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# DIVISION 01 – GENERAL CRITERIA

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1.1 FORMAT

A. Contract documents are to be developed based on, but not limited to the University of California, Riverside Campus Standards and Design Criteria, California building codes, trade standards and practices. Campus Standards and Design Criteria required for the design of buildings, building additions, remodeling, or campus central plant utility extensions are generally covered in these Sections. Review the Project Planning Guide (PPG) and/or the Detailed Project Program (DPP).

B. The Campus Standards & Design Criteria manual is not a specification. This document was written in the 2004 Construction Specification Institute (CSI) section number format for the convenience of the University and the design team in order to validate quality and material concerns established as minimum criteria by the University. The architect, engineer, and other professionals of record or under contract with the University to develop design-build construction documents on a project shall have the responsibility and contractual obligation to develop the contract specification to the satisfaction of the University. The components shall be based on systems established in the project program and those required for a complete project or as required by the Request for Proposal (RFP) documents.

1.2 REQUIRED USAGE

A. This document contains standards, design criteria and required project documentation for civil, architectural, structural, electrical and mechanical systems on the UC Riverside main campus located in Riverside. Design professionals are required to adhere to the information provided herein. Items not specifically addressed are left to the Engineer's professional judgment and accepted industry practices, although they are still subject to the University's review and acceptance.

B. Each section of this Standard is intended to assist the designer with design information, which is considered unique to the University’s systems. The University prepared this document to serve as a vehicle to insure consistency, quality, and maintainability in system design on Campus.

C. Work at the University is subject to review and comment at any time during design or construction. Progress checks will result in written review comments. Respond to each comment with written action items or a plan for resolution of items.

1.3 CAMPUS DESIGN PHILOSOPHY

A. These standards were written to comply with the University's philosophy of:

1. The Campus Architect’s vision
2. 70 year life buildings
3. exceed the State’s Energy Code
4. sustainable design
5. 20 year deferred maintenance
6. Easily maintained and durable building materials and systems that require little maintenance.
1.4 CODE COMPLIANCE

A. The University is its own enforcement agency for code requirements except those regarding Office of the State Fire Marshal for life safety and fire codes, Division of State Architect (DSA) for access compliance, and the Office of Statewide Health Planning and Development (OSHPD) for medical facilities. For these code requirements, projects are subject to plan approval and enforcement authority by those three state agencies.

B. Refer to the Project Program and/or contract for applicable codes that are to be followed.

C. The University is not subject to the City of Riverside building ordinances and zoning requirements, although the University requires the design team to follow their codes and ordinances unless otherwise directed. Compliance with Riverside Public Utilities District (RPUD), City of Riverside, and City of Riverside Fire Department (CRFD) requirements shall be required as a minimum. Promptly advise the University, in writing, of any deviation from these.

1.5 PERMITS AND PLAN CHECKING

A. City of Riverside, CRFD, and RPUD plan check, and permits are not required for projects on the campus. The University does require that all projects be processed through UCR Plan Review and Building Permit Program for compliance with minimum State and Federal compliance standards (California Building Standards Codes, NFPA, ADA etc.) except as modified in this standard. City of Riverside Building permits are not required for work on campus property unless it will impact an adjacent local property (i.e., road intersections).

B. Since the University is the Authority Having Jurisdiction (AHJ), the Campus Building Official in Architects and Engineers (A&E) together with the Designated Campus Fire Marshal (DCFM) and DSA provide final approval before construction may start. Licensed Architect and Professional Engineer (PE) stamped drawing sets with wet signature shall be submitted for approval.

C. South Coast Air Quality Management District (SCAQMD) “permit to construct” is required for air pollution control devices and combustion sources.

D. DCFM plan check is required for every project. OSHPD plan check is required for Group I Occupancy buildings only or as directed. DSA plan check is required for access compliance only.

E. Campus EH&S checks plans for Cal-OSHA industrial safety requirements.

F. Medical projects, when directed by the University, shall be submitted to the OSPHD.

G. The University’s inspectors shall observe and approve materials, equipment and workmanship during the construction.

1.6 COORDINATION WITH UNIVERSITY

A. Coordinate with the assigned University’s Representative throughout design development to ensure systems are designed or any proposed changes are compatible with the University Master Plan, Campus Standards and the Detailed Project Program (DPP). Unless directed by the University’s Representative in writing, the most conservative or restrictive requirement shall apply.
1.7 EXISTING SYSTEMS

A. The University’s Representative will provide resource documents such as building and site plans, when available. The University’s Representative will coordinate contacts with University Departments. Do not make contact with any University personnel without the University’s Representative’s permission.

B. The Architects and Engineers of Record are responsible for their designs. Supplemental design information will be provided by the University when requested. A/E or Design Builder shall research existing conditions at the project site for exact point of connection for a complete and workable design and construction.

C. Modifications or extensions to an existing system within a building require a thorough analysis and understanding of the impact on the original system. Ensure that the design includes adjustments to the original building systems to return adjacent systems to original working capacities (include "as-built" drawings with modified performance values shown). If the original condition cannot be determined, then include the services of balancing technicians to determine the actual status of the existing systems.

D. Revisions to campus physical hardscape, site lighting, utilities and landscape shall be coordinated and be compatible to blend in existing with new.

E. Projects involving the modification, renovation, or rehabilitation of existing facilities do not always lend themselves to incorporating the "latest" standard of the industry. Some of the existing electrical and mechanical systems are outdated or inadequate for the new load. Make an early evaluation to determine the implementation feasibility of the latest standards. To support state-of-the-art research and medical care, the facilities must also be state-of-the-art. It is the intent to build and maintain the electrical and mechanical systems to meet the “latest” standards. Thorough field investigation of existing conditions is the soul of proper design.

F. The Campus Master Plan shall be coordinated with building utility and site plans by the A/E or Design Builder. The impact of new building additions and remodels will consider utility systems' available capacity. Computer modeling and calculations shall demonstrate the adequacy of utilities for the additions of new loads. If existing systems are inadequate to serve the new building or additions to a building, provide the University’s Representative with engineering support in identifying alternatives for connection to existing utilities. The University has available some existing utility master plan studies for use by the design team.

1.8 PROGRESS REVIEWS

A. Meet with the University’s Representative during the design to coordinate the progress of the work. Design reviews will be conducted during each design document submission required by the contract or Scope of Work.

B. Each design review comment (regardless of the source) is to be addressed in writing prior to completing the next phase of the project design. This action report shall be submitted to the University.

1.9 DRAWINGS AND SPECIFICATIONS

A. Contract drawings shall be drawn to scale no smaller than 1/8" = 1'-0" unless a smaller scale is specifically approved by the University. Site drawings shall be drawn to the same scale as civil plans except if an enlarged plan is used for a more detailed presentation. The drawing presentation is to be organized and sufficiently detailed to fully illustrate the work to be done.
1. The University's presentation standards, CAD Standards, legends, and symbols shall be followed.

2. The University will provide the project name, reference number and format requirements for drawing and specification presentation.

B. Equipment rooms, laboratory rooms, fan rooms, chiller rooms, substation equipment rooms, telephone rooms or other congested areas shall be detailed fully with plans and sections showing equipment, piping, panels, etc. These drawings shall be no smaller than 1/4" = 1'-0". A minimum of two sections is required for mechanical rooms.

C. Shop drawings shall be submitted at the following scales:

1. Piping and Ductwork @ ¼" = 1'-0"
2. Equipment Rooms and Sections @ minimum ¼" = 1'-0"
3. Tunnel Plan and Sections @ minimum ¼" = 1'-0"

D. Utilize the University's standard details that are applicable to the project. Changes to standard details require the University's approval. Provide additional details as required for equipment showing piping connections, electrical connections, clearance routing, appurtenances, supports, service clearance, and orientation. Details will be made available to the Consultant in AutoCAD drawing format for insertion into the contract drawings.

E. Provide a flow diagram in a ladder-type arrangement for each water, refrigerant, air, steam or thermal-fluid system on the project. Ladder-type arrangement is required to eliminate the line-crossing characteristic of a plan or isometric layout to enhance rapid understanding of a system. The University can provide further details of how to comply with this arrangement if requested.

F. Exterior metal, Electrical and Mechanical components exposed to ambient weather conditions shall be selected to minimize the corrosive and deteriorating effects of ocean, sun, wind, rain, temperature, etc. The Riverside campus is not close enough to the Pacific Ocean to experience deterioration from salt air.

G. Each project shall include a schedule on one of the drawing sheets that lists the building's rated capacities for plumbing, heating, cooling, and ventilating services. Additionally, the schedule shall indicate the additional design capacity included for each service to allow end users to determine the extent of additional load they can place within each zone. Equipment capacity requirements shall be placed in appropriate schedules on the drawings.

H. Provide an electrical load summary on the drawings showing available future load capacity of the system.

I. Each plumbing, HVAC and electrical system included in the project scope of work shall be represented on a drawing by a diagram defining the system in a non-dimensional or not-to-scale format. System definition drawings shall be prepared for approval in the preliminary design phase.

J. Calculations required by the State and the University to demonstrate performance criteria shall appear on the plans.

K. Plan drawings shall be prepared for building systems and other requirements in the project scope of work. Plan drawings shall include overall floor plans and enlarged plans of equipment rooms and other areas crowded with equipment. Where the space includes equipment, which must be coordinated among several disciplines for equipment location, or the assembly of
equipment must be clarified, provide a dimensioned elevation view of the enlarged plan. Enlarged plans and elevation or section views shall provide size and location details of the equipment arrangement. Additional space for future equipment as required by the project program or RFP shall be provided and shown.

L. Provide appropriate schedules and listings on drawings to identify the items, ratings, materials and installation requirements to fully define the components of the systems under design. If the work involves existing equipment and systems, include details necessary for clear identification of the scope of work. Equipment names, identification and circuit numbering shall be provided, approved by the University, and be consistent with the University Equipment Numbering and Identification scheme.

M. The University shall prepare General Requirements Division 01. Those general requirements may be referenced but shall not be repeated in sections of Division 02 through 33.

N. The University has developed UCR campus Master Specifications for sections of common and required materials to use on campus and to assist in producing Contract documents. Check with the University’s Representative for available sections. Sections will be supplied in Microsoft Word electronic file format. Review the specification for applicability to the Project. Any changes must be reviewed with the University. The files will be locked so that all revisions can be tracked. Conform to the current edition of the Construction Specification Institute (CSI) Master Format.

1.10 CAMPUS STANDARD EQUIPMENT

A. Manufacturers listed in the Campus Standard and UCR Master Specifications shall be provided as the basis of design and installation and to be reviewed by the University. Where a single manufacturer has been determined to meet the University’s Standard of quality or to be compatible with existing systems it shall be provided. If substitutions from the Campus Standard are necessary, submit substitution request form to the University’s Representative with comparative data.

B. Packaged mechanical equipment is usually not acceptable to the University because such systems do not provide adequate access for maintenance, service and repairs. Provide built-up systems using high quality, energy efficient equipment and materials.

C. Equipment that requires specialty tools for installation, maintenance, calibration, or testing shall have those tools supplied and turned over to the University. Equipment requiring proprietary tools shall not be used.

1.11 DESIGN ANALYSIS

A. Submit a complete design analysis for review with every submittal. Analysis shall list design criteria, assumptions, calculations, and equipment selections. Pages shall be numbered or separated by tabs and indexed to facilitate review. Provide as back-up data manufacturers catalog data showing equipment dimensions, weights, capacities, electrical requirements, and maintenance and operating clearance dimensions.

B. The project program or design analysis shall document any specific exception and compliance to the criteria herein. Generalized exceptions are not acceptable.
1.12 NOISE CRITERIA

A. Noise shall be controlled so as not to interfere with or disturb the building occupants. The University is very concerned about noise from mechanical and electrical equipment both inside and outside of buildings. Noise criteria shall be established during the project program phase. Do not assume that standard noise levels used in the industry would be acceptable. The University’s criteria will normally be more restrictive to maintain a quiet environment for a superior learning experience by our students and faculty. Please reference Section 13 for specific acoustical requirements.

1.13 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. Equipment shall be isolated from the building structure in such a manner that normal operation does not interfere with or disturb the building occupants. Vibration isolation equipment shall be installed per the vibration control manufacturer’s recommendations. Equipment shall be secured to structural, concrete bases or special supports to provide protection against earthquakes involving lateral and/or vertical movement. Where vibration isolators are used, the seismic restraints shall be designed to limit this lateral and/or vertical movement during an earthquake, but without short-circuiting the vibration isolation system during normal operation. Noise shall be controlled so as not to interfere or disturb the building's or adjacent building's occupants.

B. Seismic restraints shall incorporate a vibration isolator built into a welded steel mount assembly designed and engineered to limit movement of supported equipment during an earthquake without degrading the vibration isolation during normal equipment operating conditions.

C. Equipment shall be seismically braced and/or anchored in accordance with applicable seismic criteria in the CBC for earthquake Seismic Zone 4. Design team shall submit calculations prepared and signed by a professional engineer in the State of California. Ductwork and piping shall be braced and/or anchored in accordance with Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA), First Edition, 1991 with Appendix E, California Building Code, Title 24, Part 2 Standards, 1997 Addendum for Zone 4, seismic hazard level A.

1.14 SOIL CONDITIONS

A. Soil conditions on the Riverside campus may be corrosive to metallic materials. Installation of underground metallic materials shall comply with the project’s Geotechnical Report. Metallic materials shall not be placed underground without adequate corrosion protection. Copper, steel, and cast iron piping shall be protected with polyethylene tape and/or sleeve or other approved protection.

1.15 FACTORY WITNESS TEST OF EQUIPMENT

A. For major equipment, a Factory Witness Test may be required. Factory Witness Test shall be performed when directed by the University's Representative. This may include packaged air conditioning units, boilers, chillers, and pumps larger than 25 HP, fans, air handling units, gas turbine generators, emergency generators and steam turbine generators.
1.16 COORDINATION OF DRAWINGS

A. Coordinate the fire protection, plumbing, HVAC and electrical plans with other disciplines. The University shall administer claims resulting from lack of coordination and any additional project costs will be charged. Design and installation of electrical and mechanical systems requires close coordination with other disciplines. Coordinate the orientation and scale of floor plans and critical elevations and sections for design review and coordination checks to be accomplished.

B. Site utilities other than potable water, fire suppression water, reclaimed water, storm drain and sanitation sewer on civil drawings shall be noted as “For coordination and clarification only, see electrical, mechanical and plumbing drawings for construction”.

1.17 LAYOUT AND SERVICE CLEARANCES

A. Special attention shall be given early in the design process to provide code-mandated clearance, sufficient access space for maintenance of electrical and mechanical systems, as well as space for heat ventilation and dissipation. Equipment room layouts shall be designed using the largest physical dimensions for possible equipment that could be provided. Equipment specified in pure bid drawings shall fit within the allocated space. When space restrictions and weight restrictions exist in equipment areas, maximum equipment dimensions and weights shall be indicated on the contract documents.

B. The University will not accept designs unless the drawings clearly indicate locations of ceiling and wall access panels and other necessary access space. For electrical, access doors and panels shall be indicated on plans in addition to front and rear of equipment. Equipment ventilation requirements and clearances shall be shown on the drawings. Placement of equipment outside mechanical rooms must permit access from non-restricted, uncontaminated areas. Systems must be accessible for maintenance 24 hours a day, 7 days a week. Equipment requiring frequent service, more than once in six months, shall not be installed in occupied rooms or above ceilings in occupied areas.

C. Provide adequate maintenance and service clearance around electrical equipment, mechanical equipment, piping, valves, fittings, and accessory items. Provide adequate clearances to allow for removal and re-installation of coils, tubes, tanks, strainers, transformers, switchboards, panels etc. Openings shall be situated such that tubes, filters, etc. can be removed without bending. Provide unions or flanges and valves to permit disassembly of piping and equipment. Provide couplings in conduit systems to permit disassembly of conduit and equipment. Electrical equipment shall be located to allow access to mechanical equipment and plumbing for maintenance.

D. The minimum clearances given by manufacturers are only the minimum and must be increased. Equipment mounted on grade, floor, or roofs shall sit on a minimum 4” high concrete pad that extends beyond seismic mounting connections or 10 times bolt diameter from bolt to edge. For electrical equipment mounted on grade, floor, or roofs shall sit on 4” high concrete pad that extends 4” beyond seismic mounting connections.

E. These are University’s minimum requirements:

a. Provide minimum 36” on all four sides, measured from the edge of concrete pad or unit if it overhangs. For tube space, use manufacturer’s dimension + 1’0” (may use an operable opening beyond 36” of unit).

1. Air Handling Units (AHU)
b. Provide minimum 36" all four sides from edge of concrete pad. If no access doors exist on one side of AHU, the 36" could be reduced to 24" on that side. For coil pull space, use width of unit +1’-0”. May use an operable opening or door beyond 36” of unit for coil pull space. Show access door location on drawings.

1. Pumps

c. Base mounted, minimum 30" between pump concrete pads, 24” on motor end of pump and 48” on end suction side.

d. Inline, 12” to 48” above finished floor, 36” on one side and minimum of 12” from wall or other fixed construction or equipment.

   1. Water heaters = 36” on one side and 12” on other three sides.
   2. Control panel = show panel space 4’ wide and 6” deep with 36” clear in front.
   3. Fan = wheels over 30” diameter must be floor mounted and not hung.
   4. Filter = access shall be shown and accessible without a ladder. Filters over 8’-0” from floor or roof shall be provided with catwalks for access.
   5. Rooftop = mechanical equipment shall be located no closer than 10’-0” to a roof edge or adequate guardrail protection (rail, equipment screen or parapet) must be provided. Rail can only be used where it cannot be viewed from the ground.
   6. Mount piping fittings such as backflow preventers, pressure regulators, meters, etc. at 36” to 48” above finished floor. Provide minimum of 2’-6” working clearance.
   7. Terminal units, controls air valves and reheat coils control valve shall be provided with a 2’ x 2’ working space above a ceiling. Coordinate with recessed suspended ceiling so that a light fixture does not block access.
   8. Transformers – over 25 kVA must be floor mounted and not hung or elevated and have a minimum of 36 inches clearance in the front, 18 inches on the sides and 12 inches in the back. Note: Provide a permanent exit route to remove a network transformer while the other transformers remain in place and in operation.
   9. Switchboards – Shall have minimum clearances of 60” in front, 42” in rear, and 36” on the sides. “Front access only” switchboards are not permitted.
   10. Panelboards and Distribution Board – A minimum of 12 inches shall be provided between wall-mounted equipment. Top and bottom spaces shall be reserved for conduit and shall be clear of obstructions.
   11. Tunnel – 7-foot clearance height from floor after installations of every utility shall be provided. Required space for maintenance activities shall be provided.

F. In lieu of added or future capacity installed during original construction, the University requires that space be allocated for future use to install piping, ductwork and electrical systems. Provide shafts that are at least 25% larger than required for ductwork and pipiing. Provide access panels or doors to allow entrance into shafts for future installation of piping, ductwork or electrical conduits. Additional loads need not be included in the building design unless otherwise required by the RFP.

1.18 INTEGRITY OF FIRE RATED PARTITIONS

A. The integrity of fire rated partitions shall be maintained using UL, ICBO, and/or CSFM approved and listed materials. Detail how the entire assembly will meet fire-rating requirements. Fire-rated partitions shall be identified on plans.
1.19 MECHANICAL EQUIPMENT ROOMS, TRENCHES AND TUNNELS

A. Mechanical equipment rooms for energy conversion/generation and maintenance shall generally be in basements and located to minimize connection distance to central plant piping systems in the “ring” tunnel or underground location. For major projects over 10,000 sq. ft.), mechanical rooms shall include additional floor space, minimum 7’x7’ at one location. This is in addition to space for minimum clearances and future use. Identify additional space as reserved for maintenance 3’x7’ workbench area and record drawing/O&M manuals filing cabinet.

B. Mechanical equipment rooms and tunnels shall be lighted, ventilated and supplied with adequate electrical outlets and floor drains and/or indirect waste (floor sinks). Emergency lighting shall be provided. Provide at least one duplex outlet on emergency power in each machine room.

C. Floor drains shall be located within 5 feet of equipment using water. Floors shall slope to drains. Exposed drain piping that must be routed to floor drains must be organized so that it does not trip or cause injury.

D. Tunnels are to be designed for 7 foot walking height by 3 foot wide passageway after all utilities have been installed and shall allow adequate working space for any maintenance procedure required. Tunnels shall be separated from buildings with a 2-hour fire rated partition. Safety and egress shall be provided.

E. Trenches when provided utilities shall include adequate space for installation, x-ray of piping, installation of insulation and any future maintenance.

1. Trench and vault sections under fire lanes shall be designed for the traffic load of a Riverside County Fire Authority (RCFA) fire truck.
2. An oversized connection point to the existing tunnel may be needed to provide adequate room for pipe crossing and branches to buildings.
3. Trench construction shall include the following:
   a. Raised pipe supports to allow flow of water through trench without damming.
   b. The bottom of the trench shall slope to drain at a minimum slope of 1/8” per foot, the lowest end of the trench shall have a 12”x12”x12” sump and the sump shall drain to a storm drain through a 4” diameter pipe.
   c. Trench lids and trench construction shall be sealed water tight.
   d. Each section of the removable trench lid shall have four (4) Richmond type inserts for lifting mechanism attachment. The maximum weight of each lid section shall be 3000 lbs. Lids located over valves or expansion joints shall be one-half or smaller than the normal lid size.
   e. New trench shall be designed to functionally interface and connect with existing tunnel or existing trench. The design of the interface and connection shall require that elevations and joints be carefully designed to allow proper pipe routing, access and blending of lids/cover for a final installation that is aesthetically acceptable.

4. New utility trench system shall include removable concrete lids that must have finish surface, and edge design matching new adjacent hardscape surfaces. Trench lid design and adjacent hardscape areas will require special design considerations to ensure that the utility nature of the covers does not become a tripping hazard, nor and objectionable visual element within the landscape design context.
1.20 ELECTRICAL EQUIPMENT ROOMS AND SPACES

A. Electrical equipment rooms and spaces shall be dedicated to the electrical installation. The space above equipment shall be clear of piping, ducts or equipment foreign to the electrical installation from the floor to a height required by code.

B. Electrical equipment rooms shall include additional floor and wall space to be identified on plans as future use. The floor and wall space shall include 20% additional room for main electrical rooms and space for two panelboards beyond the requirements for the project. Space shall be located for expansion of switchboards, distribution boards, etc. that are furnished with expansion capability. Rooms shall be large enough to assure adequate working clearances and maintenance of equipment. Where Unit Substations are installed in an equipment room there shall be double doors. Each door shall be a minimum of 36 inches wide and 96 inches high. Where substations and switchboards exceed 1200 amps and are over 6 feet in length, at least two entrances to the room are required and shall be located at each end of the equipment. At least one door opening shall be the double door type described above.

C. Warning signs shall be provided at each entrance to electric rooms that state “Danger, Electrical Equipment, Authorized Personnel Only!” Warning signs shall be applied to equipment that state, “Danger, High Voltage.”

D. Equipment rooms and spaces shall be lighted, ventilated and supplied with adequate electrical outlets and telephone jacks.

1.21 UTILITY INTERRUPTIONS AND DIGGING PERMITS

A. Utilities generally cannot be interrupted and temporary service shall be providing. When connections or modifications to existing utilities has been approved for a shutdown, several agencies must be notified and time must be allowed for research to identify areas affected by the service interruption. Request for a required shutdown must be given to the University’s Representative not less than 30 days prior to the proposed shutdown. Provide a written procedure that will include a timeline of activities, duration from start to finish, coordination of trades and assistance required by the University’s facilities personnel. Provide a safety program for review with the procedure for connection to existing utilities. This request does not constitute an automatic approval by the Campus. Do not proceed until approval is received from the University’s Representative. No fee is assessed for the shutdowns. Failure to submit advance notification may delay shutdown, this will not be grounds for an extension of project completion date.

B. Digging permits are required for any trenching requiring shoring. Shoring is required for trench depths over 4'-0” below grade. Submit plans and shoring details for approval by EH&S for shoring permit. Before any digging is done, call “Dig Alert” and have University’s Representative contact Facilities Services Administration to locate any University utilities.

1.22 CALIFORNIA ENERGY CODE

A. The completed building must use at least 20% less than the energy budget if it had been built to meet the minimum requirements of 2013 California’s Title 24 Energy Code. Comply with the USGBC LEED Credit EA 1 to optimize energy performance to score as many points as possible with the goal of at least 4 points. Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of California Energy Code, as demonstrated by a whole building simulation using the energy budget.
B. The University’s "green" principles and the need to reduce the campus’ enormous utilities deficit require we exceed the Energy Code as much as possible. Taking into account our requirements for the envelope, HVAC and lighting provides a facility that will exceed the code. Our “green” principles include although not limited to:

1. Right size the mechanical and electrical systems to not oversize for future unknown loads.
2. Use best practice parameters for HVAC systems in terms of air-handler and filtration airspeeds, duct airspeeds, airflow transitions and turns, and total system frictional losses.
3. Low HVAC airspeed designs should employ no acoustic attenuators in ducts or plenums.
4. Labs should be designed for 6 or fewer air changes depending on use, with night setbacks to 4 or less air changes per hour.
5. Labs need to purchase the most energy-efficient freezers and refrigerators possible -- DOE-certified "Energy Star" as soon as these become available, or the equivalent.
6. Wet labs with combination fume hood and room exhaust need reasonable stack exhaust discharge airspeeds, even if the stacks have to get taller.
7. In non-lab spaces, the University encourages designs that depart from conventional VAV+reheat designs unless the latter can be made more efficient.
8. Pursue designs that use daylight and natural ventilation to the maximum extent that is cost-feasible.
9. Provide lighting designs that consume less than 1 watt/square foot.

C. Performance energy usage calculations for the total Envelope, Mechanical, and Electrical shall be submitted during design development and updated if the building envelope or systems change until accepted by the University’s Representative. Calculations shall be computer generated using EnergyPro or other University approved program to establish the building’s minimum energy requirements and to compare to the actual building design features being provided. Design shall exceed the baseline 2007 requirements by a minimum of 20% for the overall energy usage.

D. Energy Code calculations shall include the applicable Utility Incentive Worksheet(s).

E. Housing projects shall use residential computer programs approved by the California Energy Commission. Dormitory buildings are considered “hotel-motels” for Energy Code, and shall use EnergyPro.

