior Door
with Magnetic Locking Devices

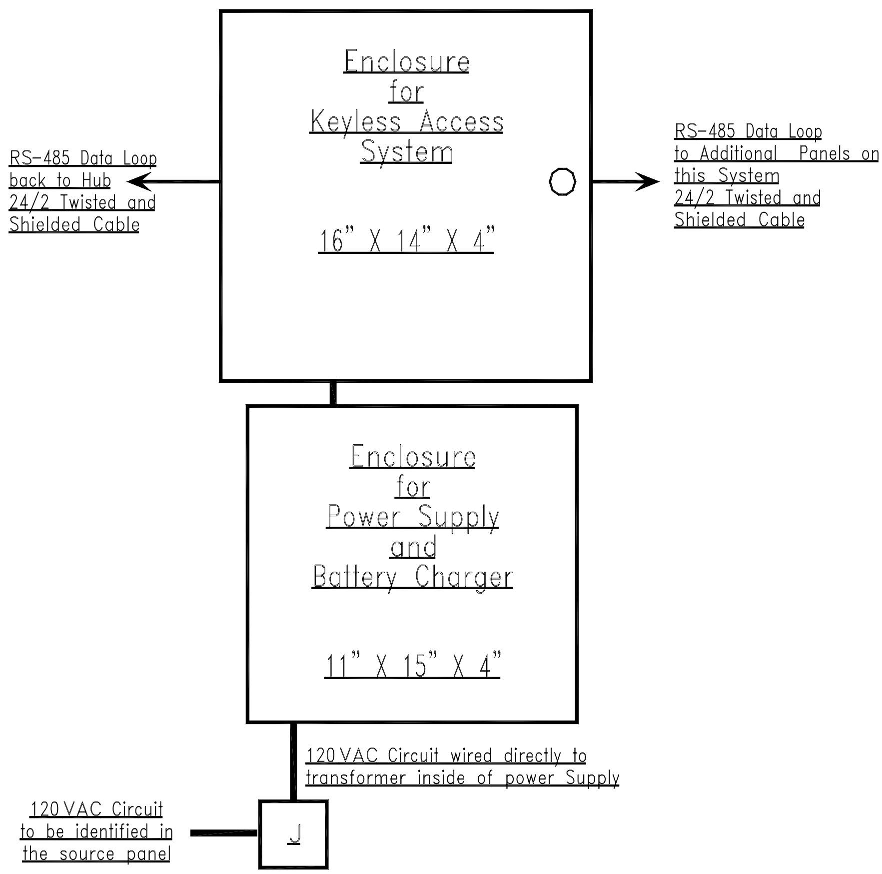
Prepared 4/15/04 (Revised)DJP

UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS

STANDARD DETAIL:
DBL EXTERIOR DOOR W/MAGNETIC LOCKING DEVICES

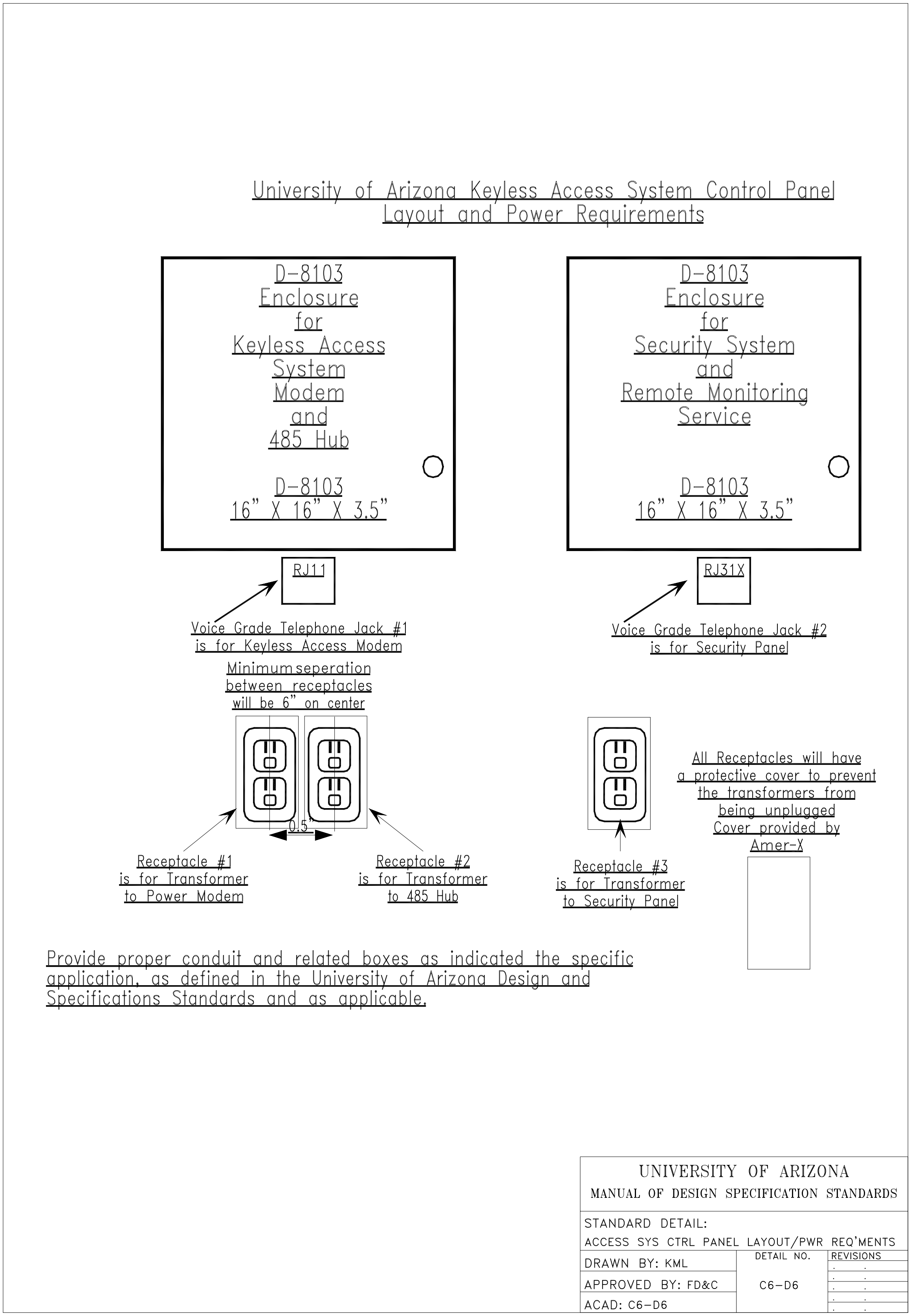
DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6–D4	
ACAD: C6–D4		