F. Submit calculation to the University’s Representative. Show code requirements sheets on drawings, preferably on a single sheet at the front of the set.

1.23 ENERGY CONSERVATION

A. Energy Efficiency Design Criteria shall be implemented into new and renovation projects. Analysis utilizing DOE 2.1, Carrier EC 20-II HAP, Trane Trace-Ultra, ASHRAE 90.1 or other University approved computer programs shall be completed on these issues to determine whether implementation for the particular project involved is cost beneficial. When in disagreement with any mandatory requirement in this standard, document to the University that an energy efficiency measure is not cost beneficial for the specific application.

B. Computer modeling shall incorporate a sufficient number of zones to accurately reflect exterior exposure, building orientation, and functional use of space as characterized by occupancy and equipment schedules, etc. Electrical energy cost shall incorporate Southern California
Edison’s TOU-8 rate schedule for voltages over 50 kV in effect at the time of design. Input data and output results of computer analysis shall become the property of the University.

C. Research laboratory buildings and vivarium (animal facilities) with 100% outside air are the majority cooling and heating energy users on campus. Everything must be considered to reduce the cost of operation.

D. Implement design features, systems and enhancements that are cost beneficial in terms of the payback criteria when evaluated and designed as a comprehensive system. Definitions are as follows:

1. Comprehensive System: One that includes or recognizes all interdependent and interacting subsystems or elements.

2. Cost Beneficial: Refers to measures, features, systems, designs, etc., for which the (incremental) cost is recoverable by simple (non-discounted) payback in fifteen or fewer years for new buildings and in eight or fewer years for retrofit projects. This requirement is further explained as follows:

   a. A fifteen-year payback figure is longer than typical for several reasons. The University designs buildings for a long life span for economical use, within a context of under-funded utility budgets. This leads to a different view of “payback” compared to what might be utilized by a private-sector owner or landlord. Moreover, simple payback ratios may understate the true investment value of energy features to the extent that inflation is unrecognized.

   b. Where features/systems are interdependent in ways that might increase the payback period for measure A beyond 15 years if measure B reduces consumption (and therefore lowers the savings of other measures), “cost beneficial” will refer to the system of interrelated features, components, and measures that achieves the payback in combination.

   c. Computations of simple payback shall utilize the University's current or projected energy rates (lower than many large users due to 66-kV electrical supply and negotiated natural gas pricing) and University’s chilled water costs (based on thermal storage).

3. Payback calculations shall take into account maintenance expense and nonutility operating expenses as well as direct utility expense.

E. For each project, the University will provide current utility cost data, maintenance cost data, and other University-based cost data that is appropriate for making analyses and evaluations. The University will also provide occupancy and equipment schedules for the applicable building type and/or functional use.

F. The achievement of University’s goals and objectives for energy efficiency will influence certain programming requirements and decisions. Based on criteria that will influence their size, certain mechanical and electrical equipment and their associated distribution systems will require more space in both footprint and height than design teams have been historically accustomed to. The space required for access and maintenance shall not be sacrificed to satisfy space requirements for upsized mechanical equipment. Both need to be recognized and adequate mechanical space for both equipment and vertical transportation of ducts and pipes shall be recognized.
1.24 SYSTEM COMMISSIONING

A. The University requires projects to include fundamental building systems commissioning on every project to comply with the US Green Building Council (USGBC) LEED Energy & Atmosphere Prerequisite 1. Achieve LEED EAc3 Enhanced Commissioning when possible.

B. The University’s Representative shall determine the need for a Videotaped Training Session. If warranted, the Training Session for system start-up, operation, and maintenance procedures shall be videotaped and edited to provide a permanent, concise record of the training information presented. Videotape will be in addition to manuals and test data documentation.

1.25 UTILITY METERS

A. Buildings on campus shall have secondary “utility grade” metering in addition to any utility company’s meter. University-owned meters shall be provided for measurement of domestic water, reclaim water, high temperature water, natural gas, chilled water and electrical power. These meters are used for accounting energy costs to each end user, not as a source of revenue.

B. A bypass meter shall be provided at the fire suppression detector check valve assembly. Natural gas meter will also be provided if a building does not have its own meter provided by Southern California Gas Company (The Gas Company). Gas meters may need to be pressure and temperature compensated.

C. HTW, CHW, domestic water and reclaim water meters and gas meters shall be connected to the building’s digital control system. The campus’ electronic metering system will connect to the building’s digital control system.

D. Natural gas meters shall be equipped with local volumetric totalization. Fire bypass meters will be manually read.

E. Meter locations shall be coordinated with the University’s Representative. Selected locations shall be readily accessible, secure, and allow direct maintenance routing and reading and adequate space for calibration or repair.

1.26 CLASSROOM AND LECTURE HALL DESIGN CRITERIA

A. Refer to section 27 for Audio-Visual requirements and section 28 for security requirements.

B. Sending walls shall be finished with painted gypsum board over minimum 6” metal studs to allow for current and future installation of conduit and wiring. Exposed concrete, CMU or similar construction is not acceptable.

C. Projection Screens

1. Classrooms:
   a. Provide two Da-light manual recessed projection screens. Screens shall be sized in accordance with optimal viewing size for room size.
   b. Provide ceiling mount for data projector and cable path to lectern area.

2. Lecture Halls: Provide large motorized Da-light (4:3) projection screen sized to maximize projected image. Provide a smaller motorized Da-light (4:3) screen sized for
an overhead transparency projector. Both screens shall be supplied with low voltage controllers connected to the control panel at the lectern and to the projection booth.

D. Ceiling

1. Classrooms: USG Millennia #78705 2’x4’ ceiling tiles or equal. Equal materials shall be evaluated for acoustical and light reflectance properties.
2. Lecture Halls shall use ceiling materials appropriate to meet acoustic criteria and needs of the space.

E. Acoustical Performance: NC 25 – 30 for classrooms and lecture halls

F. Flooring

1. Classrooms: Vinyl Composition Tile (VCT) Armstrong Imperial Texture Excelon or equal.
2. Lecture Halls: Provide carpeting at aisles and front/back of room. Provide finished concrete under all fixed seats.

G. Chair Rail

1. Classrooms: Coordinate mounting height with selected chair/tablet arm height
2. Chair rails shall be hard plastic material attached to the wall with fasteners (no glue attachments).
3. Chair rails shall be 4” – 6” in width

H. White Boards

1. Porcelain on steel construction
2. Maximize area of boards based on room configuration
3. Classrooms
   a. Provide multiple white boards to cover the full sending wall.
   b. Provide sliding white boards for rooms with 50 or more seats.
   c. Provide white boards at one sidewall (preferably the side with the door and aisle), minimum 10 feet in length.
4. Lecture Halls
   a. Provide multiple white boards with vertical sliding systems to cover the full sending wall.

I. Seating

1. Classrooms with movable seating (up to 50 seats)
   a. Provide un-upholstered seat with stationary tablet arm.
   b. Design shall maximize tablet area.
   c. Seating shall be equal to Sierra School Equipment / Irwin Seating “Heidt” 1822TA.

2. Classrooms with fixed seating (50 seats or more)
   a. Provide un-upholstered seat with folding tablet arm.
   b. Design shall maximize tablet area.
c. Seating shall be equal to Sierra School Equipment / Irwin Seating #671 Lecture Fixed Pedestal with folding tablet arm

3. Lecture Halls
   a. Provide upholstered seat with rubber back and foldable tablet arm.
   b. Upholstery shall be selected for maximum durability (minimum rating 200,000 rubs).
   c. Seating shall be equal to Sierra School Equipment / Irwin Seating “Marquis”

4. Seminar Rooms shall be provided with tables and chairs.

J. Lecture Halls and Classrooms shall be provided with tables at the front of the room.

K. Disabled-accessible seating shall be provided in all rooms as required by current codes.

L. Lighting
   1. General
      a. All fixtures and lamps shall meet current Facilities Services Administration energy efficiency standards.
      b. Lighting shall be controlled by occupancy sensors, using a motion sensor switch pack Wattstopper #DT200 B27 or equal.
   2. Small Classrooms
      a. Provide 3-lamp, 2' x 4' fixtures – no parabolic lenses.
      b. Wire lighting to provide 4 zones (front and back, one or two lamps).
      c. Lighting shall be controlled by control panel at lectern (see technology section for additional information) with wiring to switch location (with blank plate) for future modifications.
   3. Lecture Halls
      a. Provide minimum 70 foot-candles at the stage and white board, dimmable to 2 foot-candles.
      b. Provide minimum 50 foot-candles at the audience, dimmable to 2 foot-candles.
      c. All lighting to be controlled by a lighting control system, Lutron or equal.

M. Student Tally/Response System: Lecture halls shall be provided with an audience response voting system of the most current technology. Current standards require a H-IIT Classroom Response System. Selected system shall be confirmed with the Director, Division of Undergraduate Education – Information Systems or his representative. System will be owner furnished and owner installed, provide rough-in only.

N. Projection Booths: Lecture halls shall be provided with a projection booth.

O. Aisle Lighting: Lecture halls shall be provided with low-level aisle lighting.

P. HVAC
   1. Lecture Halls: Provide HVAC controls to allow separate control of each lecture hall in accordance with the scheduled room use.
2. Classrooms: HVAC controls shall not combine control of classrooms with any other use. Control zones should be as small as practical.

Q. General Principles For Design

1. Classroom design on the University of California, Riverside campus shall generally follow industry standards for higher education.

2. Windows shall be provided in classrooms and lecture halls. If possible the preferred location shall be on the students left, when facing forward. Windows shall be north facing to avoid any direct sunlight glare. Provide electrically operated blackout curtains for windows. Locate the curtain operator at the sending wall. If operable windows are installed, ensure that noisy conditions are not adjacent to the windows, such as fans or traffic.

3. In addition, the following principles shall apply for all classrooms or lecture halls unless otherwise directed:
   a. Acoustically absorbent wall finishes shall be installed on walls. The best wall finish for an institutional setting is carpeting, installed with a pad underneath. The carpet shall have an open mesh backing, with an open-cell foam or felt pad. Carpet backing shall not be latex or any other coating that creates an impervious barrier.
   b. Carpet installed on vertical wall surfaces shall be hung on tack strips at the top and bottom, adhered to intermediate battens every 24 inches.
   c. Fabric wrapped acoustic panels (made from fiberglass or another sound absorptive material) can be utilized on surfaces six feet above floor elevation, where they are not susceptible to damage from students and faculty. No custom designed or fabricated acoustical finishes are allowed. In vestibules or other applications where acoustical insulation is needed but durability is essential, directly applied carpet shall be installed without a pad.
   d. Floor surfaces shall be carpeted above lecture halls, or any other application where overhead footfall could be a problem.

4. The architect shall follow the Detailed Project Program for general acoustical and sightline objectives. The University shall be provided with ray diagrams during schematic design for voice reflection and sightlines. Ray diagrams delineate how voice reflection from lecturer positions will reach the most distant seating as well as how sightlines from each row reach the lecture positions and chalkboard surfaces.

5. Design of a fixed seat rooms shall meet the following criteria:
   a. Wall and ceiling surfaces at the front of the room have an acoustically hard or non-absorptive surface and are angled so that the lecturer’s voice will reflect to the last rows of seating. Wall surfaces at the front of the room shall also be angled to reflect a lecturer’s voice to the most distant, opposite corner seats.  
   b. Wall and ceiling surfaces in the rear quarter of the room shall be acoustically absorptive, including the rear wall.
   c. Wall finishes in the front three quarters of the classrooms shall be acoustically reflective materials such as wood (above 6 feet), concrete, masonry or sheetrock, and be shaped or angled to optimize reflections from the lecturer to the most distant seating in the classroom. Material placed within 6 feet of the floor surface shall not be wood, due to lack of durability. The rear quarter of the classroom shall be an acoustically absorptive material such as carpet or fabric faced fiber panels, depending on location above floor.
   d. Audience risers may be employed to produce sightlines which clear the head obstruction in the row ahead by four inches, using the bottom of the chalkboard as the target objective.
e. Seating shall be based on a radial plan, with a center point approximately 30 feet behind the front surface of the classroom.
f. Efficiency of the seating per unit of aisle area shall be maximized by a widening plan to a maximum of 14 seats between aisles and 7 seats on wall side of aisles.
g. Stage or platform flooring shall be a hardwood surface. Flooring under seating shall be sealed concrete.
h. Ceilings and side walls shall have no sound absorbing or trapping elements such as pockets for speakers or lighting, reveals in panels or notches that face the “sending” end of the space.
i. Do not use wall wash fluorescent fixtures at the edge of the ceiling alongside walls.
j. The depth of the stage or platform shall be a minimum of 10 feet. Deeper stages may be required for laboratory or performance applications.

6. Vestibules shall be designed as follows:
   a. Carpet shall be provided on floors and walls, with an acoustically absorbent ceiling.
   b. Small fixed vision panels in doors to see if a lecture is in progress.
   c. Minimal lighting to avoid spillage into lecture hall during lecture.
   d. Hardware on doors shall be quiet operating type, and shall be avoided on inner doors.
   e. Wide single doors are preferred to double doors if possible.

7. Utilize a 1:12 sloped floor for the first three rows of seating, and raise the third row seat height 1 inch higher that the row 2 seat height to maximize sightlines. The third row shall transition to stepped risers, utilizing progressively increased riser height of no more than 3/8" increase per step (minimum riser 4", maximum 7.5"). At an appropriate point in the row progression, transition to two step risers. At two rows ahead of transition points, raise seat heights ½” and 1” respectively. Increase the seat heights in next to last row and last row ½” and 1” respectively.

8. HVAC distribution shall be designed at low pressures to produce quiet air delivery. Large, acoustically lined ductwork shall be used with fans being located in remote locations. Diffusers shall provide little resistance and produce little noise.

9. Side wall surfaces near ceiling near the front ¾ of classrooms shall be angled slightly downward to compliment acoustic quality. The angle shall be such that a ray from this panel would intersect the direct ray extending from the lecturer to the rear row listener.

10. Staggered seating is not necessary. The main objective is to attain good sightlines in terms of vertical displacement. The lateral vision cone is too limited, given the width of the chalkboards or projection screen to make staggered seating worthwhile.

11. Minimize the width of the recessed projection screen slot.

12. Projection room glazing shall be minimum 32-inches high and as wide as practical, float glass of mirror quality without any visual imperfections and with gasketed seals. To prevent reflections the glass shall be tilted.

R. Non-Fixed Seat Classroom

1. For classrooms with non-fixed seating, ensure that floor finish is carpet and that central part of ceiling, extending to ¼ of room dimension is acoustically reflective.
2. If fixed whiteboards and projections screens are required, specify sound absorbent material on the opposite or rear wall.
3. Doors to classrooms shall be single, wide gasketed doors, with no double doors.
1.27 LABORATORY DESIGN CRITERIA

A. Specific standards for equipment shall be developed in cooperation with the University's Representative, as required for each project.

B. Consideration shall be given to end user's requirements and to the University's concerns for durability, service-ability and maintainability, as well as to appearance values in selection and specification of such equipment.

C. General Laboratory Design

1. Lab bay spacing (most efficient = 11 ft module, which allows back to back work at fixed benches).
2. Fume hood sizes (avoid nonstandard sizes; utilize 5' or 6' "generic" units; latter may accommodate 2 users at little cost-penalty).
3. Omit fixed casework from some lab bays (leave space for movable casework systems).
4. Utilize "generic" lab casework (no C-frames, no expensive movable casework systems).
5. Design the laboratory ventilation system so that the fume hood face velocity averages 100 fpm with the sash position at 18 inches high. Individual face velocities shall not exceed 20 percent of the open-face velocity average. Readings shall be measured in the center of several square grids measured in the plane of the face opening.
6. Materials shall be corrosion resistant.
7. In order to avoid locations of high turbulence and to avoid blocking an exit if there is an emergency, locate fume hoods in distant corners of a lab and away from high traffic areas.
8. Room cross drafts shall be avoided. In order to yield high ventilation efficiency and minimize turbulence, provide supply air in a diffused manner from behind the operator.
9. Provide two feet of storage space for each foot of fume hood width. Ventilate half of this space. Provide sufficient protected storage space to accommodate new and waste chemicals. Without adequate storage space, containers of waste chemicals are often boxed and then stacked on the floor where they are subject to breakage that might cause occupant injury.
10. Do not install heated drying base cabinets under fume hoods.
11. Light fixtures in work areas such as at laboratory benches shall be parallel to and overlap the edge of the bench by 8 inches so that the person will not work in a shadow. The use of task lighting does not eliminate the need to design the lighting to prevent shadowing of the work surface. Task lighting shall be provided for additional lighting for work activities that require a higher intensity of lighting.

D. Supply Air Requirements

1. Prohibited: Auxiliary air supply hoods are prohibited.

E. Laboratory Ventilation Systems

1. Ensure that the laboratory is under negative pressure and has at least six air changes per hour.

F. Fume Hood Operation: In order to minimize the potential that hazardous operations could be conducted when the fume hood is off, fume hoods shall run continuously. On-off control is to be by maintenance staff only.
G. Fume Hood Construction

1. Non-combustible construction is required.
2. In order to minimize turbulence in the air entering the hood, utilize airfoil design.
3. Provide a vertical sliding safety glass sash, balanced and counter weighted so it can be raised or lowered with one hand from any point along the bottom.
4. In order to prevent opening above 18 inches without operator intervention, the vertical sliding safety glass sash shall have a positive steel mechanical latch. Latch shall be operable with one hand and allow unobstructed closing of sash from any position.
5. Provide an 11-inch to 12-inch wide horizontal sliding safety shield on four-foot and larger hoods. The shield shall be suspended on bearings or slide in an easily cleanable channel; it must be supported to resist pressure displacement and removal by the users.
6. Removable safety shields are permitted on hoods four feet or smaller. When removable shields are provided, do not consider the area of the shield when calculating fume hood exhaust volumes.
7. Provide an air by-pass so that hood face velocity shall not exceed 200 feet per minute as the sash is lowered.
8. Locate electrical outlets outside of the fume hood interior.
9. Locate utility (gas, water, vacuum, etc.) controls on the exterior of the hood with utility outlets mounted on the interior sidewall. Label and color-code controls.
10. Provide liquid-tight work surface built to contain at least 3/8-inch liquid depth.
11. Mount cup sinks on a raised lip; this will allow for some containment of a spill before the liquid flows into the sink. The raised cup sink shall be lower by 1/16 inch than the surrounding raised margins of the work surface.
12. Provide a baffle system that allows air to be drawn evenly to the top, middle, and bottom of the hood. Baffles shall be arranged so that it is possible to adjust the flow of the air but not shut it down completely. The top baffle must have an opening width no greater than 3/4 inch.
13. Provide an electronic airflow indicator with an audible alarm in a conspicuous location so that the user can see that safe airflow is present. Set the high airflow alarm at 150 fpm and the low airflow alarm at 80 fpm, except when variable airflow hood are at reduced airflow setting.
14. Interior lighting shall be vapor sealed and covered with a safety glass lens. Illumination levels at the working surface shall be at least 80 foot-candles.

H. Filter Enclosures

1. Prohibited: Proprietary or custom sized filters and pre-filters are prohibited.
2. When a filter enclosure is required it shall be easily accessible from the outside of the hood. Filter enclosure shall provide bag-in/bag-out of filters, so there is no exposure to maintenance staff from collected material.
3. On hoods with filter enclosures provide an indicator in a clearly visible location to indicate pressure drop across the filter.
4. The filter enclosure shall be air tight and constructed of stainless steel. It shall use a standard size pre-filter and charcoal and/or HEPA filter.
5. To allow for filter loading, the hood face velocity with the sash at 18 inches and a clean filter shall be 150 fpm. If a filter is not installed in the enclosure, the face velocity shall be 100 fpm. However, the system design shall include reserve capacity for the future installation of a filter.

I. Exhaust System Requirements

1. Prohibited: Fume hood exhaust volumes shall not be modulated or controlled to balance air requirements for air conditioning or heating.
2. Systems shall be installed in accordance with the requirements of NFPA 91, “Standard for the Installation of Blower and Exhaust Systems.”

3. General-purpose fume hood ductwork shall be stainless steel. The fan and housing shall be corrosion resistant.

4. Laboratory units shall have a one-hour fire resistance rating. Sheet metal ductwork is usually considered to provide one-hour fire separation. Where more than one-hour fire rated separation is required or if the use of combustible ductwork material is proposed, a duct work enclosure may be required to meet the required fire rating.

5. General purpose fume hoods may be ducted individually, or connected to a common exhaust duct leading from that room to an exhaust fan(s). If more than one hood is connected to an exhaust duct, a pressure control valve (PCV) or blast gate dampers must be provided. Fume hoods provided with filter enclosures shall always be individually ducted.

6. Fire dampers or other restrictions shall not be included in any chemical fume exhaust duct.

7. Fume hood exhaust systems shall function independently of the general building HVAC system.

8. Provide an independent exhaust system for associated equipment in the same room, such as flammable liquid storage cabinets, biological safety cabinets and atomic absorption units. In exceptional circumstances associated equipment may be exhausted into the fume hood ductwork. On hoods with filter enclosures, associated equipment shall be connected between the hood and the enclosure.

9. Ventilate equipment room where fume hood exhaust fans are located.

J. Fans and Discharge

1. Prohibited: Square to round fabric connector is prohibited.

2. Prohibited: Velocity cones are prohibited at the stackhead.

3. Discharge ducts and fan housing shall be airtight when fans are installed in an equipment room. Fan shafts shall be sealed. Seamless welded ductwork shall be installed on the discharge side of the fan. Transition fittings between the fan housing and discharge ductwork shall be factory fabricated with round connections. Flexible connectors shall have flanged ends and be factory fabricated.

4. Provide rain protection that does not increase discharge air pressure.

5. Stack-design and discharge velocity shall distribute contaminants outside the current envelope of the building. On structures with roof areas at more than one level, discharge ducts within 30 feet of a higher level shall terminate at a point at least 10 feet above the elevation of the higher level.

6. Clustering discharge ductwork helps to dilute discharges and increases effective stack height by increasing air column mass.

7. Attention must be given to maintaining maximum distance from building fresh air intakes. This means that air intakes on adjacent buildings must also be identified and avoided. At least 100 feet should be allowed between fume hood exhausts and fresh air intakes.

8. High duct velocity results in high noise levels, excessive leakage and high power consumption; therefore, air velocity on the suction of the fan shall be a minimum of 1,000 fpm and shall not exceed 2,000 fpm under any condition. A velocity of 1,200 fpm is recommended. Ductwork shall be round to assure uniform airflow.

K. Additional Requirements: Radioisotope Fume Hoods

1. Contact the Department of Environmental Health and Safety for construction requirements.

2. The interior lining and baffles of the fume hood shall be lined with stainless steel. The need for seamless welded construction is dependent on NRC license requirements.
3. The work surface shall be capable of supporting up to 200-pounds/square foot of shielding material.
4. Work surface corners shall be smooth and seamless with 1/2 inch radius.
5. An absolute filter enclosure is usually not required.

L. Additional Requirements: Perchloric Acid Fume Hoods

1. **Prohibited:** connecting Perchloric acid hood ductwork, other exhaust equipment is prohibited.
2. Hoods and exhaust ductwork shall be constructed of acid resistant, non-reactive, impervious materials. Duct work seams and joints shall be welded.
3. Duct work shall take the shortest and straightest path to the outside. Positive drainage shall be provided back to the hood.
4. A water spray system shall be provided to wash down the entire exhaust system from the hood interior behind the baffle, through the fan, up to the rooftop. The hood work surface shall be watertight with a minimum depression of 1/2 inch at the front and sides.
   An integral trough shall be provided at the rear of the hood to collect wash down water and direct it to a drain. The baffle shall be removable for cleaning. Provide a hose bib within 40 feet of the discharge stack to allow for manual wash down.
5. Provide controls so that the user can easily initiate wash down. Provide an automatic wash down cycle, the duration of the automatic cycle depends on the configuration of the ductwork. Because wash down of a contaminated hood requires up to 24 hours of continuous washing, provide manual over ride of the automatic cycle.
6. Provide an easily readable placard stating: "FOR PERCHLORIC ACID OPERATIONS - WASH DOWN OFTEN."

M. Additional Requirements: Radioactive Fume Hoods

1. Requirements for radioactive fume hoods shall include the design requirements indicated for the General Purpose Fume Hoods above, with the addition of the following:
2. Hood superstructure shall have a complete type 304 stainless steel lining and baffle, including stainless steel work surface reinforced to support 200 pounds per square foot. All interior corners shall have a 1/2 inch radius.

N. Flammable Storage Cabinets Design Requirements

1. Each laboratory may use a fume hood base cabinet for flammable storage; however, cabinets shall be properly ventilated.
2. When installed under a fume hood, the cabinet shall be ventilated to maintain air pressure by a duct penetrating behind the baffle to at least one inch above the work surface. Make up air supply for the cabinet shall be taken from the pipe space behind the cabinet; supply vents shall not be placed on the front or side of the cabinet to avoid drawing hot gases from the laboratory fire into the cabinet. Flame arrestors shall be provided on all flammable storage cabinet vents.
3. When the cabinet is free standing, it may not be necessary to ventilate it. The front of the storage cabinet shall be labeled with at least one inch high, 1/4 inch stroke red letters on a contrasting background “FLAMMABLE-KEEP FIRE AWAY.”
4. Cabinet shall be 18 gauge (minimum) double wall construction with 1-1/2 inch air space between walls.
5. Cabinet bottom shall be two inches deep, removable liquid tight pan.
6. Cabinet ventilation rate shall be five cfm minimum through a stainless steel duct extending one inch above hood work surface behind hood baffle. Make-up air shall be taken from pipe space behind cabinet and flame arrestors shall be provided on the cabinet inlet and outlet vents.
7. Exterior exposed surfaces shall be painted with yellow, and labeled “FLAMMABLE KEEP FIRE AWAY” with one inch high red letters.
8. Flammable liquid storage areas shall comply with NFPA 45 or 99. Base cabinets of hoods may be used as a flammable liquid storage.

O. Corrosive Chemical Storage Cabinets

1. Corrosive chemical storage base cabinets shall be constructed with a complete corrosion resistant liner. The cabinet must be ventilated at the rate of at least 5 CFM.
2. When installed under a fume hood, vent pipes shall extend above the work surface and behind the fume baffle to at least one inch above the work surface. Flame arrestors are not required. Relief air vents may be provided in the cabinet door.
3. If installed under a fume hood, the cabinet may be ducted to the fume hood or general exhaust. The cabinet shall be provided with a liquid tight pan that is capable of holding a two inch depth of liquid. Cabinets shall be labeled with at least one inch high; 1/4 inch stroke letters “ACID STORAGE.”

P. Gas Cabinets

1. Gas Cabinets shall be constructed on not less than 12 gauge steel. In order to access and view controls, cabinets may be provided with self-closing, limited access ports that may also have a safety glass window. Gas cabinets shall be exhausted; cabinets may be ducted to a fume hood or general exhaust. If provided with an access port, the average face velocity across the open port must be at least 200 fpm.

1.28 COMMUNICATION ROOM DESIGN CRITERIA

A. General Requirements for Telecommunications rooms or Main Distribution Frames, (MDF) or Intermediate Distribution Frames, (IDF)

1. The main equipment room is where inside and outside cables and conduit terminate. It is usually referred to as the MDF (Main Distribution Frame). It is also the usual location for most of the electronic hardware associated with the building's telecommunications facilities, including data equipment. They could even house PBX switching equipment if necessary. Ancillary equipment rooms are usually referred to as IDF's (Intermediate Distribution Frames). The changing technology along with user's data requirements has caused a corresponding increase in the electronics required in the equipment room, thus an increase in space, power and HVAC requirements.

2. Design specifications to consider for the MDF:

a. The MDF is generally located in the basement or bottom floor of a building. IDF's located on the floors above are generally "stacked" above the MDF to allow for ease of cable distribution and limit cable distances. Cable distance is an important factor for data users. Most data communications systems are limited to 300 feet maximum, to allow for 1000 Mbps over 23 -24 AWG twisted pair telephone cable. Because of these factors, it is extremely important to know the user's requirements for data as early in the design phase as possible.

b. MDF/IDF's shall not be co-located with electrical equipment due to the EMI mechanical noise transmitted from the electrical equipment. This noise interferes with most voice and data equipment, thus the reason for segregation.
c. Room size: (MDF) 12' W x 8' H x 10' L minimum, (IDF) 8' W x 8' H x 8' L minimum. The size may vary depending on the amount of communications equipment needed.

d. Backboard size: 8' x 8' x 3/4" white intumescent painted with exposed fire-retardant treated stamp, plywood backboard for cable terminations and electronic equipment, with a minimum 4’ clearance in front. It is mandatory that this room lock securely. If a double door is used, there shall be no center posts or sills.

e. The lighting fixtures shall be hung at 8'-6" from the floor. No ceiling tiles shall be installed in a telecommunications closet.

f. Maximum distance from the furthest jack to the terminal room on the floor shall be 250 feet.

B. Ceiling Height

1. The minimum ceiling height is 8'-6" above the finished floor. Suspended ceilings are not permitted.

C. Doors

1. Design to have fully outward opening (to 180 degrees recommended), lockable doors that are at least 3'-0" wide and 7'-0" tall.

2. Door sills are not allowed because they impede the movement of equipment. Removable mullions are permitted, if required.

D. Dust and Static Electricity

1. Avoid dust and static electricity by:

   a. Installing tile or sealed concrete instead of carpet.

   b. Treating floors, walls, and ceiling to minimize dust.

E. Environmental Control

1. Provide HVAC that will:

   a. Maintain continuous and dedicated environmental control (24 hours per day, 365 days per year). If emergency power is available, consider connecting it to the HVAC system.

   b. Expectable temperature range is 64-75 degrees F, with a humidity range from 30 to 55% relative.

   c. Maintain positive pressure with a minimum of one air change per hour in the telecommunication rooms.

   d. Dissipate the heat generated by active devices.

   e. Each telecommunication room will require an independent thermostat to control the air within the respective room.

F. Fire Protection

1. Provide fire protection.

2. If sprinkler heads are provided, install wire cages to prevent accidental operation.

3. Install fire rated plywood on the backboards and paint with intumescent white.
G. Flood Prevention

1. Locate telecommunication rooms above any threat of flooding. Avoid locations that are below or adjacent to areas of potential water hazard (e.g., restrooms and kitchens).

H. Location

1. To minimize the horizontal cable lengths (with a maximum of 300 ft), locate the telecommunication rooms as close as possible to the center of, and on the same floor as the area it is intended to serve. Another terminal room shall be provided if the distance is exceeded.
2. Telecommunication room’s location may also be limited by the maximum cabling distances possible to the various end user equipment throughout the serving area.
3. Ensure that telecommunication rooms are accessible from a hallway or other common area. Telecommunication rooms that serve multiple tenants must be accessible from a public hallway or other common area that serves the same tenants as the telecommunications rooms.
4. Telecommunication rooms in multi-floor buildings should be stacked vertically.

I. Other Uses

1. Telecommunication rooms must be dedicated to the telecommunications function and related support facilities.
2. Equipment not related such as piping, duct work, and distribution of building power must not be located in, or pass through, the telecommunication rooms.

J. Wireless Network Designs

1. Although it is not the designer’s responsibility to design a wireless network, it should be noted that sheetrock that is coated with foil, or other unique materials designed into a building should be made known to NACS for the wireless design process. Typically any metal covered large flat panels located within the building will inadvertently impede the signal propagation. Please notify NACS if these types of building materials are proposed for any of the walls within the building.

1.29 JANITOR CLOSET DESIGN CRITERIA

A. General requirements for Janitor Closets

1. A janitor closet shall be centrally located on every floor level, preferably adjacent to the restrooms. One main room sized at 7’W x 12’L x 10’H shall be provided on Service or Main Level and smaller rooms sized at 7’W x 6’L x 10’H shall be provided on other levels.
2. Partitions shall be abuse-resistant gypsum board and go up to deck if no ceiling or provide gypsum board ceiling to provide a secured room.
3. Lockable doors that are 3’-0” wide and 7’-0” tall.
4. Provide 28” x 28” x 13” eamed iron service sink (mop sink) in the corner adjacent to door with polished chrome finish wall-mounted utility faucet with threaded hose end. Provide vinyl rim guard and flat grid drain.
5. Provide stainless steel mop/broom holder rack with four (4) spring loaded rubber cam holders mounted at 66" A.F.F. (to centerline of holders) with one half of the rack over the mop sink.

6. Provide three (3) stainless steel shelves, 7' long by 12" deep, starting at 48" A.F.F. at 12" apart vertically.

7. Provide Fiberglass Reinforced Plastic (FRP), or ceramic tile wainscot to 60" A.F.F. beginning at the door frame, continuing completely around the service sink and extending 12" past the end of the mop/broom rack.

8. Provide exhaust. See Section 23 for requirement.


10. Provide slip resistant sealed concrete floor with 6" high cove base and raised threshold at door.

11. Provide two coat hooks mounted on door.

12. Equipment not related such as water heaters, electrical panels must not be located in janitor closets.

B. In addition to the above, the main janitor closet shall have the following:

1. One GFI duplex outlet.

2. 3" floor drain at center of room. Slope the floor toward the drain. Flood test the floor after installation and make whatever corrections needed to ensure positive drainage.

C. Backing shall be provided in walls for all fixtures as required per Campus Standard and current CBC.

D. See Campus Standard detail 01-100 for detail of Janitor Closets.

1.30 UC POLICY ON GREEN BUILDING DESIGN

A. UC Riverside by UC policy shall incorporate the principles of energy efficiency and sustainability in all capital projects within budgetary constraints and programmatic requirements. UC Riverside’s minimum requirement is to attain USGBC LEED “certified” rating and strives to achieve “Silver” certification whenever possible (based bid LEED certification level required for project is described in specification section 01 8113, Sustainable Design Requirements).

B. Prerequisites requirements from the LEED program must be incorporated into each project, as applicable.

C. Provide areas dedicated to recycling as required by Materials & Resources prerequisite MRp1: Storage & Collection of Recyclables Required.

1.31 ROOM NUMBER SYSTEM

Note: UCR does NOT number rooms sequentially!

A. Use a 4 digit numbering system (B100, 1000, 2100, 3200, etc.). The first number shall be the floor designation number; basements shall have the letter “B”, followed by a 3-digit room number.

B. Start at main entrance. Suites on left side of a lobby, hallway or corridor and going clockwise shall be even number sequence skipping every other number (i.e. 1002, 1006, 1010) and suites on the right side of a lobby, hallway or corridor and going counterclockwise shall be odd number
sequence skipping every other number (i.e. 1101, 1105, 1109, etc.). Skipping numbers provides room numbers for future changes, renovation or expansion.

C. Rooms within a suite:

1. The first number shall be the floor designation number. The second number shall be the suite number. The last two numbers shall be the room identification number within the suite. (i.e. First floor, Suite 100, rooms 1, 2, and 3 will be numbered 1101, 1102, 1103, etc.).

2. Multiple entry doors into a folding or accordion partitioned space shall have a separate room number on each side of partition.

3. Rooms less than 50 square feet, located off of a larger room shall be the larger room number followed by a letter (i.e. 1100A, 1100B, 1100C, etc.).

4. Bathrooms, toilets, janitor rooms, electrical rooms, mechanical room, telecom/data, etc. shall have the same numbering scheme as above.

5. Stairs shall be numbered as "Stair #1", Stair #2, etc. Do not use letters or four digit numbering scheme.

D. Hallways, Corridors, Vestibules and External spaces and equipment yards (i.e. rooms that will not receive signs): The first number shall be the floor designation number. The second number shall be 9. The last two numbers shall be the room/area identification number as needed.

E. Special instructions: Buildings with wings (e.g. McGaugh Hall, Reines Hall, etc.), follow same instructions as above except:

1. One wing shall have 1st digit floor designation followed by 2nd digit even number suites (i.e. 1000, 1200, 1400, etc.).

2. Other wing shall have 1st floor designation followed by 2nd digit odd number suites (i.e. 1100, 1300, 1500, etc.).

3. Do not use north, south, east or west for a room designation number.

1.32 ROOM & DOOR IDENTIFICATION SIGNS INSTALLATION

A. Multiple entry doors into a suite shall have the same room number sign at each door.

B. Hallways, corridors, and lobbies shall not receive physical room signage.

C. Vestibules shall have room number sign of larger room.

D. Exterior doors and intervening doors in hallways:

1. Mount centered at top of doorframe for Facilities Services Administration maintenance identification only sign (non ADA compliance issue).

2. Beginning at main entrance, use the floor designation number (usually B or 1) followed by a letter (i.e. “Door” B-A, 1-A, 1-B, etc.).

E. Stairway doors:

1. Mount centered at top of doorframe for Facilities Services Administration maintenance identification only (non ADA compliance issue).

2. Use the letter “S” (-), followed by stairway number and then (-) floor designation number (i.e. S-1-1, S-2-1, S-3-1, etc.).

END OF SECTION 01
DIVISION 03 - CONCRETE

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1.1 GENERAL INFORMATION

A. This section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following:

1. Footings.
2. Foundations and retaining walls.
3. Slabs on Grade. (Not including sidewalks, driveways)
4. Suspended slabs.
5. Concrete toppings.
7. Building walls.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following:

1. Blended hydraulic cement.
2. Fly ash and other pozzolans.
3. Ground granulated blast-furnace slag, and silica fume.

NOTE: All of the aforementioned materials shall be subject to compliance with the requirements and all specific project specifications.

1.3 GENERAL REQUIREMENTS (PER LATEST ACI 318)

A. Concrete: All concrete shall be designed, transported, placed, finished and cured in accordance with American Concrete Institute (ACI) standards. Components of the concrete mix shall meet or exceed applicable ANSI/ASTM requirements. Mix requirements and strength shall be specified by the project design team, each who shall be licensed and/or registered in the State of California, for item of construction. Limit the number of mix strengths specified as much as practical.

1. Concrete reinforcement material, design and placement shall meet the applicable requirements of ACI and the Concrete Reinforcing Steel Institute (CRSI) along with associated ASTM requirements. Reinforcing bars shall typically be ASTM A 615/A 615M, Grade 60, deformed bars and all weldable bars should comply with ASTM 706. No welded wire fabric reinforcing is allowed except in topping slabs or unique situations as approved by the project Design Professional and the A&E project team. Main reinforcing bars shall be minimum No. 4 in size. Limit No. 3 bars (Grade 40) to ties and dowels.

2. Admixtures to the concrete mixes shall meet applicable ANSI/ASTM specifications and may be used as recommended by the structural engineer to improve concrete workability, wear/weather resistance characteristics, etc., to better meet project conditions. Pozzolan Admixtures should be used only within the limits recommended by the structural engineer, allowed by code and approved by the Owner. Calcium Chloride or admixtures containing Calcium Chloride shall not be used.

3. The project specifications shall clearly establish finish measurement tolerances/standards suitable to the intended use of the surface and its exposure along with other quality control requirements needed to verify the concrete meets
the specifications. FF and FL numbers are to be met ACI 117.

4. Curing compound manufacturer shall provide certification that their product is compatible with the finish flooring scheduled for the space.

5. Exposed concrete finishes shall be sealed (See Division 7). For exposed architectural concrete where appearance is important, require formwork design submittal and mock-ups. Set clear tolerances for finish surfaces acceptance.

**NOTE:** The PM/GC is responsible for creating a BIM of the cast-in-place concrete building structure from which shop, fabrication, and as-built drawings shall be derived.

### 1.4 GENERAL FLOOR LOADING

A. Design floor live loads on all campus buildings shall carry a minimum of 100lbs/sf unless greater is required by Code and/or use for a particular space such as library shelving. This allows flexibility of future design when the building is renovated. Floors must be designed sufficiently rigid to prevent objectionable vibration. For all other buildings the design live loads shall be in accordance with the currently adopted edition of the California Building Code.

### 1.5 CEMENT FINISHED FLOORS

A. Generally cement finished floors are to receive hardener with colorant in accordance with specific project specifications. Positive protection is to be provided to prevent staining and chipping during construction work. Slick finishes shall be avoided.

### 1.6 CONCRETE REINFORCING

A. No welded wire fabric shall be used for reinforcing concrete except in topping slabs, as specified by the project specifications. All other reinforcing shall be by reinforced steel bars.

### 1.7 PRECAST, TILT-UP AND/OR SPECIAL FINISHED CONCRETE

A. On projects designed for precast, tilt-up and/or special finished concrete, the project specifications shall require a sample panel, constructed all as specified, or at least 42 square feet to be erected at the jobsite for approval consideration by the A&E project team. The approved panel shall remain on the jobsite as a visual criterion which the final construction must match.

### 1.8 EMBEDDED ITEMS (PER LATEST ACI 318)

A. Place and secure anchorage devised and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Embedded items shall be secure and in place at the time of inspection.

### 1.9 FIELD QUALITY CONTROL

A. Testing and Inspections: The University will assign a UCR Senior Construction Inspector (IOR) to perform regularly requested inspections for all construction work on all projects.
This inspector is an employee of the University of California, Riverside.

B. Special Testing and Inspecting: University will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Comply with Chapter 17, California Building Standards Code (Title 24, California Code of Regulations) and related provisions of ACI Standards except where more stringent requirements are shown or specified in this Section.

1. Inspections Required:
   a. Steel reinforcement placement;
   b. Headed bolts and studs;
   c. Embedded items;
   d. Verifications of use of required design mixture;
   e. Concrete placement, including conveying and depositing;
   f. Curing procedures and maintenance of curing temperature;
   g. Verification of concrete strength before removal of shores and forms from beams and slabs;

C. Concrete Tests Required:
   (Per latest ACI 318)
   1. Testing Frequency:
      a. Obtain one composite sample for each days pour of each concrete mixture exceeding 5 cu. Yds., but less than 25 cu. Yds., plus one set for each additional 50 cu. Yds., or fraction thereof.
      b. Obtain at least one composite sample for each 100 cu. Yds. Or fraction thereof of each concrete mixture placed each day.

2. The following standards shall be followed for each of the listed tests:
   a. Slump: ASTM C 143/C143 M.
   b. Air Content: ASTM C231, ASTM C 173/C 173 M
   c. Concrete Temperature: ASTM C 1064/C 1064 M.
   d. Unit Weight: ASTM C 567.
   e. Compression Test Specimens: ASTM C31/C31 M.
   g. Nondestructive Testing.
   h. Additional Tests:
      1. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Design Professional. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Design Professional.

2. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced, corrected or additional work with specified requirements.

3. Correct all deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents at the contractor's expense.
1.10 Sustainability

A. All University projects, including major renovations, shall attempt to meet and exceed the requirements of Materials and Resources Credit 4 – Recycled Content and Credit 5 – Regional Materials under the current LEED rating system for this material. Generally, the use of cement substitutes and additives in the concrete design that promote the use of recycled materials such as fly ash and slag shall be considered. Concrete materials and products should be extracted, recovered and manufactured within 500 miles of University.

B. Sustainable Materials, Products and Equipment.

1. Specify materials, products and equipment with the following attributes where they meet the performance goals needed for the project:

   a. Materials, products and equipment that have an inherent ability to serve their function with minimal maintenance.
   b. Materials, products or equipment that can be removed and re-used when they are no longer needed for the project.
   c. Materials, products or equipment that create no or minimal health risks to the people who occupy, construct and maintain the project.
   d. Materials, products or equipment that have significant post-industrial and post-consumer recycled content.
   e. Local/regional materials and equipment manufactured or having final assembly at a facility within 500 miles of the Project.
   f. Certified wood from manufacturers declaring conformance with Forest Stewardship Council Guidelines for certified wood building components.

END OF SECTION 3
**DIVISION 04 - MASONRY CONTENTS**

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1.1 GENERAL INFORMATION

1.1.1 REVIEWS

A. The Project Design Team must approve all masonry veneers and mortar selections.

B. Contract documents shall require contractor to erect a mock-up of masonry assemblies for review by Emory University prior to commencement of exposed masonry work. The materials used in all mock-ups must be identical to those to be used on the building.

C. All mock-ups should be constructed in same orientation as final building/structure whenever possible.

D. All mock-ups shall be completed and approved at least 14 days prior to the scheduled commencement of masonry installation.

1.2 GENERAL MASONRY DESIGN PRINCIPLES

A. Masonry materials are used on campus for bearing wall construction, dual exterior cladding, and low-rise construction. When masonry is used for exterior cladding, the design must accommodate movement and prevent cracking or water infiltration. The type of support system used for the masonry will affect the quantity, spacing, and type of expansion joints used.

B. Masonry construction shall be designed and constructed in accordance with recommendations and guidelines of the Brick Institute of America Technical Notes. These guidelines primarily apply to the design of anchorage, expansion control, joints, and reinforcing. The SMACNA Architectural Guidelines shall be followed for design of flashing, including cap flashing, through wall flashing, and lintels, as well as this Standard’s requirements.

C. Masonry construction may be designed as low lift grouting or high lift grouting, in accordance with CBC requirements. High lift grouting has the potential for block blow out during grouting. Repair and replacement of blowouts is required.

D. Masonry walls shall be capped with either metal coping, or pre-cast units with flashing. See Section 07 and SMACNA Architectural Guidelines for additional requirements.

E. The University is constructing 70-year buildings that require no maintenance for the first 20 years. All metals used in exterior masonry construction that could deteriorate or cannot be replaced shall be stainless steel or other approved material that will provide longevity without deterioration.

F. The sizes selected for exterior masonry units should address building scale and quality, as well as cost. Oversize bricks (16” long with a score joint at the mid-point, and 4” high) may be used on appropriate projects to provide smaller scale and economical installation.

G. Masonry shall be dimensioned throughout in modular units (typically 8”), both horizontally and vertically, to minimize cut material. Door and window head heights shall be coordinated with masonry coursing to avoid partial courses.

H. Where brick is used for exterior cladding; it shall not extend below grade. The design of foundations and grade changes shall be coordinated with the brick modules.

I. Exposed masonry colors and finishes shall be approved by the University’s representative.
J. Where concrete curbs are required, masonry with epoxy grout may be substituted.

K. Concrete masonry units used on building exterior shall be manufactured with an integral water repellant admixture, equal to Dow Chemical Dry Block System (for both block and mortar). Use of integral water repellant does not delete the requirement for flashing and weep holes.

L. Expansion and Control Joints

1. Proper detailing and construction of expansion and control joints are necessary to ensure that the final construction results are free of cracks.
2. The type of structural frame, the seismic design, and the applicable codes will impact the design of the expansion and control joints as well as their location. Joints shall be designed and located in accordance with the recommendations of the Brick Institute of America.
3. The following general rules for locating expansion and control joints shall apply. Provide joints at:
   a. Junctions of openings
   b. Mass changes
   c. Corners of openings
   d. Building or building plane offsets
   e. Corners within 5’ each side (maximum)
   f. Parapets
4. Reduced spacing of vertical expansion joints will permit deflection to occur without cracking the masonry.
5. Horizontal expansion joints shall be provided as required by the CBC. Horizontal joints are required in non-load bearing walls over 20 feet high.

M. Masonry Window Sills

1. Window sills shall have a drip edge and overhang the masonry by ½” minimum.
2. Through wall 24-gauge stainless steel flashing with coordinated end dam shall be provided and integrated with the window sill flashing.
3. Sills shall slope away from the window a minimum of ¼” per ft.

N. Masonry Copings

1. Copings shall have a drip edge and overhang the roof side of the parapet by 1½” minimum.
2. Through wall stainless steel flashing and anchorage system shall be provided. The design shall take expansion and contraction requirements into consideration.
3. Roof flashing and counter flashing shall be overlapped to provide redundant flashing.

1.3 MASONRY UNITS

A. Unit Masonry - Brick

1. Brick shall be an FBS type of high quality, dimension tolerance, and color consistency (ASTM C216 and C652). The allowable tolerance shall be changed to reflect proper installation (½ of the normal allowable), as defined by the Brick Institute of America. To the maximum extent possible, exterior
openings, soft joints and lintel locations shall be based on modular design and have no cutting of masonry units.

B. Mortar and Grout

1. Types of mortar shall be either Type S (exterior, above grade and interior) or M (exterior at or below grade), depending on conditions. Masonry cement is not permitted. Aggregate for mortar shall be in accordance with ASTM C 404. If a colored mortar is desired, aggregate shall be either ground marble or granite. Additives are not acceptable due to long term fading.

2. Masonry joints shall be concave for water resistive finish. Joints shall be struck flush, pointed and tooled for vertical and horizontal surfaces. Non-structural joints, in subdivided units, shall be slightly concave to physically retain the mortar due to its shape.

3. Use epoxy grout where masonry is used in wet areas.

C. Ties

1. Anchors tying the masonry to the structure shall be two-piece units, which will allow flexibility in both a vertical and horizontal direction while still resisting tension and compression forces perpendicular to the plane of the wall. The ties shall be the type specially designed to resist seismic events and crushing of the back-up system when metal stud and drywall backup systems are used.

D. Masonry Units

1. Shapes and sizes of brick and block shall be clearly illustrated on the drawings. Prior to incorporation into the design, the University's Representative shall approve use of masonry units.

2. Applications of glass block units shall be fully detailed and structurally designed. Take into consideration structural movement around the glass block units.

3. Masonry units shall be cut with dry, motor driven saws for clean, sharp, unchipped edges. Special "Lip Stretcher” brick may be used at lintels, cut or custom cast.

4. Masonry “CMU” installation tolerances: Except for work constructed of prefaced concrete masonry units, masonry units shall be set plumb, level and true to line within the non-cumulative tolerances herein identified, and corners shall be square.

   a. Variation from plumb:
      1. In adjacent units ⅛”
      2. In 10 ft. ¼”
      3. In 20 ft. ⅜”
      4. In 40 ft. or more ½”

   b. Variation from level or grades:
      1. In 10 ft. ¼”
      2. In 20 ft. ¼”
      3. In 40 ft. or more ½”

   c. Variation from linear building lines:
      1. In 20 ft. ⅛”
      2. In 40 ft. or more ½”

   d. Variation from cross sectional dimensions in walls:
      1. Plus ⅛” to minus ⅛”
E. Masonry Anchors

1. Corrugated metal ties are not to be used on masonry veneers.

2. Anchors shall be made of corrosion-resistant materials, or stainless steel when anchoring natural stone or stone veneers.

1.4 BRICK

A. All brick masonry shall be designed and constructed in accordance the standards of the Brick Industry Association and shall comply with ASTM C 216.

B. Products: Subject to compliance with requirements, provide the following:

1. Pacific Clay Products face brick “UCR Brick” (No Substitution).

C. Grade: SW.

D. Type: FBX

E. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.

F. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated not effloresced.

G. Size (Actual Dimensions): 3 1/2 inches wide by 2 3/16 inches (57 mm) high by 11 1/2 inches long.

H. Application: Use where brick is exposed unless otherwise indicated.

1.4.1 BRICK SELECTION PROCEDURE

A. Brick will be selected during project design and shall be specified in the bid documents. Face Brick shall be in accordance with ASTM C216; Type FBS grade SW.

B. Color and Texture: UCR Blend, color and texture matching existing facility. Contractor shall select complete color range of samples from existing facility and obtain units matching colors for work under this Contract. Color match shall be based on adjusted production run. Brick does not include “red” color on existing facility.

C. In the drawings the A/E will provide a detail that indicates the size of the brick mock-up panel that will also contain all exterior materials such as stone, cast stone, curtain wall, glazing, sealants, etc. for final approval of brick color as well as all exterior colors for the project.

1. The A/E team shall require, in the Project's Specification along with a detail in the drawings, that prior to ordering brick, the Contractor shall erect a 300 brick sample panel in mortar, all as specified, at the jobsite for final approval consideration by the Director of Project Delivery or designee.

2. The approved panel shall remain on the jobsite as a visual criterion which the final construction must match.

3. Mortar shall be Type N with concave tooled joints.
4. Expansion joints and control joints in masonry veneer walls shall be appropriated detailed and shown on building elevations. Extra precautions shall be taken at Texas A&M International University due to extreme summer temperatures.

1.5 CONCRETE MASONRY UNITS (CMU)
A. Concrete masonry units shall be used wherever feasible for back up to exterior face brick.
B. Concrete masonry units shall comply with ASTM C90.
C. Use bullnose type concrete masonry units at all edges and exterior corners.

1.6 STONE
A. Limestone shall be no closer than 4 inches to grade when adjacent to lawns and planting areas. Interior limestone masonry shall be sealed.
B. Marble and granite shall be domestic.
C. Anchors, dowels and other accessories used in setting stone shall be stainless steel.