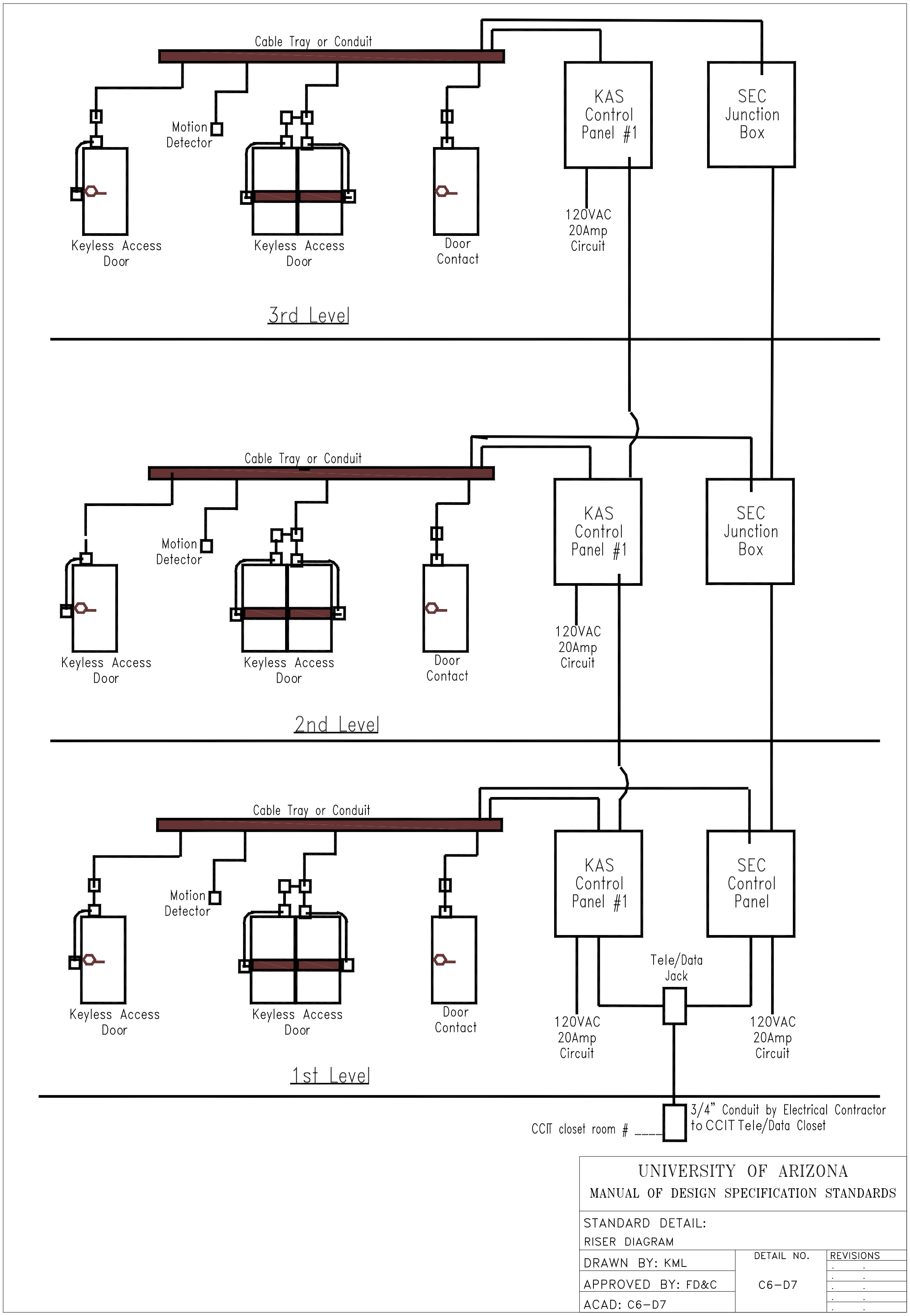
University of Arizona Keyless Access System
Control Panel
Layout and Power Requirements



Provide proper conduit and related boxes as indicated the specific application, as defined in the University of Arizona Design and Specifications Standards and as applicable.

UNIVERSITY OF ARIZONA MANUAL OF DESIGN SPECIFICATION STANDARDS		
STANDARD DETAIL: LAYOUT AND POWER REQUIREMENTS		
DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6-D5	
ACAD: C6-D5		


University of Arizona Keyless Access System Control Panel
Layout and Power Requirements
D-8103
Enclosure
for
Keyless Access
System
Modem
and
485 Hub
D-8103
16" X 16" X 3.5"
D-8103
Enclosure
for
Security System
and
Remote Monitoring
Service
D-8103
16" X 16" X 3.5"
RJ11
RJ31X
Voice Grade Telephone Jack #1
is for Keyless Access Modem
Voice Grade Telephone Jack #2
is for Security Panel
Minimum seperation
between receptacles
will be 6" on center
0.5"
Receptacle #1
is for Transformer
to Power Modem
Receptacle #2
is for Transformer
to 485 Hub
Receptacle #3
is for Transformer
to Security Panel
All Receptacles will have
a protective cover to prevent
the transformers from
being unplugged
Cover provided by
Amer-X
Provide proper conduit and related boxes as indicated the specific
application, as defined in the University of Arizona Design and
Specifications Standards and as applicable.
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS
STANDARD DETAIL:
ACCESS SYS CTRL PANEL LAYOUT/PWR REQ'MENTS
DRAWN BY: KML
DETAIL NO.
REVISIONS
APPROVED BY: FD&C
C6-D6
ACAD: C6-D6


Cable Tray or Conduit
Motion Detector
KAS Control Panel #1
SEC Junction Box
120VAC 20Amp Circuit
Keyless Access Door
Keyless Access Door
Door Contact
3rd Level
Cable Tray or Conduit
Motion Detector
KAS Control Panel #1
SEC Junction Box
120VAC 20Amp Circuit
Keyless Access Door
Keyless Access Door
Door Contact
2nd Level
Cable Tray or Conduit
Motion Detector
KAS Control Panel #1
SEC Control Panel
Tele/Data Jack
Keyless Access Door
Keyless Access Door
Door Contact
120VAC 20Amp Circuit
120VAC 20Amp Circuit
1st Level
3/4" Conduit by Electrical Contractor to CCIT Tele/Data Closet
CCIT closet room # ____
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS
STANDARD DETAIL:
RISER DIAGRAM
DRAWN BY: KML
APPROVED BY: FD&C
ACAD: C6-D7
DETAIL NO.
C6-D7
REVISIONS

University of Arizona
Keyless Access and Security Systems
Symbol List

KAS Control	Keyless Access Control with Hub and Modem
CR	Cat Card Reader
CR PP	Cat Card Reader with Pin Pad for PIN
ES	Electric Strike or Locking Device
ML	Magnetic Locking Device
SEC Control	Security Control Panel with Communicator
KP	Security System Keypad
C	Door Contact
MD	Motion Detector
M	Medical Assistance Call Device
P	Duress Assistance Call Device
T	Temperature Monitor
	CCTV Camera Location

UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS

STANDARD DETAIL:
ACCESS AND SECURITY SYSTEMS SYMBOLS LIST

DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	C6-D8	
ACAD: C6-D8		

TAB C-7

ROOM NUMBERING

Obtain building number and address from the Office of Space Management; Attn.: Johan M. Lahtinen.

All drawings issued for construction shall contain and reference accepted room numbers so that electrical panels, telephone backboards, air distribution devices, as-built information, balance reports, etc. will not have to be cross referenced or revised after occupancy of the space.

Renovation projects shall maintain the same room numbering sequence which presently exists within the building. Obtain a current key plan for the building and fit new room numbers into the existing scheme and the following protocol. Secure acceptance of room numbers before proceeding with any drawing schedules.

New buildings and additions shall generally adhere to the following room numbering protocol:

All room numbers shall consist of 3 primary digits.

The first digit shall identify the floor level. The first floor is always level 1 regardless if it is below, at or above ground level. Multiple basement levels will have to be treated as a special case.

The second and third digits shall be used to sequentially identify rooms on a floor level (01 to 99).

A fourth digit may be employed as a prefix to describe an independent building within a cluster or a sizable addition (i.e., N118).

From the elevator or main floor access; room numbers shall be assigned sequentially in a clockwise fashion left to right. Even numbers shall be used on the right hand side of the corridor and odd numbers on the left hand side. (When walking from the elevator or main floor access.)

Corridors shall be identified by a large even number and a suffix indicating the direction in which it runs (i.e. 500W).

Room numbering shall be assigned so as to allow for future room additions (i.e., spread the numbering system out so that infill numbers are available, based on available space).

An effort shall be made to maintain consistent room numbers for similar elements on each floor (i.e., if bathrooms are located in same area of each floor they should share common room number ending digits).

Rooms within a room (second order) shall be consecutively labeled alphabetically in a clockwise manner from left to right (i.e., 118A, 118B etc.). Additional rooms (third order) shall be sequentially numbered similarly (i.e., 118A1, 118A2 etc.).

Open vestibules and alcoves shall not be assigned permanent room numbers.

Scheduled door number references should match the room number to which it enters.