1.7 OVERHEAD MASONRY
A. Construction where the masonry units are supported overhead using concealed mechanical devices in tension, or where the units extend beyond lower courses using concealed mechanical support devices in tension shall not be used. Building being renovated where these conditions exist shall be thoroughly examined for safety and a report of condition provided.

1.8 MASONRY ASSEMBLIES
A. References
   1. Follow the recommendations of the Brick Institute of America, SMACNA, and good design practices.
B. Anchorage Systems
   1. Masonry veneer shall have seismically braced anchors, “Dur-a-Wall” or equal.
      a. Ties shall be minimum 1 per every 24” x 16” area and 8” on center vertical, per manufacturer’s recommendations, per BIA Tech Notes recommendations, or per Engineer/Architect of Record – whichever is more restrictive.
      b. Ties shall start at every soft joint and within 6” of each window and door, 8” on center vertically and horizontally. Tie spacing shall be coordinated with the backup system being utilized.
   2. Masonry veneer systems shall have hot-dipped galvanized lintels. Attach lintels to the backup system where appropriate. Where stud back up is used, weld lintel to studs.
   3. Stainless steel ties shall be used for panelized stone or brick systems.
4. Precast caps attachments and attachments hidden from view shall be stainless steel. Flashing at precast caps and hidden locations shall be minimum 24-gauge stainless steel.

C. Cavity Construction

1. Flashing
   
   a. Flashing shall be minimum 24-gauge stainless steel.
   b. Corner flashing shall be one piece, pre-manufactured, riveted and soldered, with 12” to 18” legs.
   c. Corner flashing shall overlap with straight flashing components a minimum of 4”. Seal overlap, and design to accommodate movement.
   d. Provide overlap expansion joint in flashing at each masonry vertical expansion joint, but not greater than 20'-0” on center.
   e. Provide end dams at all openings.
   f. Alternative means of flashing such as W. R. Meadows Sealtight may be proposed for University Representative’s review and approval.

2. Waterproofing
   
   a. Backup systems shall be waterproofed. Design a waterproofing system that is appropriate for the backup system used.
   b. CMU or concrete shall be purged to seal all voids.
   c. Flashing shall be placed into CMU joints or cut into concrete.
   d. At stud framing and exterior gypsum, provide minimum two layers of 15# felt with a 6” overlap minimum between layers.
   e. Where transitions between systems exist, provide stainless steel flashing, scaling one system to the other.


4. See Campus Standard details for additional information and requirements.

1.9 MASONRY ACCESSORIES

A. Mortar net or a comparable mortar collection product shall be added to the base of brick veneer and single Wythe concrete masonry walls to prevent clogging of weep holes.

1.10 SUSTAINABILITY

A. All UCR projects, including major renovations, shall attempt to meet and exceed the requirements of Materials and Resources Credit 5 – Regional Materials under the current LEED rating system for this material. Masonry materials and products should be extracted, recovered and manufactured within 500 miles of UCR.

END OF SECTION 4
1.1 GENERAL

A. Galvanizing: All metal exposed to view or moisture shall be non-ferrous or heavy hot-dipped galvanized, or high performance paint shall be applied to exposed or viewable metal surfaces. This option shall be at the discretion of the university.

B. The contractor shall be required to provide an affidavit, at the completion of the project, that the structural steel framing is plumb and level within the normal tolerances specified in the AISC Code of Standard Practice.

C. The main slope for the roof shall be accomplished by the structural system. Only secondary slopes can be accomplished by the roof system.

D. The CM/GC is responsible for creating a BIM of the structural steel from which shop, fabrication, and as-built drawings shall be derived.

1.2 REFERENCES

A. Structural Steel

1. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

   2. ASTM: Standards of the American Society for Testing and Materials apply where designated in this Section. Use applicable year of adoption or revision as published in the current "Annual Book of ASTM Standards".

   3. CBC: The current California Building Code


1.3 STRUCTURAL STEEL FRAMING

A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

   1. ASTM: Standards of the American Society for Testing and Materials apply where designated in this Section. Use applicable year of adoption or revision as published in the current "Annual Book of ASTM Standards".

   2. CBC: The current California Building Code


   4. American Institute of Steel Construction
   1. The General Conditions, Special Conditions and Division 01 shall govern in the case of conflicts with provisions of the AISC 303.

   1. Including Supplement 1, Nov. 16, 2006


F. American Welding Society's
   3. AWS D1.8: Structural Welding Code – Seismic Supplement, 2005. (Comply with the requirements of AISC 303, AISC 341, and AISC 360 except where the additional or more stringent requirements of AWS D1.8 are shown or specified in this Section).

G. Research Council on Structural Connections’


1.4 COLD-FORMED METAL FRAMING

A. Cold-formed metal floor and wall framing shall be spaced 16 inches on center, maximum.

B. Backing in Walls:
   1. Campus Standard: Provide backing in areas where equipment will be installed on walls. [Confirm with Project Manager for these locations].
   2. Campus Preference: Provide backing in additional areas where equipment may be installed on walls in the future. Provide minimum 20 gage steel studs at 16 inches on center.

1.5 METAL FABRICATIONS

A. All exterior ferrous metals shall be hot dip galvanized.

B. Wherever dissimilar metals come in contact with each other, they must be separated with an approved layer of bituminous coating. Galvanized metal or zinc plated fasteners
shall not be used to anchor aluminum or copper. Use aluminum or copper fasteners.

1.6 METAL STAIRS

A. Metal stairs with concrete, terrazzo or other similar treads are acceptable for use as egress stairs.

1.7 LIGHTNING PROTECTION SYSTEM

A. Ensure lightning protection system is designed to prevent galvanic corrosion between dissimilar metals. Do not use a combination of materials that form an electrolytic couple.

1.8 QUALITY ASSURANCE

A. Comply with applicable provisions of AISC 303, ANSI/AISC 341, ANSI/AISC 360, except where more stringent requirements are shown or specified.

1. For welding, comply with the requirements of AISC 303, ANSI/AISC 341, and AISC 360 except where the additional or more stringent requirements of AWS D1.8 are specified in this Section.

B. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC’s “Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.”

1.9 EXTRA MATERIAL

A. Provide and install 15 tons of structural steel in addition to quantities shown on drawings at no additional cost to Owner. This additional steel shall be installed during construction, in size and locations as directed.

1.10 PRODUCTS

1.10.1 Structural Steel Materials:

A. General:

1. All steel shall be identified as required by CBC Section 2203A.1. Steel that is not properly identified shall be tested to show conformance with requirements of applicable ASTM Standard at Contractor’s expense.


1. Supply Charpy V Notch impact testing for members of the Seismic Load Resisting System with flanges 1 1/2 inches thick or thicker. Steel shall evidence a minimum average value of 20 ft. lbs. at +70 deg. F when tested in accordance with ASTM A6, Supplementary Requirement S30.

C. Channels and Angles:

1. ASTM A36; or ASTM A572, Grade 50 at Contractor’s option.
D. Plates and Bars:
   1. ASTM A572, Grade 50; ASTM A588, Grade 50; or ASTM A529, Grade 50 or Grade 55, except as otherwise designated.

E. Pipes:
   1. ASTM A53, Type E or S, Grade B.

F. Structural Tubing:
   1. Square and Rectangular HSS: ASTM A500, Grade B.
   2. Round HSS: ASTM A500, Grade B.

G. Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 5% of the total value of the materials in the project.

1.10.2 Bolts, Anchors and Connectors

A. High Strength Bolts: One of the following, unless otherwise designated on Drawings.
   1. ASTM A325, Type 1, heavy hex structural bolts with ASTM A 563, Grade C or DH heavy hex nuts and ASTM F 436 hardened washers.
   2. “Twist-Off” Bolts: ASTM F1852, Type 1, round head tension control bolts with ASTM A563, Grade C or Grade DH heavy hex nuts and ASTM F436 hardened washers.

B. ASTM A490 Bolts: ASTM A490, Type 1, heavy hex structural bolts with ASTM A563, Grade DH heavy hex nuts; ASTM F436 hardened washers, and ASTM F959, Type 490 direct-tension indicator washers. Provide where designated on Drawings.


D. Anchor Rods (Bolts): ASTM F1554, Grade 36.

E. High Strength Anchor Rods (Bolts): ASTM F1554, Grade 105, with Supplementary Requirement S4, "Grades 55 and 105 Charpy Impact Requirements at +40 deg F." Mark exposed end in accordance with Supplementary Requirement S3, "Permanent Grade Identification”.
   1. Head: Form head at embedded end with ASTM A36 round plate washer sandwiched between ASTM A563, Grade DH, heavy hex nuts. Plate washer size shall be 2 1/2 times bolt diameter and thickness shall be 1/2 of the bolt diameter, unless otherwise designated.
   2. Plate Washers: ASTM A36; 1/2 inch thick. Where size is not designated, furnish bolt diameter plus 2 inches square.

F. Headed Studs: AWS D1.1, Type B.
1.  Shear Connector Studs: For studs ¾ inch diameter and larger, furnish in configuration matching S3L Shear Connectors by Nelson Stud Manufacturing or approved equal.

2.  Headed Concrete Anchors: For studs 5/8 inch diameter and smaller, furnish in configuration matching H4L Headed Concrete Anchor by Nelson Stud Manufacturing or approved equal.

G.  Reinforcing Bar Couplers: Weldable half couplers for joining reinforcing bars to structural steel. Acceptable products shall have an Evaluation Report evidencing code compliance for full mechanical tension splice in accordance with the ICC ES acceptance criteria, AC133 “Acceptance Criteria for Mechanical Connectors for Steel Reinforcing Bars”. Acceptable Products: Lenton Weldable Coupler C3J/C2 by Erico (IAPMO ESR_0129), or approved equal.


1.11  FIELD QUALITY CONTROL

A.  Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section “Quality Requirements”.

B.  Testing Agency will:

1.  Inspect and test field high strength bolting and welding in accordance with Article 2.7, “Source Quality Control”.

2.  Inspect Protected Zones for:

   a.  Discontinuities created by fabrication or erection operation, such as tack welds and erection aids.

   b.  Welded shear stud and decking attachments, except deck spot welds shall be permitted.

   c.  Welded, bolted, screwed, or shot in attachments for attachment of edge angles and the Work of other trades.

   d.  Placement of suitable warning signage.

C.  Contractor shall:

1.  Engage qualified QC inspection personnel to inspect field welding in accordance with Project Specifications.

END OF SECTION 5
## DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

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1.1 GENERAL

A. Provide wood products conforming to the Forest Stewardship Council (https://us.fsc.org/index.htm) Guidelines for certified wood building components.

B. Wood products for use in building interiors, composite wood and agrifiber products (including core materials) shall not contain added urea formaldehyde resins. Adhesives used in field and shop-fabricated assemblies containing these products shall not contain urea-formaldehyde.

C. Maximum Moisture Content of Lumber: 19 percent at time of installation unless otherwise indicated.

D. Avoid use of imported or exotic species of woods.

E. Provide all required LEED documentation and submittals for product data credits.

1.2 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

1.3 REFERENCES- WOOD PRODUCTS, GENERAL

A. Lumber:

1. DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

2. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

3. ASTM: Standards of the American Society for Testing and Materials apply where designated in this Section. Use applicable year of adoption or revision as published in the current “Annual Book of ASTM Standards”.

4. CBC: The current California Building Code


1.4 ROUGH CARPENTRY

A. Forms:

1. Form release agents used on wood concrete forms shall be biodegradable to enable the wood to be recycled.
B. Preservative Treated Wood:
   1. Provide preservative treated wood in conjunction with roofing (nailers, curbs, etc.); any wood in contact with masonry, cement or the earth. Provide material safety data sheets for all wood preservative for review and approval by the UCR Office of Environmental Health & Safety.
   2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

C. Fire Treated/Resistive Plywood:
   1. Provide plywood backboards; minimum 3/4-inch fire treated CDX for all wall mounted boxes and boards in mechanical or electrical rooms.

D. Backing in Walls:
   1. Campus Standard: Provide backing in areas where equipment will be installed on walls
   2. Campus Preference: Provide backing in additional areas where equipment may be installed on walls in the future. Provide minimum 20 gage steel studs at 16 inches on center.

1.5 FASTENERS

A. General:
   1. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   2. Where carpentry is exposed to weather, pressure-preservative treated, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.


D. Screws for Fastening to Metal Framing: ASTM C 1002 or ASTM C 954, length as recommended by screw manufacturer for material being fastened.

1.6 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

1.7 INTERIOR FINISH CARPENTRY

1.8 INTERIOR ARCHITECTURAL WOODWORK

A. Locks for Drawers and Doors:
   1. **Campus Standards**: Provide 2 keys per room of differently keyed drawers and doors where non-State keys are used.

1.9 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Grade: Premium.
   1. AWS Exception permitting Economy grade at custodian and utility rooms is not acceptable.

B. AWS Type of Cabinet Construction: Flush overlay.

C. Laminate Cladding for Exposed Surfaces: Refer to Project Specifications.

E. Materials for Semi-Exposed Surfaces: Refer to Project Specifications.

F. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.

G. Toes, Kicks, and Sleepers: Moisture resistant exterior MDF.

H. Colors, Patterns, and Finishes – PL-#: Refer to Project Specifications.

I. Provide dust panels of 1/4-tempered hardboard above compartments and drawers, unless located directly under tops.

1.10 CABINET HARDWARE AND ACCESSORIES

A. Hinge: Refer to Project Specifications

B. Pull Type: Refer to Project Specifications

1.11 MATERIALS

A. General: Provide materials that comply with requirements of quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
B. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

C. High-Pressure Decorative Laminate – PL-#: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.

D. Composite Wood and Agrifiber Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

E. Adhesives: Type I, complying with South Coast Air Quality Management District (SCAQMD) Rule 1168.

F. Adhesive for Bonding Plastic Laminate: Type I, specific formulation as recommended by manufacturer for application.

1. Adhesives applied on site shall comply with South Coast Air Quality Management District (SCAQMD) Rule 1168.

1.12 MEDIUM DENSITY FIBERBOARD (MDF)

A. Manufacturer: Subject to compliance with requirements, provide MDF, by one of the following, or equal.

1. Sierra Pine (Basis of Design)
2. Flake board
3. Or equal

END OF SECTION 6
# DIVISION 07 – THERMAL AND MOISTURE PROTECTION

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1.1 GENERAL

A. Design Criteria

1. When designing roof access ladders and stairways to roof shall not be alternating tread type. Provide 18 gauge flashing at roof locations accessible to students or building occupants to prevent damage and vandalism.

2. All rooftop mounted equipment shall be mounted on platforms.

3. All platforms (curbs) shall be a minimum of 8 inches in height from the finished roof surface. Walk-pads shall be provided from roof access points to and around all rooftop equipment.

4. All conduits and piping shall have a 4-inch minimum height and all conduit and piping supports shall be made from DURA-BLOK as supplied by Cooper B-Line, Inc. Roof Topper by Arlington, Safety Yellow Pipe guard, or equal.

5. Building Envelope shall comply with California Energy Code, ASHRAE 90.1-2010.

6. A method to clean all exterior glazing must be incorporated into the project. Verify method with Facilities Services Administration.

7. Maximize insulation value of the building envelope to conserve energy and incorporate an air barrier. Avoid all insulation material containing formaldehyde and consider insulations with recycled content.

8. Non-combustible or FM Approved insulation is recommended in place of foam-based products (polyurethane, polystyrene, etc.), and is especially important in unprotected, concealed spaces, such as attics and crawl spaces, or in hollow-core walls that will be penetrated by electrically-rated equipment.

9. FM Approved foam insulations for wall/ceiling have been evaluated according to FM Approvals Standard 4880, and are listed at www.approvalguide.com under Building Materials/Building Insulation/Foam Insulation

B. Renovation Projects

1. When rooftop equipment is removed from roof, all associated components shall be removed as well. This includes: complete removal of any curbs, supports, piping, conduits, electrical lines, blocking, etc.

C. Fall Protection: All areas that expose workers to a fall of six feet or greater shall be protected by parapet walls or permanent guardrails that comply with Cal OSHA Title 8 section 3209. When guardrails or parapets are not feasible, provide one of the following:

1. Horizontal Lifelines as part of a complete fall arrest system that is compliant with Cal OSHA Title 8 section 1670 designed by a “Qualified Person” as defined by ANSI/ASSE Z359.0-2007-2.109.

2. Anchorages that comply with Cal OSHA Title 8 section 1670 as designed by a “Qualified Person” as defined by ANSI/ASSE Z359.0-2007-2.109.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):


B. National Fire Protection Association (NFPA):

C. Underwriters Laboratories, Inc. (UL):
   1. UL 1479 Fire Tests of Through-Penetration Firestops.
   3. UL Fire Resistance Directory:
      a. Fills, Voids or Cavity Materials (XHHW).
      b. Firestop Devices (XHJI).

1.3 DAMPPROOFING AND WATERPROOFING

A. For more information, refer to the University’s Standard Specification Section 07 25 00 Water Resistive Barrier System.

1.4 SHEET WATERPROOFING

A. On all below grade applications: Prior to installation of any product all areas shall be clean and have an approved primer applied per manufacturer’s specification. All non-exposed areas shall be a minimum of 40mil self-adhering sheet, composed of butyl rubber based adhesive, backed by a layer of protection board separating it from contact with soil or other damaging properties. Grace Ice & Water Shield self-adhered underlayment; or equal. For special applications only, consult University’s Representative before applying.

1.5 WATER REPELLENTS

A. All exterior exposed masonry and concrete (to receive no other finish) shall be treated with a clear penetrating waterproofing.

1.6 ROOFING

1.6.1 Roofing

A. All new roof assemblies and roof recovers should be an FM Approved Roof Assembly, designed in accordance to the applicable FM Data Sheets: 1-28 Wind Design, 1-29 Roof Deck Securement and Above Deck Components, 1-31 Metal Roof Systems, 1-49 Perimeter Flashing, and 1-54 Roof Loads for New Construction. All roof submittals should include the FM RoofNav Roof Assembly Identification Number. Further guidance on Wind Design (FM DS 1-28) and FM Approved Roof Assembly Listings is available at www.roofnav.com

B. Roofing system shall be determined by local Facilities Services Administration or as indicated in this Division.

C. Specify service walkways (minimum 2'0" in width) appropriately located to service all roof top equipment from the roof access.

D. Carefully detail roof expansion joints and flashing.

E. Completely detail all parapet walls, caps, coping and scuppers. Top of coping should slope toward roofs.

F. Detail roof edges sufficiently high to prevent water from spilling over and spotting walls and fascia where roof drains are used.
G. Provide drips on overhangs, ledges, window stools and coping to prevent discolorations of fascia’s, soffits and walls.

H. Ensure that sealants specified are to be used within their limitations. When pre-cast concrete wall panels are used, ensure proper compatibility between the surface sealant and the concrete panel when caulking a joint.

I. Flashing materials for permanent type buildings to be aluminum, stainless or copper (not galvanized metal).

J. Slope roof adequately to drain (minimum 1/4”/ft. slope). Design primary roof slopes for new buildings into structural frame and not by roof insulation. Crickets to roof drains may be sloped with insulation. Metal building roofs (minimum 1/4”/ft. slope).

K. Lightweight concrete insulating fill roof decks will not be used in conjunction with urethane roof system. Lightweight structural concrete is allowed.

1.6.2 COMPOSITION ROOFING

A. Composition roofing shall be installed in accordance with current NCRA guidelines for installation and shall have a minimum 40-year warranty. Composition roofing Systems shall meet the following standards:

1. UL 997
2. ASTM D3018 TYPE 1
3. ASTM D3161 TYPE 1, CLASS F
4. ASTM D3462

B. Fasteners shall be in accordance with the manufacturer’s specifications for application.

C. Type 30 felt underlayment or better shall be used. For special applications consult University’s Representative before applying.

1.6.3 CLAY AND CONCRETE TILE ROOFING

A. All roofing tile shall be installed in accordance with the manufacturer specifications.

B. A minimum of two layers Type 30 Felt underlayment or better shall be installed. For special applications, consult University’s Representative before applying.

C. Tiles shall be installed on an elevated battened system. For special applications, consult University’s Representative before installing.

D. Fasteners shall be in accordance with the manufacturer specifications for the application used.

1.6.4 ROOFING AND SIDING PANELS

A. All metals used shall be prefinished Zincalume/Galvalume sheet metal or G-90 galvanized steel in minimum 24 gauge as described in ASTM A792.

1.6.5 METAL PANEL ROOFING
A. Standing seam roofing system shall consist of integral self-locking seams with a minimum seam height of 1-3/4 inches. Standing seam roofing system shall have no exposed fasteners. Panels shall have clips designed to allow for thermal expansion and contraction.

B. Type 30 felt underlayment or better. For special applications, consult University’s Representative before applying. Sealants shall be gunnable grade single component polyurethane caulk or gunnable grade butyl. Tape Sealant shall be Butyl.

C. Manufacturer shall provide a standard 35 year coating performance warranty. All installations shall be in accordance with specified manufacturer guidelines.

1.6.6 SINGLE-PLY MEMBRANE ROOFING

A. PVC Single-Ply Membrane (Thermoplastic) Roofing System (SMR) is the standard roofing system for low sloped applications. TPO membranes are not approved for campus installations. SMR systems shall be fully adhered or mechanically fastened qualifying for a UL Class A Roof Covering with Factory Mutual I-60 Windstorm Classification for Class 1 Construction. The SMR system shall be covered by the material manufacturer’s 20-Year Total System Warranty covering all roofing components installed above the roof deck upon completion and acceptance of Work.

B. All roofing systems shall meet ASTM standards per their respective systems.

C. Roofing materials shall meet ASTM D4434, minimum 60 mil thickness and have a Solar Reflectance Index (SRI) as required below for a minimum of 75 percent of the roof surface. (Product shall meet current CA Title 24 Requirements for reflectivity.)

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D. For special applications, consult University’s Representative before applying. All installations shall be in accordance with manufacturer recommendations.

1. Products: The following SMR systems are listed to establish a standard of quality:
   a. Plasticized Polyvinyl Chloride (PVC): Sarnafil S327, manufactured by Sarnafil, Inc.; EGSR-60 Roofing Membrane distributed by Everguard/GAF; or equal.

E. Emissions: The following maximum emissions are listed in grams per liter.

1. Trowelable Mastic and Pitch Pocket Sealant: 450
2. Sealant: Refer to Section 07 92 00 Water Resistive Barrier System
3. Adhesive: 250

1.6.7 SHEET METAL ROOFING SPECIALTIES

A. Campus Preference: For roof penetrations service utilities.

1. Manufacturer: LSC Corp., POB 6308, Phoenix, AZ 85005. Phone: 877-301-8592; Fax: 602278-6397; Email: dougmh@msn.com
a. **Pipe Chase Housing** – Removable lid with gasket. Pipe seals for pipes from ¼-inch to 1½ inches outside diameter. Housing with gasket to curb. 3-inch skirt protects leading edge of roof. Constructed of welded power coated aluminum and stainless steel bolted connections. 2-inch flange out onto roof. Tower extension allows for space to mount disconnects and control boxes. Some models are equipped with hose bib and knock-outs for GFCI.

![Typical installation](image)

1.7 **FIRE AND SMOKE PROTECTION**

1.7.1 **GENERAL**

A. Section includes:

1. Fire stopping at fire rated openings for conduit and cable trays.
B. Quality Assurance:

1. Through Penetration Fire stopping of Fire Rated Assemblies: ASTM E814 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings not less than 1-hour.

   a. Wall Penetrations: Fire F-Ratings not less than 1-hour.

   b. Floor Penetrations: Fire F-Ratings and temperature T-Ratings not less than 1-hour.


C. Penetrating Items:

1. Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

1.7.2 FIRESTOPPING

A. Campus Preference: For wall and floor penetrations of cabling for telecommunications, fire alarm and security.

a. Wall – Model: EZDP433GK-C with four colored pathways to be organized as follows:

- **ORANGE** = Fire Alarm, **BLUE** = Communications-Horizontal Cabling, **YELLOW** = Security and Door Access, and **WHITE** = Communications-Backbone Cabling (between telecom rooms).

2. Floor – Model: Series 44 Modular Grid System in either one, two or four modules with pathways in banks of four with the option to utilize blank firestop filler panels in multi-slot grids. Four colored pathways to be organized as follows:

- **ORANGE** = Fire Alarm, **YELLOW** = Security and Door Access, and **WHITE** = Communications-Backbone Cabling (between telecom rooms).

### 1.7.3 PRODUCTS

A. Fire stopping products

1. Campus Preferred Manufacturers and Models:

   a. 3M Fire Protection Products Phone: 800-328-1687
      
      [www.3m.com/firestopProduct](http://www.3m.com/firestopProduct)
      
      [Data: http://solutions.3m.com/wps/portal/3M/en_US/Telecom/Home/Products/Products/?PC_7_RJH9U5230GE3E02LECIE20O4M7_nid=PM982QZG92beVSPHNLN1Lcgl](http://solutions.3m.com/wps/portal/3M/en_US/Telecom/Home/Products/Products/?PC_7_RJH9U5230GE3E02LECIE20O4M7_nid=PM982QZG92beVSPHNLN1Lcgl)

   b. Tremco Inc. Phone: 866-209-2404 [www.tremcofirestop.com](http://www.tremcofirestop.com)

   c. Substitutions: Section ___ ___ ___ - Product Options and Substitutions.
2. Cable Tray:
   a. 3M, Model W-L-4004 - 24" x 4" steel or aluminum cable tray, 32% fill. Also referred as WL4004.
   b. Tremco, Model TREMstop PS, fire containment pillow system.
   c. Prohibited: Intumescent putty.

3. Metal Pipe:

4. Non-Metallic Pipe:
   b. 3M Fire Barrier FS-195+ Wrap/Strip – 2”x24”, Intumescent elastomeric strip with foil on one side (UPC # 00051115071157), and Plastic Pipe Device PPD6 (UPC # 00051115082535) for 6” pipe, or Restricting Collar RC-1-2” (UPC #00054007083245) for 2” pipe.
   c. Tremco- http://tremcosealants.com/
B. Cabling:

1. 3M, Models
   a. Single, Fire Barrier Pass-Through Devices:
      1. 2-1/2” Square (UPC # 00051115165962) and Mounting Brackets
         2-1/2” SQ Single Mount (Pair) (UPC # 00051115187506)

      2. Fire Barrier Pass-Through Device 4” Square (UPC #
         00051115165979) and Mounting Brackets 4” SQ Single Mounting
         (Pair) (UPC # 00051115187520)

      3. Fire Barrier Pass-Through Device 4” Round (UPC #00051115165986)
         and Mounting Brackets 4” Round Single Mount
         (Pair) (UPC # 00051115187544)

   b. Multiple, Square Pass-Through:
      1. Fire Barrier Pass-Through Device 4” Square and Mounting
         Brackets 4” SQ Triple Mount (Pair) UPC # 00051115187537.

      2. Tremco, Model
1.8 ROOF SPECIALTIES AND ACCESSORIES

A. Roof Hatches:

1. Standard Roof Hatch size is 30 inches by 36 inches. For special applications or sizes, consult the University’s Representative. Roof hatches that are larger than the standard size shall require hydraulic or spring loaded hinges.

2. Roof hatches shall be designed to comply with Cal OSHA Title 8 section 3212 and to provide safe egress and ingress through roof and access hatches.

3. Roof hatches shall be designed such that opening and closing of the roof hatch can be done with three points of contact on the ladder at all times.

4. Where no roof hatch is provided, a fixed ladder shall be provided that complies with Cal OSHA Title 8 section 3277.

5. Consideration shall be given for the safe exit and approach to the hatch and ladder. The roof hatch shall be located such that there is a sufficient clear space directly in front of the ladder at the roof level.

1.9 JOINT SEALANTS

A. Detail all special conditions. All materials used shall be top-of-the line available suited for the conditions being sealed and in compliance with the following VOC requirements.

<table>
<thead>
<tr>
<th>Sealants</th>
<th>VOC Limit (g/L Less Water)</th>
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</thead>
<tbody>
<tr>
<td>Architectural</td>
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<tr>
<td>Non-membrane Roof</td>
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<td>Roadway</td>
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<tr>
<td>Single Ply Roof Membrane</td>
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<td>Other</td>
<td>420</td>
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</table>

<table>
<thead>
<tr>
<th>Sealant Primers</th>
<th>VOC Limit (g/L Less Water)</th>
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</thead>
<tbody>
<tr>
<td>Architectural – nonporous</td>
<td>250</td>
</tr>
<tr>
<td>Architectural – porous</td>
<td>775</td>
</tr>
<tr>
<td>Modified Bituminous</td>
<td>500</td>
</tr>
<tr>
<td>Other</td>
<td>750</td>
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</tbody>
</table>

Requirements from South Coast Air Quality District Rule 1168 effective date (01/07/05) & rule amendment date of (1/07/05) except for aerosol adhesive requirements which come from Green Seal Standard GS 36 (10/19/00). Applicable definitions apply.

END OF SECTION 7
## DIVISION 08 - OPENINGS

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1.1 DOORS

A. Doors shall be 7'-0" high, typically. In areas where there is cart traffic (such as for movement of animal cage or other similar carts) doors shall be minimum 7'-10" high and 42" wide. Door heights in loading and/or receiving areas shall be designed to allow adequate width and height on the path from the loading dock to any storage areas. Doors leading to mechanical or other equipment areas shall be sized to allow for equipment replacement after the construction is completed.

B. Areas of specialized use such as Vivarium holding rooms will require special doors, frames, and hardware. The doors and frame shall be minimum 14-gage to accommodate the regular impact of carts. A vision light shall be provided to allow visual contact without opening the door. Vision light in holding rooms shall have a removable cover. The door and frame finish shall be epoxy paint due to the difficulty in repainting doors in these areas.

C. Doors providing access into laboratories, and doors providing access between adjacent laboratory suites shall have magnetic hold open devices that are interconnected with the fire alarm system.

D. Access shall be provided from the building exterior into all laboratory spaces through doors that are a minimum of 3'-6" wide to facilitate the movement of equipment. Provide key-locked removable mullions at pairs of doors. Key locks may be either integral with the mullion or a separate pin-and-padlock arrangement. Mullions requiring tools for removal are not allowed.

E. Additional width or height may be required for access to mechanical spaces or areas containing specialized equipment. Where service entries require large openings, overhead roll-up doors may be used.

1.2 GLASS ENTRY DOORS

A. A special architectural statement is required at the entry of each major project on campus. The University may allow changes from the Campus Standard requirements for hardware, frame requirements, thresholds, and framing standards at this type of entry. These changed items must be reviewed in detail with the University.

B. Installations and designs shall be heavy-duty to allow for long-term usage with minimal maintenance or adjustments.

C. Hardware, custom pulls, closers and thresholds shall be stainless steel, finish to be approved by the University.

D. Main entry locations shall be power-assisted with activation buttons on both inside and outside, for ADA access compliance.

E. Main entries shall have security controls coordinated with the overall security system design, code and ADA accessibility. See Section 28 for security system requirements.

1.3 STEEL DOORS AND FRAMES

A. Exterior doors shall be metal construction. Interior doors may be metal or wood construction unless otherwise required by the project, program or specific use.

B. Metal door, transom, and sidelight frames shall be welded in lecture halls, classrooms, vivariums, laboratories, equipment rooms, janitor rooms, gang toilets and other heavy use locations that could be subject to abuse. Aluminum knock-down frames shall be used for
interior doors to private offices, closets, conference rooms, break rooms, private toilets and other infrequent use doors. No exposed dimples are allowed if frames are to be installed after walls are erected. Frames shall be body-puttied, sanded and re-primed for smooth transition invisible to touch or sight.

C. Labeled and non-labeled doors shall be welded with seams filled. Close each edge channel. Rated doors and frames shall carry the appropriate listing (frames) and classification (doors) mark from Underwriters Laboratories.

D. The size of glass in fire-rated doors and frames is restricted by three factors and must be reviewed with current code requirements:

1. Hourly rating of the unit.
2. Stop height being used.
3. Type of glass being used.

E. Where wire glass is used, the wire pattern must be square and parallel with the walls and floors. Diamond-pattern wire is not permitted.

1.4 WOOD DOORS

A. Wood doors shall only be used for light duty areas such as offices, conference room, and cross-corridor doors on hold-open devices.

B. Wood doors may be pre-finished with field adjustment (routing for hinges, shaving of edges, etc.). Doors shall be sealed prior to hardware placement or hanging.

C. Comply with or exceed Woodwork Institute Manual of Millwork Section 12 for premium grade wood doors.

D. Non-rated wood doors shall have maximum undercut of ¾” above finished surfaces.

1.5 OVERHEAD COILING DOORS

A. Loading dock doors shall be overhead coiling, electric motor operated, with manual opening device for use in case of power or motor failure.

B. Basic Requirements:

1. Doors shall have an operating speed of 8 inches per second.
2. Door slats shall be constructed of galvanized steel (G90) or stainless steel (316).
3. Door shall be equipped with a soft edge bottom bar and mechanical safety reverse mechanism.
4. Electrical components shall be factory pre-wired. Control box to be equipped with emergency stop, auto/manual switch, and adjustable timer for automatic close.
5. Controls shall be key-activated. Provide controls on both sides of door.
6. Doors shall be connected through a fusible link.

1.6 DOOR HARDWARE

A. General

1. Retain an Architectural Hardware Consultant (AHC), who shall be made available to the University for consultation at no additional cost, during the course of construction.
2. AHC shall check the installation of finish hardware at the completion of the Project, making adjustments required and supervising hardware replacements.

3. The University has selected hardware components to minimize the long-term replacement expense and will not allow deviation from the manufacturers listed due to long-term maintenance and stock issues.

4. Coordination with Security, Electrical, Frames, Doors and Fire Alarm is required in the design and construction process. Review of hardware shall be accomplished only when all aspects influencing hardware can be reviewed at the same time.

5. Doors may require power-assisted door operators with interior and exterior actuator buttons. Coordinate with adjacent materials/systems to conceal conduit and/or wiring. For example, if a main entry is in a curtainwall system, coordinate the placement of wiring and control or activation devices to conceal wiring within curtain wall, and mount actuator on curtain wall. The University will not accept exposed conduit or surface mounted raceway for installation of devices. Power-assisted doors shall be provided at:

   a. Main entry to the building for ADA accessibility
   b. Lecture halls entrance to the interior ADA ramp
   c. Cage wash rooms

B. Products—As required by the Project Program—Depending on Building, some buildings use Schlage and some use Best. Determination required.

University of California Riverside

Door Hardware Standard for University Properties

Attention: Architects, Design Professionals, Hardware Specifiers, Contractors and other concerned parties:

UCR uses the following door and hardware products. Please adhere to the following when specifying hardware for Specification Section 09710 in new construction, and in renovation and tenant improvement work:

<table>
<thead>
<tr>
<th>Key System</th>
<th>Schlage Primus Level Four Interchangeable Core (See University Locksmith for Proper Keyway) Cylinders to be B-Bitted and shipped with two blank keys each.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locksets</td>
<td>On Offices: Cylindrical Locks Schlage ND63JD x Rhodes Lever x 626 Finish On Classrooms/ Labs: Cylindrical Locks Schlage ND60JD x Rhodes Lever x 626 Finish On Storerooms: Cylindrical Locks Schlage ND50JD x Rhodes Lever x 626 Finish On Perimeter and Maintenance/Mechanical rooms: Mortise Locks Schlage L0050 x Rhodes Lever x 626 Finish On Applications requiring Electric Locksets use Schlage ND series only.</td>
</tr>
<tr>
<td>Deadbolts</td>
<td>Schlage 700, 701 and 762 x 626 Finish. To be used where applicable.</td>
</tr>
<tr>
<td>Padlocks</td>
<td>Schlage PL Series Keyed into Universities Key System.</td>
</tr>
<tr>
<td>Cott Devices</td>
<td>Von Duprin AX69 and AX33 5b push Series x 08 Trim x 626 Finish, Rim Device to be used with KR Mullions on pairs of doors. No vertical rods</td>
</tr>
<tr>
<td>Mullions</td>
<td>Von Duprin Key Removable</td>
</tr>
<tr>
<td>Surface Closers</td>
<td>LCN 4111 x EDA Series x 626 and 4011</td>
</tr>
<tr>
<td>Automatic Closers</td>
<td>Dor-C-Matic Senior Swing</td>
</tr>
<tr>
<td>Flush Bolts</td>
<td>Ives Manual Flush Bolts</td>
</tr>
<tr>
<td>Hinges</td>
<td>Stanley 4 1/2 Ball Bearing, Non-Removable Pin</td>
</tr>
<tr>
<td>Overhead Stops</td>
<td>Glynn-Johnson Stainless Steel 300 Series Alloy Non Plastic Mechanisms &amp; Finished Metal End Caps, Field Interchangeable Hold Open, Friction &amp; Stop Only Function</td>
</tr>
<tr>
<td>Pulls</td>
<td>Ives UR5000 Series, (on Store Front Doors use Ives Tubular Pulls) or equal</td>
</tr>
<tr>
<td>Floor Stops</td>
<td>Ives FS18</td>
</tr>
<tr>
<td>Wall Stops</td>
<td>Ives FS435</td>
</tr>
<tr>
<td>Kickplates</td>
<td>Ives 8400</td>
</tr>
<tr>
<td>Door Seals</td>
<td>Pennco 303AS</td>
</tr>
<tr>
<td>Thresholds</td>
<td>Pennco</td>
</tr>
</tbody>
</table>

UCR personnel are trained in the installation and maintenance of the above material and the maintenance department owns considerable stock of material for repair work. The university is not prepared to accommodate the adoption of an additional standard as the hardware standard in place serves the facility well.
Attention: Architects, Design Professionals, Hardware Specifiers, Contractors and other concerned parties:

UCR uses the following door and hardware products. Please adhere to the following when specifying hardware for Specification Section 08710 in new construction, and in renovation and tenant improvement work:

<table>
<thead>
<tr>
<th>Key System</th>
<th>Best Interchangeable Core key system multiple keyways assigned to UCR. (See University Locksmith for Proper Keyway)</th>
</tr>
</thead>
</table>
| Locksets   | On Offices: Cylindrical Locks Best 93KAB-06 Lever x 626 Finish  
On Classrooms/ Labs: Cylindrical Locks Best 93K7C 06 Lever x 626 Finish  
On Storerooms: Cylindrical Locks Best 93K7D 06 Lever x 626 Finish  
On Perimeter and Maintenance/Mechanical rooms: Cylindrical locks Best 93K7D 06 Lever x 626 Finish  
On Applications requiring Electric Locksets use Best 93K7D 06 lever 626 finish. |
| Deadbolts  | Best 82S x 626 Finish. To be used where applicable. |
| Padlocks   | Best 41B72 Keyed into Universities Key System. |
| Exit Devices | Von Duprin 99 and 33 Series x 06 Trim x 626 Finish, NOTE: Pairs of doors shall have rim devices and key removable mullions. No vertical rod devices. |
| Mullions   | Von Duprin Key Removable |
| Surface Closers | LCN 4111 x EDA Series x 626 |
| Automatic Closers | Dor-O-Matic Senior Swing |
| Flush Bolts | Ives Manual Flush Bolts |
| Hinges     | Stanley 4 ½, Ball Bearing, Non-Removable Pin |
| Pulls      | Ives UR9000 Series (on Store Front Doors use Ives Tubular Pulls) |
| Floor Stops | Ives FS18 |
| Wall Stops | Ives FS435 |
| Kickplates | Ives 8400 |
| Door Seals | Pemko 303AS |
| Thresholds | Pemko |
| Doors      | Steelcraft Hollow Metal Doors and Frames |

UCR personnel are trained in the installation and maintenance of the above material and the maintenance department owns considerable stock of material for repair work. All above items have been time tested at UCR and provide top quality service life and reliability. The university is not prepared to accommodate the adoption of an additional standard as the hardware standard in place serves the facility well.

1. Fasteners
   a. Provide through-bolts for closers and exit devices on wood doors.

2. Hinges
   a. Provide heavy-weight geared hinges on exterior openings with school top cap, full concealed for new construction; full concealed for existing frames.
with new doors; or full surface for existing doors and frames.

b. For interior openings, provide three-knuckle, button tip, full mortise ball bearing template butts with non-rising stainless steel pins.

c. Provide out-swinging door hinges with non-removable pins.

d. Provide out-swinging exterior door hinges with non-removable pins and security studs.

e. Provide heavy-weight butts for doors over 42” in width; more than 1-3/4” thick, and over 7'-6” in height.

f. Provide anchor hinges on doors with exit devices and classroom doors. For each electrical hinge, provide a junction box that is fastened to the frame jamb. Provide electrical hinges with the number of wires required by the electrical hardware feed, plus two extra wires. Continuous circuit hinges shall have wires concealed.

g. At high use doors in areas such as vivarium's, loading docks, and selected areas within laboratories, provide heavy-duty full mortise hinge.

3. Locks and Trim

a. Provide latch protectors for the type of lock on exterior out swinging doors. Provide electrical mortise locksets, with solenoid operation, concealed within the lock body.

b. Locks and trim shall be provided from one the following products. The University shall determine which of these will be provided on a case-by-case basis:

4. Keying and Cylinders

a. Provide cylinders and lockset from one manufacturer, prepared for interchangeable removable core. Provide construction cores.

b. Keying shall be in accordance with key schedule prepared by the University.

5. Exit Devices

a. Provide rim exit devices on single doors; rim exit devices on pairs of doors with mullions where egress requirements allow.

b. Mullions are to be keyed.

c. Provide exit devices “UL” listed for life safety. Provide exit devices for labeled door with “UL” label for “Fire Exit Hardware”.

d. Provide heavy-duty exit devices, heavy chassis mounting design, with one- piece removable covers, and interchangeable removable core cylinders of the lockset manufacturer.

e. Provided cylinder dogging on non-labeled exit devices. Thru-bolted trim to the lock stile chassis. Use the same type of lever on the locksets with the breakaway feature.

f. Provide keyed removable mullions with interchangeable removable core cylinders.

g. When provided, electronic exit devices, power supplies and electronic access controls shall be of one manufacturer. Provide manufacturer’s complete wiring illustration.

h. Magnetic hold-open units shall be provided with through-bolts and back plates and must be tied into the fire alarm panel for emergency release. Devices shall be listed by CSFM (BML).
6. Door Closers
   a. Surface door closers shall be heavy-duty, full cover, hydraulic type with high strength cast iron case, full rack and pinion construction of heavy steel.
   b. Surface closers to have adjustable spring power. Supply closer with separate, regulating screw valves for closing speed, latching speed, and back check control.
   c. Closer arms shall be heavy-duty forged steel, rectangular shape the full length of the arm, painted to match the finish of the closer.
   d. Mount the closer body and arms on the non-public side of the opening; on the interior side of the exterior openings. Provide LCN Heavy-duty Use model 4040/41 surface closers except for existing minor construction. If Norton 7500 Series or Corbin/Russwin DC2200 Series are the existing closer in a renovation project, then match existing manufacturer.
   e. Provide floor closers with offset pivots, top and middle when surface closer is not a good application. Do not provide concealed overhead closers. Manufacturer shall be: Rixon 27 series or equal.

7. Door Stops and Holders
   a. Door stops shall be provided for each door leaf. Provide for every door either:
      1. Floor stop (first choice)
      2. Wall stop (second choice)
      3. Overhead stop (third choice).
   b. Provide heavy-duty overhead stops and holders wherever floor or wall stops cannot be used, and where the total width of the door cannot swing to a wall because of design or other obstruction by equipment and materials.
   c. Magnetic hold-open devices shall be used on fire rated doors.
8. Kick plates
   a. Provide kick plates on high-use doors, non-labeled lab doors, classroom doors, janitor's closets, storage rooms and rest room doors.
   b. Provide 16-gauge stainless steel, beveled three sides, kick plates 10” high by 2” less than door width on single openings, and 12” high by 1” less than door width, on paired openings.

9. Flush bolts and Coordinators
   a. Coordinators shall be Ives “COR Series” and include the proper brackets to allow for the mounting of necessary hardware. This includes filler bars and plates and closer brackets.
   b. Flush bolts shall be Ives FB-32 (metal doors) or FB-42 (wood doors).
   c. On pair of fire-rated doors, non-active leaf shall have automatic flush bolts.
   d. On pair of fire-rated doors, double active leafs shall have auxiliary fire latch.

10. Thresholds and Seals
    a. Provide stainless steel thresholds with a non-slip coating at exterior doors. Thresholds shall cover the full width of the opening, and wrap the frame from face to face. Cover expansion joints, floor differences and floor rises with the properly configured threshold, cutting and notching for the frame stop/soffit/rabbets. Exterior thresholds shall have beveled side edges. Thresholds shall match the wall width.
    b. Provide aluminum thresholds for interior openings. Provide finish to match hardware.
    c. Provide labeled openings with “soft puff” intumescent seals.
    d. Where automatic door bottoms are requested; they shall be surface-mounted. Concealed automatic door bottoms shall not be used.
    e. Provide seals with screw-on fasteners; no adhesive applied seals.

11. Vivarium holding room doors and other special doors:
    a. Surface mounted retractable sweeps.
    b. Door closer with 90° or 180° hold open features.
    c. Stainless steel pull plate, both sides.
    d. Lever release deadbolt
    e. Latch and strike.
    f. Armor plates and door guards.
    g. Heavy-duty full-mortise hinge, clear anodized, extruded aluminum.

12. Finishes
    a. Provide 630-Stainless Steel or 613-Oil-Rubbed Satin Bronze, per the choice of the University Representative.
1.7 WINDOWS

A. The use of operable windows shall be evaluated based on functionality, ventilation, quality of life, and code-related issues. Unless required otherwise in the Project Program, offices shall have exterior glazing and operable windows. Where sidelights or transoms are used to transfer exterior light from offices into interior spaces, the glazing shall be sandblasted, fritted, or otherwise obscured to limit the visual contact into the offices. Clear glazing may be used when located above eye level (over 7'-0").

B. Vision panels shall be provided in laboratory doors and where there is a chance that someone could be struck by a door opened suddenly from the opposite side. Doors to toilets, bedrooms, patient rooms, or any other rooms requiring privacy shall not have vision panels. The size and location of vision panels shall be standardized throughout a building. In the case where the door with a vision panel is fire rated, the size of the vision panel will be restricted by code requirements.

C. Exterior glazing shall be selected with concern for building energy consumption and general efficiency. This shall include a study of the building orientation, glazing exposure, shading coefficient and light transmission in selection of exterior glazing materials. This study shall be reviewed and materials approved by University's Representative.

D. East, South and West exposures shall utilize high-performance glazing products, unless glass is greater than 50% shaded, based on September sun angles.

E. North exposures and glass greater than 50% shaded (based on September sun angles) shall be clear (preferred) or very light tint, no more than 10% - (to the extent necessary to blend in aesthetically with the tint of the E/S/W exposures) and “oversized” for effective daytime lighting and be double-glazed.

F. Buildings constructed at UC Riverside are required to exceed the minimum requirements of the California Energy Code (Title 24). Coordination with the mechanical and electrical Engineers of Record as well as the building envelope Architect of Record is required. For additional information, see Section 01, Title 24 Energy Code requirements.

G. Fenestration shall be designed considering codes; heating, ventilation and air-conditioning requirements; aesthetic appearance; and the comfort of building occupants. Where glazing is used (fixed or operable), the need for exterior window cleaning must be recognized.

H. Safety glazing (laminated glass) shall be used in areas where security requirements or other hazards exist. Where laminated glass is required for dual-glazed windows, it may be provided for one lite only.

I. Tempered glass shall be used in locations where required by codes.

J. Exterior windows shall have sills with end dams under the window. Sill shall slope ½” per foot and create a drip edge at the building face. The sill, depending on length, shall be of a thickness that will not deflect with a 250-pound person standing on it or become damaged with a ladder placed against it.

K. Greenhouse window configurations are not allowed.

L. Aluminum window units shall comply with performance requirements within this section and California Energy Code as demonstrated by testing manufacturer’s corresponding stock systems according to test methods indicated.

M. Where the design pressure exceeds the minimum for the window grade, comply with requirements of AAMA 101, Section 3, “Optional Performance Classes” for higher than
minimum performance class.

N. Design wind velocity shall be 70 mph (Exposure C, Importance factor of 1.0). The window, when in the open position, must be able to withstand a 50 mph wind gust without incurring damage. Hardware shall be heavy-duty, with multiple point pivots and extenders with reinforcement where required due to configuration.

1.8 GLAZING

A. General

1. Use of tempered or laminated glass shall comply with CBC requirements.

2. Conform to the CBC for minimum glazing requirements, and assure that minimum frame lap (minimum grip of glass) and edge clearances are provided as required for sizes and openings.

B. Materials

1. Glass shall be new, clear float, heat-strengthened or annealed glass, depending on size, type and location. Thickness shall be ¼” minimum and as otherwise required by size of opening, tempered where required by function and Code.
   a. Insulating glass shall be two lites of glass separated by a spacer. The space between lights shall be hermetically sealed using double-seal organic sealants. Air space shall be ½” and depending on type, may be with reflective film.
   b. Insulating glass shall comply with the following:

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<th>VT (Visible Light Transmission)</th>
<th>Exterior Reflectance</th>
<th>U-Value</th>
<th>SHGC</th>
<th>Acceptable Products</th>
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<tr>
<td>Not air-conditioned (including residential)</td>
<td>&gt;70%</td>
<td>&lt;20%</td>
<td>&lt;0.35</td>
<td>Any</td>
</tr>
<tr>
<td>Air-conditioned south- and west-facing</td>
<td>&gt;45%</td>
<td>&lt;35%</td>
<td>&lt;0.50</td>
<td>&lt;0.30</td>
</tr>
<tr>
<td>Air-conditioned east-facing</td>
<td>&gt;60%</td>
<td>&lt;25%</td>
<td>&lt;0.50</td>
<td>&lt;0.40</td>
</tr>
<tr>
<td>Air-conditioned north-facing or &gt;75% shaded</td>
<td>&gt;75%</td>
<td>&lt;20%</td>
<td>&lt;0.50</td>
<td>Any</td>
</tr>
</tbody>
</table>

2. Spandrel glass shall have the frit, if possible, on the fourth face in order to produce the depth visually of vision glass.

1.9 METAL-FRAMED STOREFRONTS

A. Design Requirements

1. System manufacturer shall provide storefront systems, including necessary custom modifications to meet the University’s requirements and maintain visual design concepts. Fabricate glazing systems to allow exterior glazing at vision areas and spandrel areas.

2. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer’s recommended joint design.

3. The designer shall coordinate drawings and verify thermal or structural movement, glazing, anchorage or moisture disposal requirements. The manufacturer shall review, verify and implement those needs.

4. Requirements shown by details produced by the designer are intended to establish basic dimension of unit, sight lines and profiles of members. The Shop Drawings shall be subject to review and acceptance by the University.

5. In the calculations, it shall be assumed that glass, sealants, and interior finishes do not contribute to framing member strength, stiffness or lateral stability.

6. Assemblies shall be free from rattles, wind whistles and noise due to thermal, structural movement and wind pressure.

7. Attachment considerations shall take into account site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening or fracturing connection between units and building structure or between units themselves. Anchors, fasteners and braces shall not be structurally stressed more than 25% of allowable stress when maximum loads are applied.

8. Storefront design shall allow for expansion and contraction due to structural movement without detriment to appearance or performance.

9. The storefront system shall drain the exterior face of wall, water entering joints and condensation occurring within system by use of drain holes and gutters of adequate size to evacuate water without infiltration to interior.

10. Provide concealed fastening throughout. No exposed fasteners or supports will be allowed.

11. Metal faces are required to be visually flat under lighting conditions.

12. Use rigid isolators to maintain flatness on face cap.

13. Provide uniform color and profile appearance at components exposed to view.

14. Reinforce framing members for window washing restraining and stabilization if required.

15. Coordinate hardware, door operators, exit signs, security and fire alarm requirements to provide concealed installations.

1.10 GLAZED CURTAIN WALL

A. General

1. The curtain wall system shall have a single-source responsibility for fabrication and installation.

2. The systems responsibility including door, anchorage, flashing, glazing, sealant hardware installation and in general, shall be a single source responsibility.

3. Curtain wall is to have extruded aluminum factory sill flashing and end dams.

4. Fasteners shall be concealed.

5. If opaque panels are used, they shall be of a concealed attachment and field
dimensioned for an exact fit. No oil canning will be acceptable and panels shall be 1” thickness minimum.

6. Spandral glass shall be 1” insulated units with frit on the fourth surface. When determining glass type, size and potential build-up shall be evaluated.

7. Systems shall be exterior glazed.

8. A Structural Engineer, registered in the State of California, shall design systems for Seismic Zone D, per CBC. Uniform loading: ¾-inch maximum deflection or L/175 of span.