TAB C-9

DRAINAGE DESIGN GUIDELINES

During the project initiation phase the department of Campus and Facilities Planning (CFP) in conjunction with Facilities Design and Construction will determine if drainage issues need to be addressed with the project.

DRAINAGE REVIEW POINTS IN THE FACILITY DESIGN PROCESS

- Conceptual Design phase:

    - During this phase, a standard drainage report will be prepared by the design Consultant team, which documents the existing conditions on the project site.
    - At this point in time, the design Consultant should contact the Department of Campus and Facilities Planning (CFP) to review issues and technical data contained in the 1997 Comprehensive Campus Drainage Study.
    - In addition to documentation of existing conditions, the report shall draw conclusions about the drainage impacts of the project and what sort of mitigation may be needed.
    - The report shall conform, generally, to the format contained in the City of Tucson's "Standards Manual for Drainage Design and Floodplain Management in Tucson."
    - The report will be reviewed by Facilities Design and Construction (FDC) and CFP. CFP is primarily concerned with maintenance of the comprehensive campus drainage model, consistency with the Comprehensive Campus Drainage Study, and impacts on land use and development patterns. In addition to these topics, FDC will give attention to review of technical data presented in these reports.
    - Determine if construction activity resulting from the project will disturb *1acre* or more. If *1 acre* or more *is* disturbed a Storm Water Pollution Prevention Plan (SWPPP) will be required and an EPA NPDES Storm Water Construction General Permit must be secured. UA, Risk Management may be contacted for guidance in securing this permit and filing the associated EPA Notice of Intent (NOI).

- Schematic Design through Construction Drawings phase(s):

    - Beginning with the schematic design phase, drainage mitigation designs shall be developed by the design Consultant team.
    - Drainage mitigation designs will be submitted for review by FDC and CFP, and in some cases, other departments which may be concerned with a particular project.

DESIGN CRITERIA FOR SPECIFIC PROJECTS

- New Capital Facilities (Buildings, Parking Garages, Open Space, and Infrastructure)

    - Preliminary siting studies for new facilities shall consider information related to the existing drainage conditions of each site. The Comprehensive Campus Drainage Study (1997) shall be used as a reference.
    - New development shall not increase the quantity or rate of flow leaving a site that exists under current conditions.
    - Wherever possible, the quantity and rate of flow shall be reduced through the use of landscape swales and water harvesting.
    - In the case that the new development will increase flows, or if there is a significant open space to be developed in conjunction with the facility, consideration should be given to developing a larger detention basin.
    - The design contract for the facility shall include the requirement to conduct a drainage report documenting the impact of the facility on the existing drainage patterns, and any recommended mitigation. This report shall be based on the Comprehensive Campus Drainage Study (1997) model, and where applicable, the analysis shall include updating of the campus-wide drainage model.

  - Site development must occur in a way such that all flows exiting the project site remain in the current watershed sub-basin, so as to not impact drainage patterns in adjacent watershed sub-basins.

- New Surface Parking Lot Development

  - New surface lot development shall not increase the quantity or rate of flow leaving the site that exists under current conditions. In the case that the new development will increase flows, detention will be required to reduce flows.
  - Wherever possible, the quantity and rate of flow shall be reduced through the use of landscape swales and water harvesting.
  - The design contract for the lot shall include the requirement to prepare a drainage report documenting the impact of the facility on existing drainage patterns, and any recommended mitigation. This study shall be based on the Comprehensive Campus Drainage Study (1997) model, and where applicable, the analysis shall include updating of the campus-wide drainage model.
  - Lot development must occur in a way such that all flows exiting the project site remain in the current watershed sub-basin, so as to not impact drainage patterns in adjacent watershed sub-basins.

- New Athletic Facilities With Field Areas

  - Preliminary siting studies for new facilities shall consider information related to the existing drainage conditions of each site. The Comprehensive Campus Drainage Study (1997) shall be used as a reference.
  - New athletic facilities shall not increase the quantity or rate of flow leaving a site that exists under current conditions.
  - Facility development must occur in a way such that all flows exiting the project site remain in the current watershed sub-basin, so as to not impact drainage patterns in adjacent watershed sub-basins.
  - The design contract for the facility shall include the requirement to prepare a drainage report documenting the impact of the facility on existing drainage patterns, and any recommended mitigation. This study shall be based on the Comprehensive Campus Drainage Study (1997) model, and where applicable, the analysis shall include updating of the campus-wide drainage model.
  - Wherever possible, the quantity and rate of flow shall be reduced through the use of landscape swales and water harvesting.
  - Consideration should be given to designing fields in a way which will allow them to detain flows during major storm events (i.e., 100 year storms.) In lesser events, water would be detained in swales and landscaped basins along the perimeter of the field, but would not inundate the field surface.
  - In the case that the new facility will increase flows, or if there is a significant open space to be developed in conjunction with the facility, consideration should be given to developing a larger detention basin.

TAB C-11

ACCEPTABLE INDOOR AIR QUALITY PLANNING, DESIGN, AND CONSTRUCTION CRITERIA

CODES AND STANDARDS

- ANSI/AIHA Z9.5-1992: American National Standard for Laboratory Ventilation
- ASHRAE Standard 62-1999: Ventilation for Acceptable Indoor Air Quality, 1999
- The University of Arizona Manual of Design and Specification Standards (MDSS)
- SMACNA: IAQ Guidelines for Occupied Buildings Under Construction, First Edition, November, 1995

A. DESIGN

Purpose: To facilitate communication and improve understanding of indoor air quality issues among members of the design team and between the design team and the University and provide the basis for evaluating indoor air quality issues and the performance of the HVAC system during the commissioning process.

1. Identify and document all heating, ventilating, and air conditioning (HVAC) system design requirements, assumptions, and criteria. The following information shall be provided:

   1.1 Indoor design conditions for each building space:
   a. Temperature
   b. Relative humidity by season
      1. Maximum space humidity during all seasons: 50%
   c. Pressure relationship between adjacent areas

   1.2 Outdoor design parameters:
   a. Dry bulb and wet bulb temperatures
   b. Relative humidity
   c. Prevailing wind direction by season

   1.3 Building space information:
   a. Type
   b. Occupancy densities
   c. Activities
   d. Use patterns

   1.4 Internal loads for each building space:
   a. Lighting
   b. Equipment
   c. People
   d. Infiltration
   e. Any special or unusual electrical, thermal, or moisture loads

   1.5 Any odorous or hazardous pollution sources for which additional measures, e.g., local exhaust, additional dilution ventilation, are required.

1.6 Criteria utilized to determine outside air requirements for each building space.
   a. Minimum outside airflow rates shall be clearly indicated on design drawings.

1.7 Classification of air assumptions for exhaust and recirculation air streams shall be in accordance with Appendix A.

1.8 Air cleaning and filtration efficiencies and filter area.
   a. Filter area shall be clearly indicated on design drawings.

1.9 Means by which outdoor air quality has been assessed and outdoor air contaminants of concern (if any) and air filtration requirements determined to establish outdoor air intake location(s).
   a. The building site shall be surveyed for sources of contaminants (health, odor, or sensory irritation contaminants).

1.10 Criteria used to determine locations of air devices (e.g., supply, return, exhaust, etc.) to ensure proper dilution and mixing of air within each building space.

1.11 Means by which and locations where outdoor air can be measured and balanced.

1.12 Means by which temporary exhaust can be provided in the future to control strong source contaminants during shell space construction. For further information, refer to Appendix B.

1.13 Applicable codes, standards, regulations, etc.

1.14 Narrative describing the design and operation of the HVAC systems during occupied and unoccupied periods.

1.15 Description of HVAC system control sequence of operation and identification of control system setpoints.

1.16 Minimum and maximum flow rates for terminal units.

1.17 Description of building envelop construction, including locations of vapor and air retarders.

1.18 HVAC calculations, including cooling load, heating load, and exhaust flow rate calculations.

2. Integrate prudent design principles and features as indicated in the following paragraphs.

2.1 Locate outdoor air intakes away from known sources of contaminants, including, but not limited to, exhaust and vent outlets, plumbing stacks, emergency generator exhaust stacks, loading dock areas, flue stacks, and areas where people might congregate to smoke. For further information, refer to Appendix C.
   a. Preferred location of outdoor air intakes is above roof level.
   b. Outdoor air intakes should preferably not be located at ground level.

2.2 Locate exhaust and vent outlets away from operable windows and doors and property line. For further information, refer to Appendix D.

2.3 Bird screens shall be located over outdoor air intakes.
   a. Bird screens shall be constructed of galvanized or stainless steel. Bird screens shall be ¼-inch mesh.

b. Bird screens shall be accessible for cleaning.

2.4 Outdoor air intakes shall be protected from rain entrainment by louvers, mist eliminators, or rain hoods. For further information, refer to Appendix E.

2.5 Recirculation of air (for further information, refer to Appendix A):

a. Recirculation of Class 1 air is allowed.
b. Recirculation of Class 2 air within the same room is allowed; recirculation of Class 2 air is allowed in other rooms if particulates are filtered or the air is sufficiently diluted with Class I air.
c. Class 3 air can only be recirculated within the same room.
d. Class 4 air can be exhausted or recirculated if the air is filtered to Class 2 air criteria.
e. Class 5 air must be exhausted.

2.6 Provide access doors to the following components for inspection and cleaning purposes: outdoor air intakes or plenums; upstream and downstream surfaces of cooling and heating coils; air washers; evaporative sections and coolers; other heat exchangers; air cleaners; drain pans; fans, filters, damper sections, humidifiers; and air flow measuring stations (other than unit flow sensors).

a. Access doors shall be factory-fabricated, readily openable, and airtight.
b. Access doors shall be clearly indicated on the design drawings.
c. Access doors shall be clear of all obstructions and provide full access.
c. Air handling unit access doors shall be full man-doors or as large as equipment will allow.
e. Ductwork access doors shall be as large as ductwork will allow. If possible, ductwork access doors shall have a minimum size of 18-inches by 18-inches; 24-inch by 24-inch access doors shall be provided where possible. Hard ceiling or wall access doors shall be fire-rated and have a minimum size of 24-inches by 24-inches.

2.7 Air handling equipment shall be designed for no water droplet carryover. The MDSS requires air-handling equipment to have draw-through cooling coils having a maximum face velocity of 400 fpm properly and evenly distributed across the face of the cooling coil.

2.8 Drain pans shall be pitched towards the drain and shall be appropriately trapped. For further information, refer to Appendices F and G.

2.9 No internal exposed thermal insulation is permitted except as allowed by the MDSS.

a. Supply ductwork shall be wrapped on its outside surface with thermal insulation in accordance with the MDSS.
b. Internal exposed thermal insulation shall not be installed in medical areas, clean rooms, or high velocity ductwork.
c. Internal exposed thermal insulation may be used in acoustically critical applications where the University's written permission has been obtained.
d. If permitted, internal exposed thermal insulation shall be elastomeric closed cell, cleanable, non-biodegradeable, impermeable to water and moisture, and secured with welded pins and non-flammable adhesive. Internal exposed thermal insulation must have metal nosing or sleeves over leading edges at fan discharge, around access door openings, and at any point where the insulation is preceded by internally uninsulated duct. Internal exposed thermal insulation shall be kept away from intake screens, mist eliminators, louvers, and rain.

2.10 Air handling equipment and ductwork shall not be constructed of porous or semi-porous materials, e.g., concrete masonry units (CMU) or gypsum wallboard (GWB).

2.11 Potable water shall be used in direct evaporative humidifiers, air washers, and evaporative coolers.

2.12 Provide humidification only when absolutely necessary or when it is a special project requirement.
   a. Utilize steam-to-steam-type humidifiers only.

2.13 Provide continuous water bleed or automatic periodic drain combined with chemical water treatment to control scale and microbial growth in air handling systems designed to recirculate water from an open storage tank or sump of an evaporative cooler, air washer, or evaporative section of air handling equipment.
   a. If water treatment chemicals are used they shall not enter the air stream or must be acceptable for use in evaporative equipment and approved for this use by the University's Risk Management & Safety Department. To determine the acceptability of water treatment chemicals, contact the National Antimicrobial Information Network at 1-800-447-6349.

2.14 Filters shall be selected as appropriate for the application. For further information, refer to Appendix H.
   a. Filters for air handling equipment whose flow rate exceeds 4,500 cfm shall have a minimum sixty percent (60%) efficiency pre-filters and final filters with 80-85% minimum efficiency when passing a three (3) micron particle.
   b. Filters for all other air handling equipment shall have a minimum efficiency of sixty percent (60%) when passing a three (3) micron particle.
   c. Filter area shall be based on 400 fpm face velocity.
   d. Filter rack shall be constructed to allow no bypass of air.

2.15 Supply ductwork located in a return air plenum, chilled water supply and return piping, and domestic cold water piping below 55 degrees F shall be properly insulated to prevent condensation from forming. For further information, refer to Appendix I.

2.16 Insulation subject to damage or a reduction in thermal resistivity if it were to become wet shall be enclosed in a vapor retarder.

2.17 Outdoor air intake controls shall maintain no less than ninety percent (90%) of the design outside air flow rate at all times. For variable air volume (VAV) systems, refer to Appendix J.

2.18 Air handling system controls shall include an "optimum start-stop" provision to ensure that acceptable temperature, humidity, and ventilation is provided prior to daily space occupancy. For further information, refer to Appendix K.

2.19 Carbon dioxide ($C0_2$)-based demand control ventilation may be used, but must have a minimum outdoor air flow rate to control building sources. Refer to ASH RAE Standard 62-1999, paragraph 6.3.1 and Appendix D, "Rationale for minimum Physiological Requirements for Respiration Air Based on $C0_2$ Concentration" to determine the minimum outdoor airflow rate per person required for a specified $C0_2$ concentration.

2.20 Construction of the building envelope shall comply with all applicable code requirements relating to the control of water and water vapor penetration, air filtration, and entry of radon and other soil gases.

2.21 HVAC systems shall be designed to provide at all times no less than the minimum total amount of outdoor air required for ventilation by Table 2 of ASHRAE 62-1999.

2.22 Zone minimum airflow rates shall provide minimum outdoor air ventilation airflow rates during space occupancy.

2.23 Mechanical rooms shall not be used as air plenums. Air routed through mechanical rooms shall use hard ductwork only.

2.24 Utility fans serving fume hoods shall have a 3,000 feet per minute minimum discharge velocity in a vertically upwards direction and shall discharge at a minimum of ten (10) feet above the adjacent roof line. For further information, refer to ANSI/AIHA Z9.5.

2.25 Direct evaporative cooling may be used in air handling equipment only after the University's written permission has been obtained.

2.26 Direct evaporative cooling equipment:

a. Must limit space relative humidity to less than fifty percent (50%).
b. Must have no filter bypass.
c. Must be completely accessible, both upstream and downstream, for inspection and cleaning.
d. Must have no water droplet carryover. Manufacturers' recommendations for maximum allowable face velocities must be followed.
e. Must have filters upstream that have a minimum sixty- percent (60%) efficiency when passing a three-(3) micron particle.
f. Must have a water treatment system to prevent scale formation and anti-microbial growth that utilizes potable make-up water, blowdown, and water treatment chemicals.
g. Must use water treatment chemicals that do not enter the air stream or must be acceptable for use in evaporative equipment and approved for this use by the University's Risk Management and Safety Department. To determine the acceptability of water treatment chemicals, contact the National Antimicrobial Information Network at 1-800-447-6349.

B. CONSTRUCTION

Purpose: To ensure that work procedures and appropriate controls are utilized to minimize degradation of building indoor air quality during construction, renovation, remodeling, and maintenance activities.