1.11 LOUVERS AND VENTS

A. Provide manufactured exterior storm-proof fixed-blade louvers and vents for outside air intakes, exhaust and relief outlets or as required in exterior walls for ventilation. Provide either aluminum construction with 3-coat fluoropolymer finish or galvanized construction with a high-performance coating finish system.

B. Screens and fasteners shall be of stainless steel construction.

C. Provide extruded sill extensions and loose sills made of the same material as the louvers where required for drainage to the exterior and to prevent water penetrating to the interior.

END OF SECTION 08
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<td>DETAIL INDEX</td>
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1.1 FINISHES

A. The intent of this criterion is to provide low maintenance finishes and details. Finishes must stand up to the rigorous abuse that classrooms, office spaces, and laboratories receive over the life of a building. Classrooms and laboratories are seldom renovated, necessitating the use of only the most durable of materials and products.

B. Exterior finishes shall be durable and designed to a 70-year standard without extensive maintenance, and no deferred maintenance for the first 20 years. Painting of exterior surfaces shall be kept to a minimum, and if provided, must be a high-grade factory 3-coat Kynar finish on aluminum or a 3-part special coating for steel. Due to maintenance concerns, wood is not allowed for exterior finish or trim. The University's Representative shall approve the color selections of exterior finishes.

C. Control Joints

1. Exterior wall surfaces shall be isolated with control joints or other means where:
   a. Wall abuts a structural element (except floor) or dissimilar wall or ceiling.
   b. Construction changes within the plane of the wall.
   c. As required for brick veneer construction by the Brick institute of America, especially below ledger angle supports.
   d. Basic construction contains a control joint.
   e. Interior partition run exceeds 30 feet.
   f. Exterior soffits exceed 30 feet in either direction.

2. Less than ceiling-height door frames shall have control joints extending to the ceiling from both corners. Ceiling-height door frames may be used as control joints. Treat window openings in the same manner as doors.

3. Sheathing shall be broken at control joints. Where vertical and horizontal joints intersect, the vertical joint shall be continuous and the horizontal joint shall abut it. Splices, terminals, and intersections shall be caulked with a sealant.

4. Framing at control joints that extend through the wall shall have 1½" cold rolled channel alignment stabilizers spaced maximum 5'-0" vertically. Channels shall be placed through holes in the stud web and be securely attached to the first stud either side of the control joint.

5. Exterior control joint assemblies shall be suitable for wind pressures up to 40 lbs. /sq. ft., and shall meet ASTM E514, Class E water permeation requirements. Backing shall have 6" wide horizontal overlap in the secondary waterproofing, with additional 6" (minimum) wide strips placed vertically behind the control joint.

D. Zinc alloy accessories shall be used for exterior applications to protect against corrosion, when and if the design professional and University Representative agree that this is required for the UC Riverside campus. Metal lath, control joints, and other metal accessories, including zinc alloy accessories, shall not be used with magnesium oxychloride cement stuccos or Portland cement stucco with calcium chloride additives, unless specifically required and agreed to by the Design Professional and University Representative.

1.2 MINIMUM STC REQUIREMENTS

A. The property of a material or construction system that reduces the transfer of sound energy from one side to another is its Transmission Loss (TL), which is measured in decibels. The TL is tested according to ASTM E90. A high TL value indicates a better
ability to block sound. Some materials reduce sound transmission at high frequencies and others at low frequencies and some provide broad spectrum reduction.

B. Sound transmission class (STC) is a single number rating system designed to combine Transmission Loss (TL) values from many frequencies. STC values for site built construction range from 10 (practically no isolation) to 65 or 70 (which can be achieved only with special construction techniques). Average construction will provide noise reduction in the range of STC 30 to 60.

C. Whenever the sound isolation performance of a partition is specified in terms of an STC value, the rating is assumed to be based on laboratory tests performed under ideal conditions (flanking paths around the tested assembly are minimized). It is typically not possible to achieve the laboratory STC value in the field. The sound isolation performance of a field-tested assembly is usually taken to be at best 5 dB lower than the STC value. Field measured sound isolation performance is typically expressed in terms of Normalized Noise Isolation Class (NNIC). Prior to field testing, the acoustical engineer shall convert the STC values to NNIC.

D. The required STC for typical spaces are based on isolating noise levels from normal activities, and on achieving the NC background noise level in the receiving room. Adjustments may be required for more demanding situations.

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<td>Classroom</td>
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<tr>
<td>Laboratory</td>
<td>50</td>
</tr>
<tr>
<td>Office Area</td>
<td>50</td>
</tr>
<tr>
<td>Public Area</td>
<td>50</td>
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The minimum STC between elevator machine rooms, elevator hoist ways, mechanical, or electrical rooms and any other room shall be STC 50-60. This STC may not be adequate to address the NC criteria in adjacent rooms. Provide special wall or ceiling to meet the University’s required NC levels; see Section 13, “Sound, Vibration and Seismic Control.”

E. Doors shall be provided that has an STC rating equal to the wall rating.

F. The following are guidelines for achieving high Transmission Loss with stud and gypsum wallboard construction orientation (sun exposure) and temperature shall be reviewed to identify if additional wetting is required as the panels dry.

1. Control joints at a maximum area of 100 square feet shall subdivide the cement plaster finish material. The ratio of the subdivided areas shall be a maximum of 3 to 1, with a maximum dimension of 10'-0” (long) and a minimum dimension of 2'-0” (short).
2. Odd-shaped panels with inside corners or penetrations into the field shall not be allowed.
3. Cement plaster panel systems shall be structurally isolated to allow for shrinkage, expansion and contraction.
4. Comply with the proceeding requirements for control joints.

G. Exterior wall finishes shall consist of a 3-part integral color cement plaster system and two layers of 15# building paper over exterior sheathing.
   1. The structure may be wood studs for housing projects.
   2. The building paper shall be counter-flashed at every opening, corner and parapet location.

H. Cement plaster soffit systems:
   1. Provide square edge casing beads butted with a 1/8” sealant joint to achieve isolation and structural independence of the panel system.
   2. Provide soffit vents where recommended or required by CBC.
   3. Provide uplift struts designed for a 70 mph wind speed with a "C" exposure. A Structural Engineer, registered in the State of California, shall provide calculations to the University.
   4. Seismic restraints are required.
   5. Joints, reveals, and pre-made factory intersections shall be extruded aluminum.

1.4 GYPSUM BOARD/INTERIOR NON-LOAD-BEARING STUD PARTITION

A. Interior partition framing for non-residential buildings shall be light metal stud based on L/240 and the Steel Stud Manufacturing Association (SSMA) most recent resource guide and/or as required to comply with STC rating required.

B. Only if required by the project program or RFP shall the non-load bearing stud walls be required to extend from finish floor to the underside of the structure above. There shall be no reduction in gauge or stud size due to above ceiling bracing except where specifically approved during the design phase by the University’s Representative.

C. Provide minimum stud widths as follows:
   1. Minimum 4-inch wide or larger studs shall be used in laboratory corridors. This allows for maximum flexibility for the installation of electrical panel boxes, plumbing lines, fire extinguisher cabinets, etc.
   2. Studs in other areas shall be of appropriate thickness required for the design, piping, fixture supports or equipment/materials to be installed inside or recessed in the stud wall.
   3. Lecture Hall sending walls shall be 6-inch thick studs.
   4. Other stud sizes may be required due to unique conditions.

D. Fiberglass batts shall be used in lieu of “sound batts” in sound rated walls to achieve acoustical requirements at a lower cost to the project. Fiberglass batts shall meet flame-spread and smoke density requirements of CBC.

E. Gypsum board shall be minimum 5/8” thick.

F. Fire–resistive ratings and STC ratings represent the results of tests on assemblies made up of specific materials in a specific configuration. When utilizing details to meet certain fire–resistive requirements, caution must be used to ensure that each component of the assembly is the one specified in the tested assembly. The assembly procedures must be in accordance
with those of the tested assembly. These assemblies and procedures shall be included on the Drawings. Details such as required sealant or penetration treatment shall be identified on the drawings – do not depend on reference to a standard to achieve proper field installation.

G. Toilet rooms and other wet locations with ceramic tile shall have a cementitious backer board or Dens-Glas or equal. The waterproofing membrane behind the cement board and under the floor tile shall be coordinated with the floor construction, wall types, and penetrations.

H. If required by the DPP provide on the two longest walls of each office stud framing sized at an appropriate gauge, size, and spacing to accommodate future standards and brackets for bookshelves. The design shall be adequate for shelving that is 5 tiers high with a 50 pound per lineal foot per shelf loading.

I. Framing at walls with cementitious backer boards shall be 20-gage (0.0312-inch) minimum.

| EXTERIOR WALLS |
|-----------------|-----------------|
| Span            | Stud Size and Spacing    |
| 0'-14'          | C6 x 14 GAGE @ 12" O.C. |
| 14'-17'         | C6 x 14 GAGE @ 8" O.C.  |

<table>
<thead>
<tr>
<th>OPENING</th>
<th>HEADER</th>
<th>JAMB</th>
<th>NOTES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP TO 4'-0&quot;</td>
<td>2 @ 6” x 14 GA</td>
<td>2@ 6” x 14 GA</td>
<td>1. For openings greater than 12'-0&quot;: studs shall be supported vertically by the structure and horizontally by diagonal bracing. Provide header and jamb studs per 8'-0&quot; opening. For openings greater than 8'-0&quot;: provide sill support per 8'-0&quot; opening header.</td>
</tr>
</tbody>
</table>

J. Drywall details shall be simple and maintainable, and not contain excessive reveals, stripes, colors or other features that age badly over time. No exposed drywall corners or edges around perimeters of door jambs, window sills, etc. shall be acceptable.

K. Drywall sills at windows are not allowed.

L. Provide exterior gypsum soffit board complying with ASTM C931 at showers, toilets and locker ceilings.

M. “J” beads shall be used at every termination and screwed in place. N. Cornerbeads shall be used at every corner and screwed in place.

O. Aluminum drywall specialties shall be used for architectural interior reveals. Factory-assembled reveal intersections shall be used in lieu of field-placed. Tolerances in exposed reveals shall not be visible or less than 1/16” +/- in 20'-0”.

P. Where reveals occur in walls that have fire resistive or acoustical ratings provide additional layers of drywall behind the reveal to maintain the wall rating.
Q. Surface Finish: Exposed surfaces to receive paint shall be finished with finishing cement. Orange peel or a lightly textured finish is required for interior applications except for janitor, mechanical, electrical, or other service type rooms.

R. Gypsum Board Ceiling Systems

1. Where gypsum board ceiling systems are used, elements within the ceiling area shall be shown on the reflected ceiling plans and dimensioned. There shall be no access panels in drywall ceilings in new buildings without University Representative’s approval. Equipment that requires access for maintenance or other reasons shall not be located above gypsum board ceilings if at all possible.

2. The structural support of the drywall shall follow the recommendations of the U.S. Gypsum Handbook. Edges shall have 6” minimum vertical returns. Termination and outside corners shall have “J” molds or corner beads respectively.

3. Alignment is critical and shall be 1/8”+ non-cumulative in 20’-0”.

1.5 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Shaft-wall may be used when standard stud and drywall construction is not appropriate due to accessibility or other concerns.

B. At elevators, recessing building accessories can be difficult. If shaft-wall is constructed behind the door opening and a second non-rated stud wall is constructed in front of it, items such as elevator controls, floor indicators lights, or security access readers will not penetrate the rated construction and actual installation is simplified. The type of constructability concern shall be reviewed and resolved to limit field coordination and construction issues.

1.6 TILE, STONE, AND SLATE

A. Both mortar-set and thin-set tile systems may be utilized. System selection shall be based both on the suitability of the material and the project budget – each system has its own benefits and weaknesses. Porous materials shall not be used.

B. Provide a dry layout of the finish material to verify joint layouts.

C. The University’s Representative shall have the opportunity to pre-select or cull material prior to installation at no additional cost to the project.

D. Thin set installations:

1. When using a thin-set installation, the floor or wall substrate requires a tighter tolerance than is required for a mortar set system since there is no mortar bed to take up the variations. Provide appropriate Ff and Ff1 standards for concrete slabs that will be finished with a thin-set system. See Section 03.

2. The dimensional tolerance of the material is an important consideration when choosing to use a thin set process. The larger the component, the tighter the tolerance requirements. The ¼” thin setting bed requires a gauged tile with consistent thickness, since the tolerance of the setting bed will not compensate for excessive coping of man-made tile or non-honed natural material.
3. Tile, stone, or slate installed on walls shall have a cementitious backer board substrate. Where waterproof membranes are used, an additional layer of water-resistant gypsum board shall be provided.

E. Mortar-set floor installations:

1. Where mortar-set tile installations are used, the concrete floor slab shall be recessed to maintain a level surface between rooms or material changes. This shall be coordinated with the structural design.

2. Mortar-set systems (approximately 1-1/2") are most appropriate when using a material that has varying thickness. Use of this installation method does not eliminate the concern for compliance with codes or other issues that may arise due to an uneven finished surface. The tolerances for height variation at the edge of abutting tiles shall be established to eliminate the possibility of trip hazards. To establish compliance with these tolerances, a Type II mock up shall be constructed prior to installation using the selected material. In cases of rough natural materials, a mock up is required prior to selection and purchasing of material to ensure material suitability.

F. Toilet rooms shall have ceramic tile floor and wall finish. Tile shall extend from the floor to at least six-inches above the top of the toilet partition and/or top of mirror as a minimum. A waterproof membrane is required under the tile floors and walls in toilet rooms, locker and shower rooms, and any other wet areas, regardless of the installation method used.

G. Provide cementitious backer board complying with ANSI A118.9 at ceramic tile wall and partition locations, including shower areas.

H. Epoxy grout shall be used for tile in wet areas.

I. Provide marble thresholds at entrances to rooms with ceramic tile floors.

J. Colors and Patterns: Colors and patterns of tile shall be selected by the University's Representative from manufacturer's full product line.

K. Floor tile, tested, both wet and dry, shall have minimum static coefficient of friction of 0.60 for level surfaces and 0.80 for ramps in accordance with ASTM C1028.

1.7 ACOUSTICAL CEILING

A. Provide metal-framing system, except for chemical-resistant ceiling board. For these applications, use a chemically-resistant fiberglass framing system.

B. Lay-In-Tile Systems

1. The lay-in ceiling system shall be carefully coordinated with ceiling-mounted devices.

2. Ceiling-mounted devices, including fire sprinklers and fire alarm devices, shall be shown on reflected ceiling plans and dimensioned in order to define the design intent.

3. Fire sprinklers shall be centered in ceiling tiles. The pattern of sprinkler heads shall align with other elements in the ceiling and create a repetitive pattern throughout an entire space.
4. When locating lights in work areas such as at laboratory benches, fixtures shall be parallel to and overlap the edge of the bench by 8” so that the person will not work in a shadow. The use of task lighting does not eliminate the need to design the lighting to prevent shadowing of the work surface. Task lighting shall be provided for work activities that require higher lighting levels.

5. The acoustical requirements of the project shall be reviewed as part of selection of ceiling materials.

6. On typical projects, a minimum of 2.5% of ceiling tiles may need to be replaced due to damage caused by HVAC balancing, access after installation, and placement of communication cables (including telecommunications cabling by a separate contractor). Provide replacement of tiles at no additional cost to the University. This shall be in addition to required attic stock.

C. The selection of acoustical ceiling systems shall be based on a careful analysis of function, aesthetics, sound absorption, noise reduction, and durability.

D. For special assembly requirements such as auditoriums or lecture halls, an acoustical consultant shall be employed to assist and advise in the design of the space as well as the acoustical treatment of the space.

1.8 FIBERGLASS CEILING AND WALL PANEL SYSTEM

A. This system has been used in the food industry for over 20 years and has been imported for use in Vivarium areas at the University due to its outstanding resistance to damage and its impact- and water-resistance properties. To achieve the maximum benefit from these systems, joints shall be minimized and panels constructed to the full length of the wall.

1. Where seams must be incorporated, they shall be located above doors.

2. Inside corners shall be designed to incorporate pre-molded corner components to aid in cleaning.

3. Outside corners shall have stainless steel corner guards.

4. Transitions from wall to floor and wall to ceiling shall be detailed during the design. The fiberglass wall systems are often used with an epoxy floor– the different movement of the flexible stud walls versus the more stable concrete floors must be addressed.

B. Type 1: Provide washable wall panel and gridlock ceiling panel system for vivarium animal holding rooms, vivarium corridors and other spaces requiring routine washings to meet extreme sanitation requirements. Complete system is based on product manufactured by Life Science Products, Inc., Chestertown, MD phone 800-638-9874.

C. Type 2: For BSL-3 ceilings provide a continuous grid lock ceiling system with fiberglass battens and assembly to match the wall panel system, Life Science Products, Inc. Gridlock Ceiling System “C”.

D. Fiberglass Ceiling Panel System – lay-in grid installations

1. Fiberglass 2 x 4 lay-in panel systems are used in Vivarium areas to provide a finish that is water resistant and washable while still allowing access.
2. The panels shall have gaskets on the grid system. Hold-down clamps are required to prevent the tiles from dislodging during cleaning operations.
3. The grid system shall be fiberglass or other non-corrosive water-resistant materials suitable for the installation. Grid systems shall meet CBC seismic requirements.
4. Perimeter grid components shall be sealed to the wall.

E. Fiberglass Ceiling Panel system – solid panel suspended installation.

1. Where access is not required, a solid fiberglass ceiling panel system attached to metal stud framing may be used.
2. The solid ceiling panel/structural connection shall be suspended from framing that is seismically braced and riveted into place.
3. The design can use a continuous ceiling over multiple areas or the ceiling can be contained within the wall framing. Where the ceiling and wall intersect, pre-molded corners shall be used. Square corners shall be avoided because of the potential for bacteria growth.
4. The manufacturer shall be consulted for assistance to develop fastening and intersection details. Follow manufacturer’s recommendations for fastening and intersection details, as well as for sealing penetrations.
5. Access locations shall be identified on the drawings. Access panels shall be watertight and of stainless steel construction. Access shall be located outside the animal holding rooms and special use rooms.

1.9 FLUID-APPLIED FLOORING

A. Provide epoxy floor coatings for vivarium's, animal holding rooms, and food preparation areas and as directed by the University. Coating systems shall be double thickness epoxy system with fiberglass aggregate, nominal 1/8” thickness.

1. The completed epoxy floor coating systems shall not crack, blister, or delaminate from the substrate for uses intended and shall not leak water or any liquid. Systems shall be free of voids, pinholes and rough textures that will compromise the system.
2. Install flooring with integral base.

1.10 CARPET

A. Carpet shall be provided as required by the Project Program and in offices, aisles in lecture halls, seminar rooms and meeting rooms or traffic areas above quiet areas.

B. Carpet selection criteria shall include durability, serviceability, clean-ability and replacement accessibility in coordination with initial appearance aesthetics. While pattern, color, and texture serve an important role in the design scheme, the construction components and the method of manufacture are critical issues relating to its ability to meet the intended life for the specific area required.

C. Carpet face yarn shall be 100% solution-dyed, type- 6.0, continuous- filament nylon. Colors and shades selected should be a medium intensity value to maximize soil-hiding capabilities. Multi-colored heather’s and non-directional patterns are also preferred for improved seam ability and continuity in large open areas. Solid colors should be avoided except as borders or accent treatments.
D. The carpet fiber shall contain a minimum of 25%-recycled content from postindustrial waste.

E. Carpet face weight shall be a minimum of 28 oz per sq. yard with a minimum density factor of 5000 to maximize appearance retention over the life of the product.

F. Low static carpet is required at offices and computer areas, carpet shall develop less than 3.5 kV of static at 70°F and 20% relative humidity as measured by AATCC test method 134.

G. The carpet backing laminate shall be of a water insoluble composite such as vinyl, urethane, or thermoplastic material. Latex will not be acceptable in the carpet construction. The carpet shall have a woven polypropylene secondary backing for dimensional stability.

H. Antimicrobial properties shall be considered in health care, laboratories, and other areas where moisture is a problem to minimize mildew odors and bacterial growth.

I. Provide carpet with a minimum critical radiant flux limit of 0.22 watts/cm² in compliance with NFPA 253.

J. Installation shall conform to Carpet and Rug Institute (CRI) 104 standards.

K. Carpet shall have low VOC emitting materials and shall comply with CRI Green Label Plus program requirements, as required to obtain USGBC LEED Credit EQ 4.3.

L. Slab-Moisture Content Testing: Perform tests to determine the moisture content of the concrete slab to receive carpet. Three tests shall be performed for the first 1,000 square feet and one additional test for each additional 1,000 square feet of slab per floor level.

M. Carpet Seams: Hold cross seams to an absolute minimum. Match carpet lines and patterns at seams in both width and length.

1.11 EPOXY WALL FINISH

A. Resin and reinforced fiberglass wall system may be used for vivariums, animal holding rooms, and food preparation areas and as directed by the University to provide a washable, waterproof wall finish.

1.12 PAINTING

A. Provide certification by the manufacturer that products supplied comply with Green Seal Standard GS-11 and GS-03, as required to obtain USGBC LEED Credit EQ 4.2.

1.13 COATINGS FOR CONCRETE AND MASONRY

A. Provide a graffiti barrier for exterior concrete walls.

B. Provide certification by the manufacturer that products supplied comply with SCAQMD regulations controlling use of volatile organic compounds (VOC’s).
DIVISION 10 – SPECIALTIES

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1.8 WIRE MESH PARTITIONS 4
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1.1 VISUAL DISPLAY BOARDS
A. Provide dry marker boards and tack boards as required by the Project Program.
B. Provide support backing in the wall for both furnished and future visual display boards.

1.2 TOILET PARTITIONS
A. Provide multiple water closet rest rooms with ceiling-hung partitions. Floor-mounted partitions shall not be used.
B. Provide urinals with wall-mounted screens.
C. If the Project Program indicates a need for high-abuse-resistant design, provide institutional hardware for partitions, including extra-heavy-duty hardware, concealed attachments, and no exposed screws on doors.
D. Coordinate with Structural Engineer to provide steel supports for ceiling hung partitions.

1.3 WALL AND CORNER GUARDS
A. Provide wall surface protection system consisting of aluminum wall guards or stainless steel corner guards.
B. Wall guards (crash rails) shall be provided in corridors and hallways of vivarium’s.
C. Corner guards are required at outside corners in corridors and hallways of laboratories, classroom, lecture hall and other high abuse areas such as lab equipment rooms or areas.

1.4 EXTERIOR SIGNAGE
A. Provide exterior signage mounted on the building. New buildings require exterior signage for the building number (address) and for the building name. Buildings require signage in at least two locations.
B. Size: 6” high for address or functional building names and 12” high letters for facilities named for donors/honorees; 8” or 10” letters may be used if design considerations dictate a smaller letter size. The University will decide if smaller letter size will be used.
C. Lighting: Letters shall only be backlit when directed by the University. Light source shall be continuous, with connections to power source concealed.
D. Construct building sign to prevent roosting of birds.
E. Letters shall be supported individually on the building wall. Manufacturer shall design concealed attachment based on building substrate and if lighting is to be provided.
F. Install on wall in location where directed by University’s Representative.

1.5 INTERIOR SIGNAGE

A. Provide interior signage required by Code and additional signage as listed below. The University’s Sign Shop can provide signage for the project and may be hired by the Contractor to provide signage.

B. Provide as a minimum the following identifying signs:

1. Engraved signs for toilet room doors as required by CBC and Americans with Disabilities Act (ADA).
2. Decals at ADA accessible entries.
3. Room identification signage for every room and stairwell in accordance with the University's standardized room number system.
4. Elevator and stair signage.
5. Emergency evacuation signs.

C. A floor plan providing “emergency procedure” information shall be posted at every stairway landing, at every elevator landing, and immediately inside all public entrances to the building. The information shall be posted so that it describes the represented floor level and can be easily seen immediately upon entering the floor level or the building.

1.6 LOCKERS

A. Lockers for use in a non-humid, non-athletic facility shall be industrial grade plastic laminate with heavy-duty hinges.

B. Athletic facility lockers shall be detailed in the Project Program.

C. Lockers shall be securely attached to backing plates in walls to prevent overturning due to seismic forces.

1.7 FIRE PROTECTION SPECIALTIES

A. Provide fire extinguishers locations required by the California Codes and DCFM. Provide recessed lockable stainless steel cabinets for fire extinguishers in corridors and other public places. Extinguishers shall be the refillable type.

B. Provide a Knox Box for each new building.

1. Boxes shall be sub-Knox keyed (UCR & RFD) Riverside Fire Department).
2. For single story buildings, provided simple small box Model 3200 or Model 4400.
3. For multi-story buildings, use a large sub-Knox keyed vault that would accommodate at least six sets of keys and several “fireman’s phones”, Model 1300.
4. Knox Boxes should be mounted in the fire control room or near the exterior fire alarm annunciator panel, out of the weather, if possible. Coordinate the actual location with the Designated Campus Fire Marshal.

5. If Knox vault is exposed to the weather, rain-tight exterior weather housing shall be provided, Model 1201 Weather Housing. Key to box shall match Fire Alarm panel key (i.e. Simplex “B”).

6. University’s Representative shall order keys through Campus Lock Shop and pay for them.

1.8 WIRE MESH PARTITIONS

A. Provide as needed for interior use, heavy-duty wire mesh partitions. The types of weaves for the wire mesh are as illustrated and defined in ASTM E 437 and its Appendix X4.2.

1.9 OPERABLE PARTITIONS

A. Provide operable partitions as required by the Project Program. Partitions shall be manual, top-supported, and side-stacking style with sound seals. The acoustical consultant shall determine the required sound Transmission Coefficient (STC).

B. Coordinate with Structural Engineer to provide steel structural supports.

1.10 TOILET ACCESSORIES

A. The University has standardized toilet towel dispensers and tissue dispensers. Provide large roll towel dispensers by Scott, model No. 9759, style “Capacitor” with tan gray enclosure. Provide twin tissue dispensers by Scott, model No. 9550, style “JRT Jr” with smoke gray enclosure.

B. Units shall be surface mounted unless noted otherwise.

C. Provide the following units for toilet rooms:

1. Towel dispensers (roll type) surface mounted.
2. Waste receptacle: freestanding large capacity (33 gal.) waste receptacle. Single toilet rooms may use recessed receptacle if space is available.
3. Toilet tissue dispensers: surface mounted twin dispenser, except provide a recess to install dispenser at ADA stalls to avoid conflict with grab bars.
4. Lavatory mounted soap dispenser.
5. Recessed seat-cover dispensers.
6. Recessed sanitary napkin vendors (Women's only).
7. Recessed sanitary napkin disposal (Women's only).
8. Stainless steel grab bars.
9. Stainless steel channel framed mirrors: Full width of counter top and height from splash to ceiling.
10. Folding utility shelf at each toilet compartment.
11. Coat and Hat hook with bumper in each toilet compartment.
D. At shower stalls, provide:

1. Shower curtain rod: extra heavy-duty shower curtain rod with flanges.
2. Shower soap dish: recessed heavy-duty soap dish and bar.
3. Shower curtain hooks.
4. Folding shower seat (ADA shower): reversible folding shower seat, solid phenolic.
5. Robe hook at each shower.

END OF SECTION 10
DIVISION 11 – EQUIPMENT

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1.2 LOADING DOCK EQUIPMENT 2
1.3 SOLID WASTE HANDLING EQUIPMENT 2
1.4 DARKROOMS AND EQUIPMENT 4
1.5 LABORATORY EQUIPMENT 4
1.6 LABORATORY CONTROLLED TEMPERATURE ROOMS 5
1.1 PROJECTION SCREENS

A. Provide manually- or electrically-operated screens as required by the Detailed Project Program.

B. Screen shall be recessed above ceiling.

C. Coordinate with Electrical Engineer to provide switch on wall next to screen.

1.2 LOADING DOCK EQUIPMENT

A. When the Project Program requires a loading dock, provide a minimum of 6 foot by 6 foot, 30,000 pounds gross carrying capacity hydraulic dock leveler.

B. Provide recessed, hinged-lip type dock leveler designed for permanent installation in concrete pits, preformed in the edge of the loading platform. The dock leveler pit shall drain out at ¼ per ft. minimum.

C. Provide hot-dip galvanized finish for steel surfaces, including components.

D. Provide Clean Sweep Frame.

E. Provide dock bumpers.

1.3 SOLID WASTE HANDLING EQUIPMENT

A. Two different types of trash recovery need to be provided for buildings on campus: Three types at buildings with dining components. Add food/compost waste. Non-compact solid waste and recycled waste. Compacted waste shall only be provided when included in the Project Program.

1. This does not apply to hazardous or medical waste.
2. During construction, the Contractor is responsible for the trash produced on the site.

B. Buildings on campus need to be near a solid waste storage receptacle (dumpster) or compactor location, accessible to the refuse truck for periodic collection of the building’s trash. An appropriate dumpster location must be determined for new buildings or large building additions.

C. The quantity and size of trash receptacles or compactors is determined by size of building, number of occupants, type of building (lab or classroom), and proximity to existing receptacles.

D. Trash collection will be collected on a scheduled periodic basis, determined by existing trash schedules, building location, department, and usage.
E. The decision regarding where to place waste storage bins or trash compactors must take into account these factors:

1. Desirable isolation of odors
2. Visibility of waste storage bins
3. Proximity to users
4. Accessibility for servicing

F. The designer shall use plants, wood fencing, or concrete walls, depending on the particular program requirements, to camouflage trash bins or compactors.

G. Sizes and Construction

1. The number of solid waste storage bins is dependent upon the size and function of the building(s) that will be the primary user.
2. Normal solid waste storage bins or trash receptacles are 6’ x 8’, 3 yard standard front loader dumpsters (from consolidated Fabricators). This bin shall be placed in a trash enclosure of at least 8’ x 16’. Walls shall be a minimum of six feet high. Provide curbs or bumpers inside the enclosure to protect walls from damage by the dumpster. Provide protection from leakage to storm drain system.
3. Whenever possible, a trash compactor shall be provided to service one or more buildings. The use of a trash compactor providing a high compaction ratio will reduce trash collection, minimize odor and liquid seepage. Provide a 36-inch grade separation between the compactor and building occupant access to facilitate loading trash into the compactor. Depending on the compactor design selected, other elevation differences may be appropriate. However, the final design shall accommodate a variety of compactor designs.

H. Provide a hose bib with backflow protection and drainage at each trash or compactor enclosure. All drainage must be to sanitary sewer system.

I. Provide adequate lighting for use of compactor or trash receptacle at night.

J. Collection Access

1. Access to the waste storage areas shall be provided the collection and compaction trucks for periodic trash pick-up.
2. To accommodate the weight of the collection truck’s front axles while dumping the trash bins, provide a concrete pad, 6” minimum thickness, under truck access capable of supporting over 20,000 lbs. Reinforce a 10’ x 10’ area beginning five feet in front of the bin. The concrete pad must be the same grade as the parking lot or access road.
3. Allow 60’ clear from the front of the bin enclosure to the wall, parking or landscaping to accommodate collection truck maneuvering.
4. Access for the trash compactor shall be 10’ x 35’. Additional 35’ is needed for truck access. Straight in and out access is required.
5. Provide 23’ overhead clearance to accommodate emptying bins in collection
vehicle.

K. Recycled Refuse

1. Provide in the proximity of trash containers separate containers for recycled paper, corrugated cardboard and beverage containers to food/compost at buildings with food sale components comply with USGBC LEED Materials & Resources Prerequisite 1.
2. These containers shall be emptied once a week by the University-recycling staff.

1.4 DARKROOMS AND EQUIPMENT

A. When required by the Project Program to include a darkroom, provide darkroom sinks, base cabinet, equipment and accessories complete and ready for intended use.

B. Provide revolving darkroom doors complete with frames, threshold and hardware. Door shall meet ADA requirements.

C. Provide safety lights inside darkroom and “In-Use” lighted sign outside of the dark room.

D. Provide drains and water supplies with backflow prevention device for darkroom equipment and sinks.

E. Provide more than adequate ventilation and exhaust for the darkroom. Do not connect the exhaust in common with toilet exhaust, kitchen exhaust, or other non-laboratory exhaust. If necessary provide a separate exhaust fan for the dark room.

1.5 LABORATORY EQUIPMENT

A. Provide laboratory equipment, as required by the Project Program, with necessary components and accessories required to ensure a complete installation and ready for intended use.

B. Provide final electrical, HVAC and plumbing connections to all laboratory equipment.

C. Provide variable air volume fume hoods when such units will reduce airflow and save energy. Design for face velocity of 100 fpm except that when hoods are unoccupied, the face velocity shall be reduced to 60 fpm.

D. Provide a UL approved flammable storage and chemical storage below each fume hood except for ADA hoods. Locate storage cabinets adjacent to ADA hoods.

E. Provide biological safety cabinets when required, complete with accessories and HEPA filters.

F. Fume hoods and biological safety cabinets shall be pre-piped and pre-wired. Pre-pipe service fittings to single point connection at 6 inches above top of hood. Provide p-trap, waste piping and tailpiece extensions for cup sinks and supply stops
for faucets and nozzles. Provide pre-wired electrical devices to junction box at top of hood.

G. Provide lab fittings and fixtures specifically designed for laboratory use. Service fittings not installed with fume hoods or biological safety cabinets shall be furnished loose in cartons and marked for identification for installation.

H. Provide adequate backing seismic restraints and anchorage.

I. Laboratory Service Fittings Acceptable Manufacturers:

1. The Chicago Faucet Company
2. Water Saver Faucet Company
3. Laboratory Enterprises
4. The Campus has standardized on these three manufacturers.

1.6 LABORATORY CONTROLLED-TEMPERATURE ROOMS

A. When the Project Program requires controlled temperature rooms, provide a complete system with necessary equipment, accessories and hardware, including remote compressors, to insure a complete installation to perform intended function. Carefully ascertain and confirm the program requirements with the end users. Often, the perceived need for controlled environment rooms can be met with a conventional cold room instead. In other installations, standby compressors and high reliability systems may be required.

B. Provide piping, tubing, wiring and associated component materials necessary from controlled temperature rooms to compressors remotely located. Provide routing, chase, access and layout drawings and diagrams required to accomplish this work. Access routes and chases, penetrations through floor, wall and roof surfaces shall be provided. Seal penetrations with a chemical resistant sealer and comply with requirements of the building and fire protection codes.

C. Controlled temperature rooms shall be provided with openings through the ceiling panels of the room to accommodate piping and sprinkler heads.

D. Provide foamed-in wall blocking for installation of fixed casework and shelving.

E. Lighting system shall utilize Campus Standard 4’-0” fluorescent T-8 lamps. Lamps and T8EB low temperature electronic ballasts to be enclosed in vapor-proof gasketed fixtures with damp location label rated to operate at temperatures as low as –20 degrees C.

F. Condensing unit shall be water or air-cooled, remotely located in a mechanical room or on a roof pad. Locate the condensing unit above the temperature rooms in the ceiling if approved by the University. Where a centralized cooling water system is available, it shall be used. Provide an air cooled system as a backup. Air-cooled condensing unit coils shall be copper-copper, resistant to corrosive environments. Water cooled units shall be of corrosion-resistant design. The fan and accessories shall be made of corrosive resistant materials. The cabinet shall be galvanized steel protected with a durable waterproof epoxy finish for outdoor installation.
G. Provide the following accessories:

1. Fire Ax: Regulation fireman’s ax with plastic coated blade to prevent corrosion; complete with stainless steel brackets for attachment to interior wall.
2. Smoke Detector: Equipment with contacts for connection to remote building automation system.
3. Connect control panel high temperature alarm dry contacts to building automation system.

END OF SECTION 11
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1.3 WINDOW TREATMENTS 2
1.4 BLACKOUT SHADES 2
1.5 BOLLARDS 2
1.1 MANUFACTURED CASEWORK (LABORATORY)

A. Casework shall be provided as detailed in the Project Program. Construction of laboratory tops, stainless steel fabrications, laboratory wood casework, laboratory metal casework, special purpose cabinets, and miscellaneous laboratory furnishings shall be in accordance with the Campus Master Specifications. Changes to the Campus Master Specifications shall be approved by the University’s Representative.

B. Materials used for the construction of laboratory casework shall be the best of their respective kinds for the purpose intended including specialized materials, finishes and special forms conforming to product characteristics identified in the Master Specification.

C. Seismic rods shall be provided for all open shelving.

1.2 FLOOR MATS

A. Provide permanent entrance mats and frames at all high-volume entranceways in order to obtain USGBC LEED-NC Credit EQ 5.

B. Materials shall be in accordance with the Campus Master Specification.

1.3 WINDOW TREATMENTS

A. Provide vertical or horizontal blinds at exterior windows for offices, laboratories and reception areas and any windows that may need internal shading in order to reduce heat buildup in the room.

B. Materials shall be in accordance with the Campus Master Specification.

1.4 BLACKOUT SHADES

A. Provide blackout shades for windows in lecture halls, classrooms and colloquia rooms.

B. Blackout shades shall be manually-operated or electric-motor-driven in accordance with the Campus Master Specification.

1.5 BOLLARDS

A. Coordinate with the University’s Representative to determine where and what kinds of bollards are required. The Campus Standard detail may or may not be appropriate for the application.
DIVISION 13 – SPECIAL CONSTRUCTION

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1.1 **SOUND, VIBRATION AND SEISMIC CONTROL**

A. **General**

1. This design criterion is intended to provide general information about noise and vibration control. Included are situations that arise in the design process and significant items to check during design. This is a supplement to the advice of an acoustical consultant and other sources of technical information such as the "Sound and Vibration Control" chapter of the ASHRAE HVAC Applications Handbook. This is intended to help the Design Team to achieve appropriate sound and vibration levels required by the Project Program.

2. Noise is characterized by a certain spectrum indicating the sound pressure level at various frequencies. Very often, the spectrum of a noise is as important as its absolute level. Although speech and airplane takeoff sounds may be perceived as being about the same loudness, it is much more difficult to attenuate the lower-frequency noise. The level of such background sounds is commonly related to a series of noise criteria (NC) or room criteria (RC) curves. These curves have been developed to account for the approximate sensitivity of the human ear to high-frequency noise over low-frequency noise and also to the typical spectrum of human speech. The highest point in relation to the NC curves then determines the NC/RC value for a given spectrum. To determine the NC/RC value in the field, sound pressure levels shall be measured with an octave-band sound-level meter.

3. Studies have shown RC curves to have a more desirable spectrum for background noise. However, RC curves may require more noise reduction in lower-octave bands than would be required for a NC curve. This noise reduction may entail significant costs in equipment and operations. For spaces at NC-30 or NC-40, the duct silencers will be 1-1/2 to 2 times longer and pressure drop will increase 10% to 20%. In general, NC curves provide a more reasonable fit between costs and benefits and shall be utilized.

B. **Design Criteria**

1. The evaluation of mechanical system noise shall take place in the early design phase of a project. System noise calculations are the responsibility of the Engineer of Record designing the system, unless an acoustical consultant is employed.

2. An Engineer without acoustical experience should not attempt to perform an acoustical analysis for a major project. If these analyses are wrong in very elementary ways, the initial construction and ongoing operational monetary consequences to correct acoustical deficiencies can be quite substantial.

3. Refer to Section 09 for the established STC wall requirements. The STC identified may be increased due to adjacent noise source, but shall not be decreased.

4. Vibration criteria for floors will be detailed within the Project Program.

5. The University will perform acoustical and/or vibration testing after the structure is constructed to validate criteria is met. If an area fails, acoustical or structural enhancement will be required at no cost to the University.

6. In designing a building HVAC system, it is most common to size ductwork on an equal-friction basis and consider velocities indirectly, as they relate to the volume flow and pressure drop in the ducts. For purposes of noise control, it is necessary to consider duct velocity for its ability to generate noise in a system.
The amount of noise generated is proportional to \( \log (\text{velocity}) \). Because of the uncertainties involved in calculating exact velocities through elbows, dampers, and other fittings during the design process, it is often best to use general guidelines.

7. Low air velocity systems less than 2,000 fpm shall be used. Low-velocity distribution requires less energy to move the air and also greatly reduces the generation and regeneration of noise produced by high velocities.

8. A key item to consider is the acceptable noise level at the receiver location. Duct velocities serving auditoriums must be considerably less than those serving research laboratories. Elbows and other fittings can increase airflow noise substantially, depending on the type. Thus, duct airflow velocities should be reduced accordingly.

9. The selection of quieter, initially more expensive equipment is generally more economical than a less expensive type, which requires considerably more noise and vibration control. Measured sound-power ratings shall be supplied by the manufacturer and shall be a factor in the selection of each major piece of mechanical equipment.

10. The path of noise to any potential receiver shall be examined. In most cases, the dominant path for noise is through the duct to a room outlet. In more severe cases, noise from turbulence may "break out" of the duct and enter a space directly.

C. Noise Levels

1. For most spaces, recommended NC levels have been established through many years of experience. In general, for areas where listening is critical and speech communication is important, the NC level shall be low. For areas where speech is at close distances (6-10 feet), the NC level may be higher. Table No. 1 lists required NC levels for University projects. NC levels are based on rooms not being occupied and with any end user equipment off. HVAC shall be running at 90-100% of full capacity to the space.

<table>
<thead>
<tr>
<th>AREA</th>
<th>NC LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditoriums</td>
<td>20-25</td>
</tr>
<tr>
<td>Audiology Suites, Audio/Speech, Pathology</td>
<td>25</td>
</tr>
<tr>
<td>Phonology/Cardiac Chapel, Chapel Meditation</td>
<td>25</td>
</tr>
<tr>
<td>Residences</td>
<td>25-35</td>
</tr>
<tr>
<td>Conference Rooms</td>
<td>25</td>
</tr>
<tr>
<td>Patient Rooms</td>
<td>35</td>
</tr>
<tr>
<td>Executive Offices (Department Heads)</td>
<td>30-35</td>
</tr>
<tr>
<td>Offices</td>
<td>35</td>
</tr>
<tr>
<td>Classrooms less than 750 ft²</td>
<td>30</td>
</tr>
<tr>
<td>Classrooms greater than 750 ft²</td>
<td>25</td>
</tr>
<tr>
<td>Lecture rooms (large) without speech amplification</td>
<td>30</td>
</tr>
<tr>
<td>Open-Plan Offices</td>
<td>35-45</td>
</tr>
<tr>
<td>Dining Rooms, Lobbies</td>
<td>40</td>
</tr>
<tr>
<td>Central Sterile, Food Service/Serving</td>
<td>45</td>
</tr>
<tr>
<td>Operating Rooms</td>
<td>25-35</td>
</tr>
<tr>
<td>Research Laboratories</td>
<td>45</td>
</tr>
<tr>
<td>Lab Equipment Corridors and Support Areas</td>
<td>45</td>
</tr>
<tr>
<td>Kitchen, Lockers, Warehouse, Shops</td>
<td>50</td>
</tr>
<tr>
<td>Research Animal Housing Areas (vivarium)</td>
<td>See paragraph below</td>
</tr>
</tbody>
</table>
2. These NC values will only be increased when approved by the University. The sound levels apply to these spaces in most common situations. Systems must be engineered and the use of sound attenuation provided to achieve these sound levels.

3. Within Research Animal Housing Area: When evaluating the noise levels in research animal housing areas, it is necessary to consider both the people and the animals in these spaces. For reasonable speech communication in these spaces, a maximum noise level of NC-35 to 40 shall be maintained. The University will determine specific requirements within animal housing areas.

D. Noise Control

1. Mechanical Equipment Rooms: To begin an analysis of the requirement for sound attenuation and vibration isolation of the mechanical room, two items must be identified. The first is requirements of adjacent rooms, both in plan and in section. The second is the type and size of equipment in the mechanical rooms.

2. The ASHRAE HVAC Applications Handbook chapter "Sound and Vibration Control" allows the Engineer to make general estimates of equipment noise levels. For significant equipment, manufacturers shall be asked to provide laboratory-generated sound power levels. These shall then be incorporated into the equipment requirements of the project. In many cases, it may be possible to minimize expensive noise control measures if quieter equipment can be selected.

3. The noise reduction requirements shall be estimated for the mechanical room. Identify early in the design if a mechanical room must be located below or above a noise-sensitive space. If the floor slab above or below mechanical equipment is not sufficiently massive to provide adequate noise isolation, then it may be difficult to modify it after the structural system has been sized and set. At this point, there are two solutions that are often used. One is a floating floor, and the other is a resiliently suspended gypsum board ceiling in the mechanical room or in the noise-sensitive space below. The first is very expensive, and the second is very difficult to install properly in the equipment room below because of pipes, conduit, and equipment. Spaces underneath mechanical rooms face similar problems, but it is generally easier to install suspended gypsum ceiling in a conference room or office than in a mechanical room.

E. Mechanical Rooms

1. Mechanical rooms with noise generating equipment shall be located away from noise-sensitive spaces. Buffer spaces such as corridors, toilets, elevator shafts, electric closets, and other service spaces may eliminate the need to build special noise-isolating constructions such as floated floors or double-layer wall constructions. Central mechanical rooms in occupied buildings shall always have heavy walls of masonry or poured concrete. Penetrations of walls, floors, and ceilings by ducts, pipes, conduit, etc., shall be resiliently sealed airtight. Particular attention shall be paid to doors, as these often represent the "weak link" in sound isolation. Gasket systems to seal air leaks and reduce noise transmission are available. Another option to consider is the installation of a second door or double-door "air lock."

2. Mechanical equipment spaces located within critical buildings shall have a sound-absorbing treatment installed on the walls and ceiling. At least 30% percent of the available wall surfaces and 50% of the ceiling surface shall be covered with a sound-absorbing treatment. Provide rigid glass fiberboard having a density in the range of 1.5 to 3 lbs./cubic feet. Other sound-absorbing materials may be used, except for cellular plastic materials, and these shall provide a minimum noise reduction coefficient (NRC) of 0.65 for a one-inch thickness and a minimum NRC of 0.80 for two inch and three-inch thickness as determined by ASTM C 423. They shall also provide a minimum flame-spread rating of 25 and a minimum smoke-developed rating of 50 as determined by ASTM E 84. Wall treatment shall be installed in an
approved manner and without any exposed pins. Use of loose pin covers is not acceptable.

3. The minimum thickness of the sound-absorbing glass fiber material used in equipment spaces shall be as follows:
   a. Air Compressors, Vacuum Pumps, Chillers and Emergency Generators: 3"
   b. Boilers and Fans: 2"
   c. Pumps, Transformers, Elevator MG Sets, and Switchgear: 1"

4. Consideration shall be given to the application of factory-supplied enclosures or jackets over chillers and generators to provide additional attenuation for equipment operators within the space.

5. Sound-absorbing treatment also reduces the noise levels in mechanical equipment and other high noise-level spaces and helps reduce the possibility of hearing damage to maintenance personnel. Tabulated below are the maximum allowable noise exposure limitations for hearing conversation of individuals in high noise-level areas, as defined by the Title 8 General Industry Safety Orders section 5099.

<table>
<thead>
<tr>
<th>EXPOSURE DURATION HOURS PER DAY</th>
<th>SOUND LEVEL LIMITS DB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2</td>
<td>102</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>1/2</td>
<td>110</td>
</tr>
<tr>
<td>1/4 and less</td>
<td>115</td>
</tr>
</tbody>
</table>

F. Noise Outside Equipment Rooms

1. Many noise problems with mechanical systems are associated with that part of the building just outside the equipment room. This type of noise is generated in two ways. The most common is noise generated by the fan that is propagated within the ducts to outlets. The second type is noise generated by air turbulence at fittings, vanes, and dampers. Pressures higher than 2" and velocity systems greater than 3,000 fpm will often have significant quantities of both types of noise and vibration.

2. The noise generated by ducted systems will typically enter spaces in three ways. The noise may pass through the duct walls and into noise-sensitive spaces. It may travel within the ductwork and enter a space through supply or return grilles. Finally, vibrations in the duct may be transmitted into other surfaces or utility systems to either create noise or become a feel able vibration.

3. Noise that passes through duct walls is referred to as "breakout" or "break-in" noise. This noise may be either fan noise or velocity-generated fitting noise. This is often a problem closest to the fan. At this point, the ducts are large and therefore not very stiff. Near the mechanical room, noise from the fan has not been attenuated by long runs of ducts. This usually causes a low-frequency rumble in the vicinity of main
ducts, especially if the duct is directly above a lay-in acoustical tile ceiling.

G. Noise Control for Electrical Equipment

1. Electric Transformers and Dimmer Banks: Transformers and dimmer banks may be sources for both noise and vibrations. Large utility distribution transformers may be a noise problem in the surrounding community because of the pure tone noise or "hum" associated with them. Smaller distribution transformers inside a building shall be isolated from noise-sensitive spaces. Neoprene pads or hangers shall be used to attenuate structure-borne vibrations.

2. Variable-Speed Drives (VFD's): Pulse-width modulation (PMV) types generally make the motors on the equipment most noisy while the drive units themselves may be very quiet. Drive and motor noise shall be reduced per manufacturer's recommendation during start-up.

3. Electrical conduit connections to isolated equipment shall be made so they do not short-circuit the resilient connections.

4. Conduits less than one inch in diameter shall be made using flexible conduit sections forming a slack connection. Larger-sized connections shall be made with manufactured flexible fittings.

5. For multiple- or variable-speed equipment, the isolator critical frequency shall be half of the slowest equipment frequency.

H. Equipment Placement on Roofs

1. Sometimes the University will allow use of packaged rooftop equipment rather than equipment located in central or individual mechanical rooms. Special care shall be taken in the location, selection, and design of this type of equipment. The roof structure shall be sufficiently stiff that it does not vibrate with the equipment or transmit vibration. Most commonly used vibration isolation selection tables assume a reasonably stiff supporting structure, but this shall be confirmed. In the case of lightweight roof mechanical equipment shall not be placed on the roof.

2. From an acoustical viewpoint, the preferred mounting arrangement is to place the unit above the roof by 36 inches, or 48 inches on supplemental steel framing. Catwalks with removable railings are required for raised equipment, along with a 4'-0" minimum maintenance servicing area. Due to the expense of the raised structural system, and the use of the roof diaphragm in resistance for seismic events, the structural design can create a stiff structure to allow equipment installation on a 12" to 18" raised concrete platform.

3. Equipment manufacturers' internal vibration isolation furnished as standard may not be adequate for controlling the transmission of noise and vibration. Determine required deflection and confirm it shall be maintained for either internal or external isolation.

I. Maximum Air Velocities

1. Table No. 3 lists maximum velocities for ductwork serving spaces with a required NC level. When measuring distance from the air terminal, it is important to measure from each terminal, not just the last one. In this case, the "terminal" is a bit different from what is used for static pressure calculations. These velocities may be increased by installing a silencer along the duct, if paths to the receiver from the turbulence in the duct are considered. To prevent breakout noise, a duct enclosure or architectural construction must also be used.
TABLE NO. 3
Maximum Airflow Velocity in Duct System

<table>
<thead>
<tr>
<th>Duct Location</th>
<th>MAIN DUCT</th>
<th>BRANCH DUCT</th>
<th>FINAL RUNOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>In shaft or above drywall ceiling</td>
<td>NC</td>
<td>Rectangular Duct</td>
<td>Circular Duct</td>
</tr>
<tr>
<td>45</td>
<td>2600</td>
<td>2050</td>
<td>1300</td>
</tr>
<tr>
<td>35</td>
<td>1850</td>
<td>1500</td>
<td>900</td>
</tr>
<tr>
<td>25</td>
<td>1250</td>
<td>1000</td>
<td>600</td>
</tr>
<tr>
<td>Above suspended acoustic ceiling</td>
<td>45</td>
<td>1850</td>
<td>1500</td>
</tr>
<tr>
<td>35</td>
<td>1300</td>
<td>1050</td>
<td>650</td>
</tr>
<tr>
<td>25</td>
<td>900</td>
<td>700</td>
<td>450</td>
</tr>
<tr>
<td>Duct located within occupied space</td>
<td>45</td>
<td>1500</td>
<td>1200</td>
</tr>
<tr>
<td>35</td>
<td>1150</td>
<td>900</td>
<td>550</td>
</tr>
<tr>
<td>25</td>
<td>700</td>
<td>550</td>
<td>350</td>
</tr>
</tbody>
</table>

J. Exposed Ductwork

1. Exposed ductwork could create a noise problem. The noise reduction provided by a lay-in ceiling is negligible at low frequencies. Calculations based on ASHRAE HVAC Applications Handbook's "Sound and Vibration Control" chapter shall be performed to determine the likelihood of a problem. If a problem is present, there are several methods to reduce the potential noise level. First, the duct may be rerouted over a non-critical area. Second, round duct or multiple round ducts may be used in lieu of rectangular duct if adequate space is available, since round duct is stiffer. Third, the duct may be externally wrapped or encased for sound attenuation. Sound attenuating duct wrappings may encounter sufficient numbers of obstructions and penetrations to render them ineffective. Further, access to valves and duct-mounted equipment becomes difficult. While sound attenuating wrapping can be effective, it shall be employed only when absolutely necessary.