1. Initial Planning

1.1 The party responsible for construction, renovation, remodeling, and/or maintenance activities must prepare a plan that addresses how indoor air quality issues will be handled during these activities.

a. If the activity only involves University staff, the responsible party will be a University department, e.g., Facilities Management, Facilities Design and Construction, Space Management, etc.
b. If the activity involves an outside consultant, the responsible party will be the consultant.
c. The University department or consultant shall contact and consult with the University's Risk Management & Safety Department during plan preparation.
d. The plan must be approved by the University's Risk Management and Safety Department prior to the beginning of construction.

1.2 The plan shall include the following information at a minimum.

a. Identification of potential work-related airborne contaminants, e.g., dusts and odorous or hazardous substances.
b. Identification of how contaminants may spread through the building.

c. Identification of how building occupants will be affected by the spread of such contaminants.
d. Identification and selection of feasible, specific control measures to keep dusts and odorous and hazardous substances out of occupied areas. These measures could include work area containment, modification of HVAC operation, reduction of emissions, intensification of housekeeping, rescheduling of work hours, moving occupants, defining re-occupancy criteria, etc.

2. Isolation of major construction, renovation, remodeling, and maintenance activities in occupied buildings. For further information, refer to Appendix L.

2.1 Affected areas in occupied buildings shall be isolated from adjacent non-affected areas through the use of temporary walls, plastic sheeting, or other vapor retarding barriers.

2.2 Affected areas shall be maintained at a negative pressure relative to surrounding non-affected areas.

2.3 Recirculating air ducts shall be temporarily capped and sealed. If particulates are the only indoor air quality concern, appropriate filters may be used in place of capping and sealing the ducts.

3. Protection of the building HVAC system from dust and moisture during major construction, renovation, remodeling, and maintenance activities in occupied buildings.

3.1 Supply air systems shall not be operated without filters in place.
a. Filters shall have a minimum sixty- percent (60%) efficiency when passing a three- (3) micron particle.

3.2 Building materials subject to degradation from ambient environmental exposure shall be protected and replaced if damaged.
a. Air handling equipment and ductwork shall be stored in a clean, dry location prior to installation and openings shall be securely covered to prevent entry of dust, moisture, and general construction debris and dirt.

3.3 In new construction air-moving equipment shall be used to "flush" the building to reduce off gassing of interior furnishings and finishes a minimum of 48 hours prior to building occupancy. For further information, refer to Appendix M.
a. Temporary filters shall be utilized in the air handling equipment during this period.
b. Filters shall be replaced after the flushing of the building has been completed.
c. Filters shall have a minimum sixty- percent (60%) efficiency when passing a three- (3) micron particle.

4. Notification of building occupants of major construction, renovation, remodeling, and maintenance activities.

4.1 Notify potentially affected building occupants of planned work via Facilities Management's alert notification procedure. A brief description of the work and the precautions that will be taken to protect the occupants' indoor air quality shall be included.

5. Substitution of equipment and/or materials:

5.1 Substitution of equipment and/or materials that may affect the HVAC system or its ability to maintain acceptable indoor air quality shall be reviewed by the University for consistency with documented design criteria.

5.2 Requests for substitution of equipment and/or materials shall be made in accordance with the requirements of Section 01600, Material and Equipment, of the MDSS (refer to MDSS tab D, Boilerplate).

6. Ongoing management after work has begun:

6.1 Specifications shall be monitored and enforced.

6.2 Periodic updates on progress shall be provided to building occupants.

APPENDIX A

CLASSIFICATION OF AIR

Return air, transfer air, and exhaust air shall be classified as follows:

Class 1: Air drawn from spaces without unusual sources of contaminants such as offices, conference rooms, classrooms, lobbies, retail spaces, coffee stations, storage rooms (except those housing high-emitting products such as paint supplies), equipment rooms such as air handling equipment rooms, elevator machine rooms, individual dwelling units including hotel rooms, and electrical/telephone closets.

Class 2: Air drawn from spaces that may have mild contaminant intensity, such as copy rooms, printer rooms, dining areas and break rooms, kitchenettes or dining areas with ovens or other cooking or food dispensing capability such as steam tables, cafeterias, laundry rooms, locker rooms, residential kitchens (general or hood exhaust), limited access non-residential toilet rooms (such as those in office buildings and other spaces not open to the general public), and residential or single toilet rooms and bathrooms (except those to patient rooms of health care facilities). For the purpose of this section, a copy or printer room is a room whose primary purpose is to house copy machines and printers, respectively. Air drawn from a room housing the occasional or personal copier or printer may be considered Class 1 air. [Air exhausted from limited access non-residential toilet rooms are placed in this category because the expected frequency of use of these facilities, combined with the minimum exhaust are rates prescribed in the Design Section 2.21., generally result in exhaust gases that have mild odor intensity. Exhaust from toilet rooms that are publicly accessible, particularly those that are heavily used at times such as in airports, theaters, and other assembly spaces, can be expected to have much higher contaminant concentrations and thus qualify as Class 3 air.]

Class 3: Air drawn or vented from locations with significant contaminant intensity, such as nonresidential and public toilet rooms (except those listed above under Class 2), toilet rooms and bathrooms to patient rooms of health care facilities, janitor's closets, commercial kitchens (general and non-grease hoods), laboratories (general exhaust), dry-cleaning processing establishment (general exhaust), indoor swimming pools, diazo printing rooms, and plumbing vents.

Class 4: Air drawn or vented from locations with noxious or toxic fumes or gases, such as paint spray booth, garages, tunnels, kitchens (grease hood exhaust), chemical storage rooms, refrigerating machinery rooms, natural gas and propane burning appliance vents, and soiled laundry storage.

Class 5: Effluent or exhaust air having a high concentration of dangerous particles, bio-aerosols, or gases such as that from fuel burning appliance vents other than those burning natural gas and propane, uncleaned fume hood exhaust, evaporative condenser and cooling tower outlets [due to possible microbial contamination such as legion Ella, the causative agent of Legionnake's Disease and Pontiac Fever].

APPENDIX B

SUPPLEMENTAL EXHAUST

The design documents shall indicate the means by which supplemental exhaust can be provided to meet the requirements of Construction Section 2.2. This section does not require special systems to be installed since they may be installed on a temporary basis, for example by temporarily removing windows for exhaust fans. Rather, this section requires only that the means be indicated in design documents so that it is available when the need for supplemental exhaust occurs in the future.

It is not uncommon for spaces to be temporarily exposed to strong sources of contaminants, such as during remodeling or after an accidental spill of a volatile liquid. These occurrences may be handled by temporary exhaust systems. In many cases, temporary exhaust is difficult to provide such as, in interior spaces of large buildings. To improve flexibility in future renovations, exhaust systems such as those serving toilet rooms can be designed to include additional capacity that may be manually (or automatically) invoked as needed during the building life. Smoke removal systems might also be used for this purpose if approved by the local fire district.

APPENDIX C

LOCATION OF OUTDOOR AIR INTAKES

[This section requires minimum separation distances for outdoor air intakes from known sources of contaminants adjacent to and in the vicinity of the building in order to minimize the introduction of contaminants.] Outdoor air intakes shall be located such that the distance measured from the closest point of the intake opening to the object, or point, listed in Table Cl exceeds the minimum separation distance listed in Table C1. See also Appendix D for restrictions relative to exhaust air outlets.

Exception: Shorter separation distances are acceptable if it can be shown that an equivalent rate of introduction of outdoor air contaminants will be attained using an alternative design, and if approved by the authority having jurisdiction.

The distances required in this section are minimums; in general, locating intakes as far as practical from contaminants sources reduces the likelihood of entrainment. Prevailing winds and airflow patterns around the building and building elements may also be important considerations for intake locations.

Table C1.
Air Intake Minimum Separation Distance

Object	Minimum Distance, m (ft)
Property line	1(3)
Garage entry, loading area, or drive-in Queue (Note 1)	7 (25)
Driveway or street	3 (10)
Limited access highway	7 (25)
Mantels or ledges (Note 2)	1 (3)
Landscaped grade (Notes 3,4)	2 (6)
Roof or grade (Note 4)	0.25 (0.75)
Cooling Towers (Note 5)	5 (15)

Note 1: These areas are likely locations where vehicles will be paused and idling, such as while paying parking fees or waiting for traffic in the case of the garage entry, while loading or unloading materials in case of the loading area, or waiting in line for drive-in restaurant or bank service in the case of the drive-in queue.

Larger separation distances may be needed if the intake is located directly above the likely location.

Note 2: Applies to mantles or ledges that are sloped less then 45 degrees from the horizontal and that are more than 0.15 m (6 in.) wide. [Such ledges tend to become bird nesting or "resting" places.]

Note 3: Landscaped grade is soil, lawn, shrubs, or any plant life within 0.5 m (1.5 ft)
horizontally of intake. [The purpose of this section is to minimize the introduction of pollen, odors and vapors from biodegrading materials, pesticides, bacteria, etc. from landscaping.]

Note 4: Intake must be at least 0.2 m (8 in.) above the average maximum snow depth at the intake.

Note 5: Applies to closest wetted surface of tower, such as intake or basin. See Appendix D for separation distance from tower discharge.

APPENDIX D

LOCATION OF EXHAUST AIR AND VENT OUTLETS

Exhaust air and vent outlets shall be located no closer to property lines, outdoor air intakes, windows, and doors, both those on the subject property and those on adjacent properties, than the minimum separation distance S listed in Table Dl. S is defined as the shortest "stretched string" distance measured from the closest point of the outlet opening to the closest point of the outdoor air intake opening, window or door opening, or property line along a trajectory as if a string were stretched between them. [For example, if a wall separates an intake from an exhaust as shown Th Figure Dl below the distance S is taken from the exhaust outlet in a straight line to the top of the wall over the wall then in a straight line to the intake. In this case, S-SI + S2 + S3.1

Figure D1.

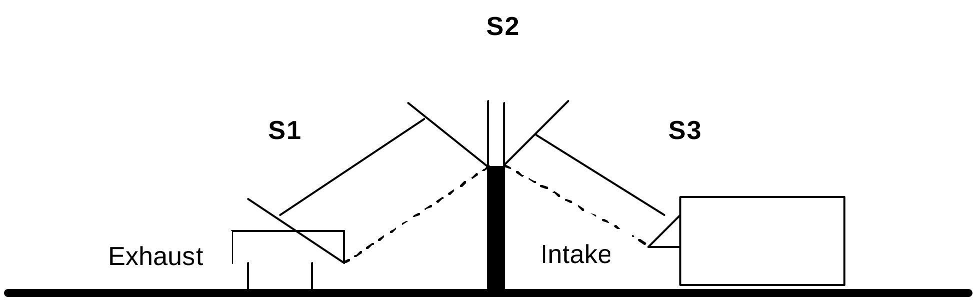


Table Dl
Exhaust Outlet Minimum Separation Distance (S), M (ft)

Object	Exhaust Air Class (see Appendix A for definition)				
	1	2	3(Note 1)	4(Note 1)	5(Note 1)
Outdoor air intake	Equation Dl	Equation Dl	Equation Dl (Note 2)	Equation Dl (Note 2,6)	Equation Dl (Note 2,6)
Operable window or door (Note 3)	0.3(1)	Half of Equation Dl (Note 4)	Half of Equation Dl (Note 4)	Half of Equation Dl (Note 4, 6)	Equation Dl (Note 6)
Property line	0	1.5 (5)(Note 5)	3 (10) (Note 5)	3 (10)	5 (15)

Note 1: Laboratory exhaust air outlets shall be in compliance with NFPA 45-1992.

Note 2: Class 3, 4 and 5 air outlets that terminate in an equipment well that also encloses an outdoor air intake shall meet the requirements of Table D1 and, in addition, shall either: a) terminate at or above the highest enclosing wall and discharge air upward at a velocity exceeding 5 m/s (1000 fpm); or b) terminate 1 m (3ft) above the highest enclosing wall (with no minimum velocity). For the purpose of this section, an equipment well is an area (typically on the roof) enclosed on three or four sides by walls that are less than 75% free area, and the lesser of the length and width of the enclosure is less than 3 times the average height of the walls. The free area of the wall is the ratio of area of the openings through the wall, such as openings between louver blades and undercuts, divided by the gross area (length times height) of the wall.

Note 3: Operable doors and windows that are required as part of a natural ventilation system shall comply with the row labeled "outdoor air intake."

Note 4: Separation distance S is one half of the requirement of Equation D1.

Note 5: For Class 2 and 3 air, where the property line abuts a street or other publicway, no minimum separation is required if exhaust termination is 3m (10 ft) above grade.

Note 6: For Class 5 exhausts located below intakes or operable windows and doors, distance S in Equation Dl shall be a horizontal separation only; no credit may be taken for any vertical separation.

Where Equation D1 is referenced in Table D1, minimum separation distance S shall be determined as:

$$S = 0.04vQ(vD - V/_{2} \qquad \text{(5-la) (SI)}$$
$$S = 0.09vQ(vD - VA/_{400} \qquad \text{(5-lb) (IP)}$$

Where:

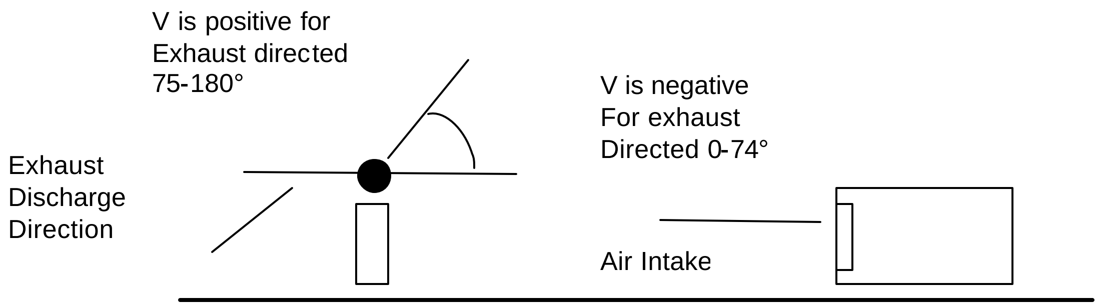
Q = Exhaust air volume, L/s (cfm). The value used in Equation Dl shall not be less than 75 L/s (150 cfm) nor exceed 1500 L/s (300 cfm) regardless of actual volume. For gravity vents such as plumbing vents, use an exhaust rate of 75 L/s (150 cfm). For flue vents from fuel burning appliances, assume a value of 0.43 L/s per kW of combustion input (250 cfm per million Btu/hr) or obtain actual rates from the combustion appliance manufacturer.

D = Dilution factor determined as a function of exhaust air class (see Appendix A) in the table below:

Exhaust Air Class	Dilution Factor, D
1	5
2	10
3	15
4	25
5	50

V= Exhaust air discharge velocity, m/s (fpm). V shall have a positive value when the exhaust is directed 75° to 180° away from the object, and shall have a negative value when the exhaust is directed 0 to 74 towards the object) as shown in Figure D2. V shall be set to 0 in Equation 5-1 for vents from gravity (atmospheric) fuel fired appliances, plumbing vents and other non-powered exhausts, or if the exhaust discharge is covered by a cap or other device that dissipates the exhaust air stream. For hot gas exhausts such as combustion products, an effective additional 2.5 m/s (500 fpm) upward velocity shall be added to the actual discharge velocity.

Figure D2.



Exceptions:

1. Shorter separation distances are acceptable if it can be shown that equivalent dilution factors will be attained using an alternative design, and if approved by the authority having jurisdiction.

2. Outdoor air intakes need not be separated from furnace vents and other fuel-fired appliance vents that are a part of a unitary or factory packaged heating/ventilating unit that is manufactured within 2 years of the publication date of this standard. This exception applies to the separation of the outdoor air intake and vent discharge of the unit itself and does not exempt maintaining separation distances from one unit to another adjacent unit. [The 2-year time delay is to allow manufacturers an opportunity to redesign and remanufacture equipment in order to meet the separation distances required by this section.]

Separation distances do not apply when exhaust system and outdoor air intake systems do not operate simultaneously.

Note that even where the required minimum separation distances are maintained, reentrainment of odors and toxic gases may still occur depending on wind conditions, building geometry, and exhaust design. An analysis of the air flow pattern around buildings and exhaust plume behavior using the methods described in the AHSRAE handbook, Fundamentals, Chapter 14 can provide more accurate information to assess the potential for reentrainment and to determine adequate separation distances.

[Equation Dl may be summarized as follows:

			Separation Distance At Zero Discharge Velocity		Minimum Discharge Velocity For Zero Separation Distance
Class of Air	Dilution Factor D	Square Root of D (vD)	Minimum (75 L/s. 150 cfm)	Maximum (1500 L/s. 3000 cfm)	
1	5	2.24	2.5	11.0	894
2	10	3.16	3.5	15.6	1265
3	15	3.87	4.3	19.1	1549
4	25	5.00	5.5	24.6	2000
5	50	7.07	7.8	34.9	2828

Example 1: a 2000 L/s (4000 cfm) dome type exhaust fan used for toilet exhaust (class 3 air per Section 5.4.1) is located on a roof near a rooftop unit. For class 3 air the intake must be located per Equation Dl. Since the exhaust fan discharge velocity is not directed away from the air intake (discharge is down to roof which then deflects out evenly is all directions), the velocity in Equation Dl is taken as zero. Since the exhaust volume exceeds 1500 L/s (3000 cfm), the value of Q in Equation Dl is taken as 1500 L/s (3000 cfm). The equation (in I-P units) is solved as:

S = 0.09 v3000 (v15-0/400
= 19 ft

Example 2: Instead of a dome exhaust fan in the previous example, an up-blast exhaust fan is used. The discharge velocity as obtained from manufacturer's data is 6.5 m/s (1300 fpm). The required separation distance is now:

S = 0.09 v3000 (v15-1300/400
= 3 ft

Example 3: The flue from a forced draft 880 kW (3 million Btu/hr) input natural gas boiler is located near an operable window. The discharge air quantity is approximately 380 L/s (750 cfm) assuming 0.43 L/s per kW of combustion input (250 cfm per million Btu/hr) (per definition of 0 above). The flue is terminated with a flue cap. So no credit for discharge velocity can be taken. However the flue gas is hot and buoyant and thus a 2.5 m/s (500 fpm) upward velocity may assumed. The minimum separation distance (in SI units) is:

S = 0.04 v380(v50-2.5/2
= 4.6 m

As a Class 5 air stream, distance S becomes a horizontal separation distance (no credit for vertical separation) when the discharge is below the window (see Note 6 to Table Dl).

Example 4: A rooftop AC unit has an outdoor air intake and economizer relief/exhaust outlet (class 1 air per Appendix A) configured as shown in the section below. The relief air (5000 cfm) is directed away from the intake at 2.5 /ls (500 fpm). (If the exhaust outlet distance above the roof is so small that air will be substantially defected toward the intake, V should be assumed to be zero in Eq. D1) Since the horizontal separation is zero, the minimum separation distance S is simply the vertical distance D in the figure below. Using the maximum value of 3000 cfm in equation D1, this distance must be:

S = 0.09 v3000(v5-500/400
=4.9ft

This separation is required not because Class 1 air is unhealthy, but to ensure the air entering the outdoor air is primarily unventilated outdoor air. This example demonstrates that it is impractical to place the intake and discharge as shown without significant recirculation. Possible solutions: Move the intake to the opposite side of the unit; increase the discharge velocity to more than 4.5 m/s (900 fpm); or add a baffle between the intake and discharge to increase the "stretched string" separation distance.

APPENDIX E

RAIN ENTRAINMENT

Outdoor air intakes shall be protected from rain entrainment by use of one of the following:

a. Louvers or mist-eliminators designed to limit water penetration to 3 mL per m2 (0.01 oz per ft2) of free area when tested in accordance with AMCA Standard 500-1994 (15 minute test period).

b. Rain hoods sized for no more than 5 m/s (1000 fpm) face velocity and tilted at least 45 degrees downward from the vertical.

c. Louver or mist-eliminators in conjunction with a drain pan complying with Appendix F.

Exposed Internal insulation shall not be located within 0.5 m (1.5 ft) downstream of the air intake louver, eliminator, or screen.

[Water droplets entrained in HVAC system outdoor air inlets provide niches for microbial growth.]

These rain entrainment requirements may not be adequate to control entrainment of snow. Preheat coils with downstream filters or some other scheme may be needed to avoid snow build-up inside outdoor air intakes or on filters.

APPENDIX F

DRAINS AND DRAIN PANS

Drain pans located in supply air ducts, plenums, fan coil units, and other locations shall be sloped and trapped as required to meet the testing requirements in Appendix G. Drains located upstream of fans (those negatively pressurized relative to outdoors or those negatively pressurized to air in a mechanical equipment room) shall have traps having a depth and height differential between inlet and outlet equal to or greater than the fan design static pressure$_1$ or otherwise sufficient to maintain a water seal and allow complete pan drainage with fans on or off. Traps shall have a means of inspection to verify that the water seal has been maintained [such as an open or screened tee on the downstream end of the trap.1

Condensate traps exhibit many failure modes that can impact on indoor air quality. Trap failures due to freeze-up, drying out, breakage, blockage, and/or improper installation can compromise the seal against air ingestion through the condensate drain line. Traps with insufficient height between the inlet and outlet on draw-through systems can cause the drain to back-up when the fan is on, possibly causing drain pan overflow or water droplet carryover into the duct system. The resulting moist surfaces can become sources of biological contamination. Seasonal variations, such as very dry or cold weather may adversely affect trap operation and condensate removal

Exception: Secondary or auxiliary drain pans intended only for emergency overflow collection.

APPENDIX G

TESTING OF DRAINS AND DRAIN PANS

Drainage of pans under cooling coils, air washers, humidifiers, outdoor air intake plenums, and other duct or plenum mounted drain pans shall be tested to ensure proper slope and drainage to prevent conditions of water stagnation that result in microbial growth. Drainage shall be tested using the following procedure:

a. Temporarily plug the drain and cover the entire pan with 13 mm (1/2 in.) water (or to the maximum allowed by the height of the pan)

b. Start the fan if it is downstream of pan (in the draw through position). [The fan system must be in operation to test for improperly trapped drains that become air locked when the fan creates a negative pressure in the cold plenum.] Stop the fan if it is upstream of the pan (in the blow through position). [Fan operation assists in coil drainage of blow-through system so the pan must be tested with the fan off]

c. Remove the temporary plug and observe the performance of the system. Drainage is considered acceptable when the pan drains within 3 minutes to leave puddles no more than 50 mm (2 in.) in diameter and no more than 3 mm (1/8 in.) deep.

d. For draw-through systems, check to see that the water seal is maintained in the trap with the fan operating. Stop the fan and recheck the seal. The trap is considered acceptable if the water seal is maintained in the trap with the fan both OFF and ON. [Traps are not required by this Standard for blow-through systems since supply air leakage out of untrapped drains is not an IAQ issue. Traps can be provided to eliminate this air leakage for energy conservation purposes.]

Exception: Secondary or auxiliary drain pans intended only for emergency overflow collection need not be tested.

APPENDIX H

MINIMUM AIR CLEANING AND FILTRATION

Mechanical systems that supply air to an occupied space through supply ductwork exceeding 3 m (10 ft) in length or through a humidifier, evaporative cooler, fin-tube heating coil, or cooling coil, shall be provided with particulate filters or air cleaners having a minimum efficiency of 60% when tested in accordance with ASHARE Standard 52.2 for 3 um particles. [This standard is pending approval. If it has not been published before this document, the requirement will reference 25-30% efficient filter as rated by ASHRAE Standard 52.1, Atmospheric Dust Spot Method.] Filters racks shall be designed to minimize the bypass of air around the filter media or filter cartridge frames when the fan is operating. [This section is intended to reduce the accumulation in duct systems and on duct components of dirt which may become a source of microbial growth or which may clog the system and affect airflow. It is not intended to address the possible use of cleaning return air to be used in lieu of outdoor air; which is covered in Section 6.4.]

The 60% filtration for 3 um particles is a minimum filtration requirement but some particulate accumulation within the ventilation system can still be expected over the life of the system. Where the system design can accommodate higher efficiency levels, efficiency levels of >65% for 1-3 um particles wm improve indoor air quality with respect to particles and wm reduce particulate accumulation in ak distribution systems where cleaning is often difficult. Efficiency levels >65% efficiency for particles >0.3 um wm be most effective where potentially large concentrations of respirable particles may occur.

APENDIX I

INSULATION OF COLD SURFACES

Insulation shall be provided on the following ductwork and piping where located within the building envelope:

a) Unlined cooling supply ductwork.

Exception:

1. Cooling ducts located within air-conditioned spaces.
2. In other than humid climates, cooling supply ductwork in return air plenums.

[The dewpoint of the return air will generally be less than the surface of the ductwork supplying air to the space. This exception does not apply to humid climates because condensation can occur due to infiltration of humid air into the ceiling plenum and during cool-down transients after moisture has built up in the space when the system was off. Note that insulation of supply ducts in plenums may be required by other codes or may be required to prevent excessive heat gain to supply air]

b) Chilled water supply and return piping, domestic cold water piping where primary water supply can be expected to be below 13°C (55°F) during the cooling season.

c) Domestic cold water piping where primary water supply can be expected to be below 13^0C (55^0F) during the cooling season.

The thickness of insulation shall be as required to prevent condensation on cold surfaces. Insulation that is subject to damage or reduction in thermal resistivity if wetted shall be enclosed with a vapor retarder sealed in accordance with manufacturer's recommendations to maintain the continuity of the barrier. Special coatings that inhibit condensation are an alternative to insulation if approve~ ~ the authority having jurisdiction.

[The purpose of this section is to prevent condensation, which may cause material damage or microbial growth indoor spaces. This section does not consider energy usage, which is covered by ASHRAE 90.1 - 1989.]

APPENDIX J

OUTDOOR AIR INTAKE CONTROL

Variable air volume systems (except those supplying 100% outdoor air) shall include controls and devices to measure outdoor airflow at the air handler and designed to maintain outdoor airflow not less than 90% of required levels over the expected supply air operating range. [A major consideration with VAV systems is that the negative pressure behind the outdoor air intake in the mixed air plenum will typically vary with supply air volume and at low supply volumes sufficient outdoor air flow may not be maintained if a fixed outdoor air intake damper position or even if a dedicated fixed minimum air intake is used. In most cases, an active outdoor air control system must be provided to ensure minimum rates are maintained.]

Acceptable air intake measuring devices include those that measure intake volume directly by measuring air velocity through an outdoor air duct or inlet of fixed area (e.g. duct mounted pilot or hot wire anemometer) or differential pressure across a fixed orifice (e.g. wide open damper or other non-adjustable duct mounted obstruction). If the system includes an outdoor air economizer; a separate minimum outdoor air damper may also be required in order to ensure adequate velocity across the intake for an adequate measurement. Note that a fixed speed outdoor air fan without control devices will not maintain rates within the required accuracy unless the fan curve is relatively steep with respect to changes in pressure and/or if the pressure changes in the mixing plenum are relatively small compared to the fan total pressure requirement. Using return air, outdoor air, and mixed air temperatures or $C0_2$ concentrations to measure air intake percentage is usually inaccurate when the outdoor and indoor values are close together and thus should not be used for this application unless it can be shown to meet the >90% accuracy requirement Similarly, measuring outdoor air by taking the difference between supply and return air flow measurements will also seldom meet the >90% accuracy requirement due to cumulative errors in air flow measurement and the generally small outdoor air flow rate relative to supply and return air flow rates.

APPENDIX K

PRE-OCCUPANCY OPERATION

Ventilation systems shall be operated prior to the time any space served is expected to be occupied for a period of time determined in accordance with the requirement specified below and documented in the ventilation system design documentation (see Design Section 2.18)...

Ventilation systems shall include either manual or automatic on/off controls that allow the fan system to operate whenever the spaces served are occupied. When thermostats used to control heating or cooling for systems that also supply required ventilation air include a manual switch accessible to untrained personnel that allows the fan to operate only upon calls for heating or cooling, controls shall be included to ensure the hourly average outdoor air supply rate and overall supply air rate are maintained. [Thermostats often have an "auto" position on the thermostat or subbase fan switch that cycles the fan only when heating or cooling is required. When the fan system also supplies ventilation outdoor air, this causes air supply to be discontinuous. Since many untrained people do not understand this, the switch is often placed in the "auto" position, resulting in inadequate ventilation.]

To comply with this section, the thermostat may be provided without an "auto " position, or with the control sequence in the "auto" position modified in a manner that either operates the fan on a continuous basis when the space is expected to be occupied or that activates a time or other device to ensure that hourly average supply air and outdoor air rates are maintained. Systems operated in this manner must be capable of supply more than minimum rates when the system is on in order to compensate for the time the system is allowed to cycle off.

In general, to comply with this section, programmable timeclock thermostats must be capable of operating the fan on the time schedule rather than simply changing setpoints on a time schedule. Note that many residential thermostats do not have this capability.

APPENDIX L

ISOLATION OF MAJOR CONSTRUCTION AREAS

Spaces of an occupied building that are undergoing major construction, renovation, or remedial work that become a temporary but significant source of indoor air contaminants (term “construction areas" hereinafter) shall be isolated from directly adjacent non-construction areas using temporary walls, plastic sheeting, or other vapor retarding barriers. These construction areas shall be maintained at a negative pressure relative to the adjacent non-construction areas by either exhausting construction areas and/or pressurizing adjacent areas. Recirculating return air ducts from construction area shall be temporarily capped and sealed to prevent the spread of contaminants to occupied areas served by the same system. Where particles are the only contaminant of concern, in lieu of capping off return ducts, return air shall be filtered as required to reduce particles with mean diameters less than 10 um (PM_{10}) to concentrations below those listed in table 5-1. For the purposes of this section, major construction areas within a building undergoing construction activities that require the temporary displacement of occupants for more than 48 hours, or new construction where spaces are newly completed (no former occupants). [This definition is intended to include major tenant work such as complete remodels plus major revisions that include demolishing or finishing drywall partitions, installation of new furnishings and carpeting. Minor touch-up painting and replacement of a small area of carpet are not considered significant contaminant sources.]

These requirements are also applicable to any other construction or installation of materials that generate significant contaminants. Contaminant concentrations within the construction zone itself are covered by applicable construction workplace standards from ACGIH, OSHA, or other local authority. Refer also to IAQ Guidelines for Occupied Buildings under Construction
(SMACNA, 1995a).

APPENDIX M

PURGING OF MAJOR CONSTRUCTION AREAS

After construction is complete, major construction areas, as defined in Appendix L, shall be purged by supplying or exhausting no less than the design outdoor air rate required by Section 6 for a period of no less than 48 hours before occupancy. When spaces are exhausted, make-up air may be drawn from adjacent non-construction spaces rather than the outdoors. The requirements of Appendix L, pressurization relationships to adjacent spaces, shall apply until the 48-hour period is complete.

Exception: If it can be demonstrated that an alternative ventilation scheme can provide similar results and if approved by the authority having jurisdiction.

These procedures are also suitable for any other construction or installation of materials that generate significant contaminants. Depending on the new materials in the space and the rate at which they off-gas, a shorter or longer purge period may be required. When ambient conditions and the HVAC system design permit. The effectiveness of the purge, can be enhanced by ventilating spaces at rates far exceeding minimum ventilation rates.