K. Ductwork Borne Noise

1. The passage of noise from the fan along inside the duct and into a space is one of the most common noise problems associated with mechanical systems. The engineering procedures to deal with this problem are also well documented in the ASHRAE HVAC Applications Handbook "Sound and Vibration Control" chapter. This method could be used to calculate the propagation of noise generated at fittings and dampers away from the fan. This is particularly relevant in the design of laboratory exhaust systems where the velocities and pressures in the systems are often quite high. In these circumstances, high levels of noise may be generated at fittings and volume-regulating dampers. This noise shall be included in the acoustical analysis of the system.

2. Within the duct system there are several items that provide some attenuation of noise. These are branch takeoffs, open-end reflections, fittings, and duct silencers. These are discussed in detail in the ASHRAE Handbooks, so only some minor points will be discussed here. Branch takeoffs provide a division of sound energy proportional to the decibel ratio of the areas involved. Credit shall only be taken where one of the branches does not enter the room in question. Where a fan serves many rooms, this can be a substantial help. While duct lining is one of the most efficient noise control measures available, it cannot be used in University buildings due to its well-known indoor air quality problems. Limited duct lining behind perforated plates can be
used. The University has been successful in using just one side of large ducts with liner and covered with perforated plate. This eliminated the installation of a duct mounted attenuator in a lab exhaust system.

3. Sound attenuators installed at the factory within air handling units shall be the first choice. The attenuators can be significantly larger within AHU’s and have very low-pressure drops. Installation at the factory allows sound testing of the units. Manufactured duct silencers are another commonly used means of noise control. These are commercially manufactured sound absorbers. They consist of a section of sheet metal with perforated interior skin and sound absorbing in-fill. They are available in many constructions, sizes, and shapes. In general, these factors can be matched to the requirements of the system under design. In the design of hospital, animal, and laboratory systems, it is not appropriate to use standard perforated, fiberglass-packed, galvanized silencers. Instead, provide a high-grade stainless steel, packless washable silencers.

4. Silencer manufacturers can also provide thin plastic bags for the fill. A thin mesh screen between the bagged fill and the perforated metal baffles will ensure a minimum degradation of acoustical performance. Insertion loss and spectrum level is also important characteristics when selecting duct silencers. Generally, the 125, 250, and 500 Hz octave-band center frequencies are most critical. Duct borne sound-level factors to be considered are:

a. Sample calculations provided by some manufacturers will often show a very close match between the octave-band insertion loss requirements and the performance of the silencer that is chosen. This does not usually happen in real-world situations. The insertion loss requirement for the silencer will usually be dominated by one or two low-frequency octave-band center frequencies depending on fan type, blade passage frequency, and blade configuration, which affect the fan sound-power level.

b. The size and pressure drop are key considerations. It is usually possible to meet the insertion loss requirements with several different-sized silencers. The choice is usually between a long, low-pressure drop silencer, and a shorter, high-pressure drop silencer. The University requires long, low-pressure drop silencers be provided.

c. Once a silencer is selected, it must be incorporated into the duct layout. The silencer shall be located so that smooth airflow is maintained into and out of the silencer. Poor design in these areas can cause the actual pressure drop to be much more than that listed by the manufacturer and can reduce ratings in dynamic insertion loss (DIL), i.e., with air flowing through the silencer.

d. Duct mounted sound attenuators are a major source of energy loss in HVAC systems every consideration shall be given to minimizing their use and great care shall be taken to ensure that the “as installed” pressure loss through the sound attenuator is less than or equal to the “as designed” pressure loss.

e. The University shall be consulted on variables used.

5. In locating the silencer, keep in mind that any noise generated downstream (or upstream in the case of exhaust systems) from the silencer will not be attenuated. It is important to remember that constant volume regulating dampers will usually generate a substantial amount of noise, especially if there is a substantial pressure drop (more than about 1 inch) across the regulating damper. If the silencers are placed near the fan, then noise generated by these dampers will enter the laboratory attenuated by the silencers. For spaces with critical listening requirements, such as auditoriums and large conference rooms, excessive velocities at supply or return terminal devices can create similar problems. Since the amount of noise is velocity related, it is advisable to elect terminal devices with more free area for critical spaces.
L. Miscellaneous Mechanical Equipment

1. Consideration shall be given to noise from relatively small pieces of equipment, particularly if they are located in an occupied space, rather than in a remote mechanical room. These include "active" devices and "passive" devices. Active devices are most often items such as fan coil units, heat pumps, electric water coolers, or air terminal units. Passive devices are most often diffusers, air-monitoring devices, grilles, and louvers.

   a. For active devices most manufacturers can submit ratings of octave-band sound-power levels.
   b. Passive devices manufacturers' ratings shall also be submitted.
   c. Use of passive or active calculations may be considered if some attention is paid to quantity of diffusers in a room.

2. Hoods and louvers with velocities around 150 fpm almost never are a direct cause of noise. Noise may often be heard coming out of these devices, but they are not often the actual cause of the noise.

3. Steam pressure-reducing stations, vacuum pumps, compressed air, and other major pressure control devices, and automatic drain valves can generate significant noise within mechanical rooms and need to be addressed.

4. Submit terminal units and air valve manufacturer's certification that they meet a specified noise criterion with or without noise suppressors.

M. Elevators

1. Both hydraulic and traction elevators may be the cause of disturbing noise and vibration problems and shall be evaluated during design. Hydraulic elevators shall have the motor/tank/pump assemblies mounted on neoprene isolators that achieve at least 0.35-inch deflection. Hydraulic piping shall be resiliently isolated from the building. Neoprene pad isolators shall be used at pipe sleeves, pipe supports, and pipe hangers. Electrical connections to the isolated equipment shall not short-circuit the isolation and shall employ flexible conduits.

2. For traction elevators, the motor/winch lifting assemblies and motor/generator sets shall be isolated from the structure with constrained neoprene isolators that achieve a minimum deflection of 0.35 inch. Electrical connections to the isolated equipment shall not short-circuit the isolation and shall employ flexible conduits or fittings previously noted.

N. Piping Systems

1. One of the most common acoustical problems found in buildings is noise generated by the piping systems. Due to its easily identifiable nature, piping noise is one of the most disturbing and offensive types of noises encountered in buildings even though the levels are seldom excessively high. Most of the noise from piping systems is structure-borne, being transmitted along the piping throughout the building where the noise is reradiated as airborne noise.

2. Piping runs shall be resiliently isolated from the surrounding structure.

   a. Isolating materials shall consist of rubber, neoprene, or spring mounts and felt- or glass fiber-lined sheet metal straps or clamps.
   b. At wall and floor penetration and anchorage points, water piping runs shall be free from the structure, and the opening shall be packed with a resilient insulation material and fully caulked.
c. Pipes larger than two inches in diameter shall be suspended from the structure on neoprene-in-shear hangers or floor-mounted on resilient supports.
d. Riser piping near critical areas shall be kept free of the structure, and vertical alignment shall be achieved through the use of resilient guides rather than by solid anchorage to the structure.
e. Flexible pipe connectors shall be used to connect the supply and drainpipes to vibrating units.

3. High-pressure steam and water systems are inherently noisy due to turbulence or air in the fluid flow.
   a. To prevent the generation of excessive flow noise caused by turbulent flow or air in the piping systems, do not locate piping adjacent to sensitive areas.
   b. In larger facilities where high-pressure main supply lines are required, pressure regulators shall be used in the supply branches at each floor.
   c. High-velocity flow in the piping system also produces turbulent flow and high noise levels. In piping runs adjacent to acoustically critical areas, such as conference rooms and patient rooms, select pipe sizes at the low end of the normal selection range rather than the high end.
   d. The use of short air-filled branch pipes or stubs to control water hammer is not effective and shall not be used. The most efficient means of preventing water hammer is to install one of the mechanical devices manufactured for this purpose, which employs a gas-filled stainless steel bellows to absorb the shock of the hydraulic waves by mechanical compression of the bellows. These devices are available in a variety of sizes to accommodate most fixture sizes used in buildings.
   e. Steam pressure-reducing valves shall be selected for reduced noise generation to meet design criteria. Noise suppressors shall be installed when required. Acoustical attenuation adjacent to reducing station shall be provided.

O. User Equipment Noise

1. There are many noise sources within University facilities that are not related to the building mechanical system. Buildings are often equipped with refrigerators, centrifuges, and other scientific or engineering equipment that contribute significantly to the ambient noise level. In some cases, this equipment will be located in service corridors and adjacent to occupied spaces. Most of this equipment operates intermittently and is often under the control of the user. Since the types of equipment vary greatly, it is not possible to prescribe a single means of noise control. Any equipment that either produces noise levels in excess of 50 dB(A) at a distance of three feet, or is simply known by the users to produce objectionable noises, shall be considered a significant noise source.

P. Community Noise

1. It is important to realize that noise created by the mechanical systems propagates outside the building, as well as inside. The location of nearby noise-sensitive neighboring buildings must be considered. Projects near the property lines of campus shall consider the City of Irvine’s noise standards. Keep the noise level at or below the existing ambient condition as a minimum. That level may be quite low at night, especially in the residential areas on campus. The University shall be consulted on each project to establish what will be considered a satisfactory level.

2. There are several types of equipment that may cause noise problems outside a building, as well as inside. The most common are emergency generators, cooling towers, roof fans, rooftop condensing units, etc., which if located outside can be a problem if they are numerous or large enough.
An area that is often overlooked is the exterior connections of supply and exhaust fans. These fans are usually quite noisy, and the connections to the outside are generally quite short. It is important to identify significant sources early in design. These noises are most commonly treated with duct silencers or acoustical barriers.

Q. Vibration Isolation

1. Structure-borne sound is produced by a noise source, such as a piece of vibrating machinery, which transmits energy directly into and through the structure, often to remote locations in a building, and is radiated by wall and floor construction as airborne noise. One key to elimination of vibration and noise is equipment alignment, not isolation. Pumps and fans shall be accurately aligned in the field. See mechanical section of these Standards for the University's alignment requirements.

2. Vibrating equipment in facilities shall be resiliently mounted. The purpose of vibration isolation is to reduce the vibration energy produced by rotating equipment so that it is not passed into the structure and into larger "sounding boards" where it can be translated into audible noise. In the cases of some sensitive engineering and scientific equipment, structural vibrations may be harmful to their operation. This is true even in some cases where the frequency and level of the vibration are so low that they cannot be felt but measured only with sophisticated instrumentation. When a project involves the use of vibration-sensitive equipment, such as electron microscopes, a vibration specialist shall always be consulted. The ASHRAE HVAC Applications Handbook's "Sound and Vibration Control" chapter contains guidelines and a table of vibration isolation selections for most common situations.

3. Space requirements for the isolation springs and equipment bases shall be included in the equipment layout. At least two inches horizontal and vertical clearance shall be provided between isolated equipment and the building structure. More space is usually preferred for proper access for installation and adjustment.

4. Equipment shall be located in an area that is as stiff as possible, and then vibration isolation requirements will be minimized. Vibrating equipment that is located on grade is preferred. If that is not possible, then areas above stiff major beams are the second-best location. For standard mechanical equipment, the location is most important for large equipment with a slow rotational speed. For very lightweight mounting surfaces, particularly roof decks, it may be necessary to provide separate framing for the mechanical equipment.

5. Housekeeping pads shall be provided under floor-supported equipment. The pads shall be connected to the slab with steel dowels. The pad area shall be sized to extend beyond the resilient mounts of isolated equipment. These pads are intended to provide local mass and stiffness below mechanical equipment and to keep resilient mounts off the floor, where they may be easily blocked by debris under the spring or equipment bases. Very large pieces of mechanical equipment may be installed on separate foundations isolated from the main building floor slab.

6. Four basic types of vibration isolators or resilient mounts are: resilient pads, elastomeric mounts, steel springs, and pneumatic mounts. Each type has advantages depending upon the degree of required isolation, loading, flexibility of the supporting structure, and driving frequency.

   a. Resilient Pad Mounts: Resilient isolators are the easiest and most commonly used material. Resilient pad mounts are available in a variety of materials such as: ribbed or waffled neoprene and rubber; pre-compressed, load-bearing glass fiber; felt foam; and cork. For maximum life and durability, pads of rubber, neoprene, or glass fiber shall be used. Care shall be taken in the selection of the proper material type, density, thickness, and size to ensure that the appropriate loading of the material is achieved.
Overloading a resilient pad material causes increased stiffness of the pad and thereby significantly reduces its isolating effectiveness.

b. Elastomeric Mounts: General-purpose elastomeric mounts typically consist of a resilient material such as neoprene, which can be easily molded into special shapes. These mounts shall be bonded to metal plates and support members of the equipment.

c. Steel-spring Isolators: The most effective vibration isolating devices available are steel-spring mounts, particularly where large pieces of equipment are involved.

d. Pneumatic Mounts: Where low-natural-frequency mounts are required, pneumatic vibration isolators shall be used. In this type of mount, an elastomer is combined with air to form a rubber/air spring. Pneumatic mounts provide both support and resilience for the equipment mounted on them. By proper sizing and distribution, a very stable, low profile and low-natural- frequency isolator mount can be obtained with built-in shock overload protection, built-in damping, and in certain cases, without the need for external lateral stability provisions.

e. Each type shall include additional restraints to comply with Seismic Zone 4.

7. Mechanical equipment with a high power-to-weight ratio shall first be mounted on a concrete inertia base approximately one to two times the weight of the equipment (but not less than 6” thick), plus system fluids, if any. The inertia base and equipment shall be resiliently isolated on freestanding, unhoused, stable steel springs and noise isolation pads.

8. Typical pieces of equipment that require concrete inertia bases include fans and chillers over 25 HP, and pumps and compressors over 5 HP. Fan equipment with motors smaller than 25 HP shall be mounted on rigid structural-steel frames and the entire assembly mounted on vibration isolators plus noise isolation pads.

9. When the building structural system cannot accommodate the added weight of concrete inertia bases, very high efficiency isolators such as pneumatic mounts shall be used to isolate the equipment mounted on rigid steel frames. Close coordination is required. If vibration problem exists after the fact the University will impose this type of modification at no cost to the University.

10. Restraint for lateral and vertical seismic loading shall be achieved through the use of resilient snubbers which are mounted outboard of the inertia base on the housekeeping pad.

a. The snubbers shall consist of steel angles or brackets bolted to the structure with a layer of resilient material between the inertia base and steel angle. The steel angles and bolts shall be sized by a registered California Structural Engineer to accommodate the applicable G-force loading (either static or dynamic) based on seismic zone 4.

b. Several vibration isolation manufacturers provide isolators which have integral seismic restraint elements built in. However, since inspection of the inside of a unit is difficult, they are susceptible to flanking of vibration energy due to metal-to-metal contact through misalignment. The University shall approve the selection of isolators with integral seismic restraint.

11. Steel Spring Isolator

a. The most effective vibration isolation system for mechanical equipment involves mounting the equipment plus inertia base or steel frame on
freestanding, unhoused, stable-steel springs, with additional travel between solid (fully compressed) height and design height equal to 50% of the static deflection of the spring.

b. Housed-spring units with multiple, small-diameter coils or units with rubber or neoprene cups shall not be used. The horizontal stiffness of the spring isolators shall be specified to be between 0.9 and 1.2 times the vertical stiffness, and the outside diameter of the springs shall be between 0.85 and 1.25 times the operating height of the spring. Each spring shall be equipped with a resilient noise isolation pad between the structure and spring foot. The noise isolation pad shall be pre-compressed, molded, neoprene-jacketed, load-bearing glass fiber, or multiple layers of ribbed or waffled neoprene. For mechanical equipment located on grade, the noise isolation pad shall be a minimum of ½ inch thick. At locations above the grade level the noise isolation pad shall be at least one inch thick.

12. The static deflections required for vibration isolators are determined by the speed and horsepower of the equipment mounted on them, as well as by the location of the equipment within the building. For this reason it is best to locate as much of the vibrating equipment at grade level as is practicable.

a. Mechanical equipment above grade level shall be located as close as possible to or over a column, load-bearing wall, or other stiff structural member.

b. For above-grade locations, the minimum static deflection of any steel spring used to isolate a piece of equipment shall be one inch.

c. Fractional horsepower equipment shall be mounted on rubber-in-shear or glass fiber isolators providing at least ½ inch static deflection.

13. Flanking transmission of vibration energy from mechanical equipment shall be minimized. Connections to vibrating equipment shall be through flexible connectors, conduits, piping, or hose. Resilient ceiling hangers or floor-mounted resilient supports shall support piping in mechanical equipment spaces connected to vibrating equipment. Penetrations through equipment room walls and ceilings shall be slightly oversized, packed with a resilient material such as glass fiber or mineral fiber, caulked airtight, and covered with escutcheon. Piping shall be supported on both sides of the penetrations and shall not rest on the structure.

14. One of the most common means for defeating otherwise good mechanical vibration isolation is the use of inadequate flexible connections in the piping systems. The Mechanical Engineer of Record for the project shall provide careful attention to the detailing of these connections. It is important to note that many so called “industry standards” either do not work properly initially or do not provide adequate isolation after a few years. The designer shall give sufficient attention to the movement of piping once it is pressurized. Often, vibration isolators are locked in place by fluid pressure in the piping and thereby are defeated.

R. Vibration testing:

1. Test for the maximum vibration tolerance defined as follows:

a. Tests shall be for the highest 4-second average vibration velocity in each 1/3 octave band during the 2-minute period while people are walking near the point of measurement.

b. The vibration sensor (accelerometer) is secured to the floor at the point of interest.

c. A real time spectrum analyzer is set to measure the average velocity in 1/3 octave bands from 4 to 200 hertz in a sequence of thirty consecutive 4 second time periods.
d. The test engineer starts the analyzer and walks past the accelerometer several times over a 2-minute period at a walking rate of 100 to 120 steps per minute (fast walker). In small areas where fast walking cannot be achieved, the walking rate may be reduced to 75 steps per minute.
e. After the analyzer has gathered the data, the test engineer reviews each of the 30 results for each 1/3 octave band and records the highest value for each band.
f. The test data shall be scaled by a factor to establish the results for a 230-pound walker.

1.2 HAZARDOUS MATERIAL REMEDIATION

A. Asbestos abatement projects are developed and managed directly by the University. The specifications, standards and requirements are defined by EH&S which updates them periodically. A copy of this specification section is available from the University. Confirm any revisions with Design & Construction Services Project Manager.

B. The University generally bids removal of transit pipe and other asbestos containing materials as a unit price. If demolition (i.e., removal of transit pipe or vinyl asbestos tile) is necessary for completion of the work, reference separate documents by University. Do not indicate work to be done by separate contract.

END OF SECTION 13
DIVISION 14 - CONVEYING SYSTEMS

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1.1 ELEVATORS

A. Design Criteria

1. Provide elevators in buildings two stories and higher. Direct service to each floor in the building shall be provided, including floors or roof where mechanical rooms or equipment is located. Passenger elevators shall be non-hydraulic, energy efficient machine-room-less style unless otherwise approved.

2. In the case of an elevator-remodeling project, the University shall retain the salvage rights to the existing elevator components.

3. Modern, gearless, traction elevators are the preferred elevator for new buildings on campus. Their speed, economical operation, low environmental footprint, ease of service, simplicity, and durability all combine to make them a superior choice for all buildings on campus where elevators are required. Since several manufacturers have developed machine room-less traction elevators that impose loads on the building similar to those imposed by hydraulic elevators, the difficulties of installing heavy components high in the structure have been eliminated.

4. Hydraulic Elevators

a. Hydraulic elevators shall only be used after thorough evaluation of all other options. When the University approves the design of a building with hydraulic elevators, they shall at a minimum conform to all of the following standards and other standards listed elsewhere in this Section and other Sections of this Standard:

1. Hydraulic passenger elevators are generally limited to a maximum travel of 55 feet, or five stops.

2. Hydraulic service elevators shall be limited to a maximum travel of 60 feet.

3. For easy access and maintenance, hydraulic lines from the pumps are to be installed overhead and not under slab. Locate machine room adjacent to hoistway if in any way possible.

4. Provide minimum speed of 125 feet per minute. This may require a redundant pump. The pump shall be configured to allow the maintenance on one while the other is active.

5. General Preparatory Work Required for the Elevator.

b. Design a legal hoistway according to the required fire rating, including where hoistway walls are penetrated by elevator fixture boxes. Hoistways shall include adequate fastening to hoistway entrance assemblies.

c. Provide structural supports for guide rails. Separator beams shall be installed where required. Supports to the clear hoistway line shall be installed if it is necessary to support rail brackets from the web of a beam or other structure beyond the clear hoistway line.

d. Provide properly ventilated, lighted and sound-isolated room(s) of sufficient size for the machinery. Temperature shall be maintained less than 90 degrees Fahrenheit. Access door shall be adequately sized to accept
the elevator contractor’s equipment.

e. Reinforce dry pit to sustain impact loads on cylinder head(s) and buffer(s), including either a sump with grated cover. Provide exterior waterproofing and sub-grade drain system. Coat exterior of casing with ¼” thick waterproofing material, Liquid Boot or equal.

f. A horizontal support shall be provided 1 foot above the clear opening at the top landing to support the doorframe assembly.

g. Buildings with no Fire Alarm Control Panels:

1. Elevator lobby smoke detectors with wiring to a controller. For each group of elevators, provide a normally closed contact from the smoke detector at the designated return landing, as well as a normally closed contact representing other smoke detectors at lobbies, machine rooms, and hoistway smoke detectors. If a smoke detector is located in the hoistway at or below the lower of the two designated return landings, it shall be wired to activate the same normally closed contact as the smoke detector located in the lobby at the lower of the two designated return landings.

h. Buildings with Fire Alarm Control Panels:

1. Coordinate the installation and programming of any smoke detector, heat detector, and interface relays required by this section with the Electrical and/or Fire Alarm System Contractor. All smoke detectors, heat detectors, control modules and interface relays are to be monitored and controlled by the building fire alarm control panel. The electrical contractor will provide dry form C contacts for the purpose of (1) elevator recall, (2) alternate elevator recall and (3) shunt trip. The elevator contractor shall make all final connection to the elevator controllers. The recall, alt recall and shunt interfaces shall be tested to the satisfaction of the authority having jurisdiction. Lobby smoke detectors will be used to recall the elevator(s) to the primary floor as directed by the authority having jurisdiction. One floor will be defined as the alternate recall floor and the primary floor lobby smoke detector(s) will recall the elevators to the alternate floor. Smoke detectors will be provided in the elevator machine room(s) and will activate the primary recall interface. Heat Detectors will be provided as required in the elevator machine rooms to shunt the elevator system in the event of heat activation. Smoke and heat detectors will be provided in hoist ways as required by code and provide the same recall and shunt trip as the devices in the machine rooms. Exception: If a smoke detector is located in the hoistway at or below the lower of the two designated return landings, it shall be wired/programmed to activate the same contact as the smoke detector located in the lobby at the lower of the two designated return landings.

g. If fire suppression sprinklers are installed in the hoistway, machine room, or machinery spaces, a means to automatically disconnect the main line power supply of the affected elevator prior to the application of water shall be provided. Elevator lobby smoke detectors shall not be used to activate sprinklers in hoistways, machine rooms, or machinery spaces or to disconnect the main line power supply.
h. Fluorescent lamp light fixture and convenience outlets with ground fault circuit interrupter shall be provided in pit with light switch adjacent to the access ladder.

B. Components

1. General Requirements: Provide pre-engineered elevator systems or custom-manufactured elevator systems that fully comply with and fulfill the University's standard requirements.

2. Locate electric pump, tank and control system equipment in Elevator Machine Rooms except for machine-less room style units.

3. Piping: Provide size and type of piping recommended by manufacturer, and provide isolation couplings to prevent sound/vibration transmissions from power unit. Piping shall be sized for a maximum velocity of 10 fps.

4. Car Frame and Platform: Manufacturer's standard welded steel units for passenger elevator. For service elevator, provide special heavy-duty unit.

C. Materials

1. Stainless steel: Type 304, No. 4 Satin "Brushed" Finish.

2. Plastic Laminate: ASTM E84, Class A fire-rated grade (GP-50)
   a. Exposed surfaces: Color selected by University's Representative.
   b. Non-exposed surfaces: Manufacturer’s standard.

3. Fire-Rated MDO (Medium Density Overlay) Panels: Minimum ¾ inch thick backup for natural veneer or plastic laminated panels.

4. Paint: clean exposed surface of oil, grease and scale. Apply one coat of rust-resistant mineral paint and two coats of finish enamel.

5. Glass: Laminated safety glass.

D. Car Performance

1. The individual performance of like elevators shall be the same. Each elevator shall be adjusted for optimum performance and shall be within the following maximum limits:
   a. Brake to brake time for contiguous floors of not more than 12 feet of travel shall be less than 4.8 seconds for cars of speeds of 500 fpm or above and for gear-less applications.
   b. Overall performance time from start of door close, travel to next floor, and doors ¾ open shall be less than 8.5 seconds for 42 inch center opening doors and 10.5 seconds for 48 inch two speed side opening doors. This applies to installations with contiguous floors of not more than 12 feet of travel and a speed of 300 fpm or more.
c. Floor stopping accuracy shall be maintained with a ¼ inch of level, and leveling accuracy shall be maintained within 3/8 inch through load and unload conditions.

d. Running speed shall be maintained within two percent of required speed under load conditions for traction elevators and within 10 percent for hydraulic elevators.

e. Noise level shall be less than 50 dB(A) with cab fan running during running operations and a maximum increase of three dB(A) during door operation.

f. Ride quality shall be such that there are no excessive horizontal or vertical vibrations. The maximum allowable peak-to-peak vibration shall be no greater than 10 milli-g’s with the band specified in ISO 8041 for whole body, X, Y, and Z. These measurements shall be taken with an accelerometer placed in the center of the platform without any sound or vibration absorption material between the unit and the platform. Readings in excess of the allowable shall require adjustment or alignment to correct the cause of excessive readings.

2. Door Opening Time: Shall be measured from start of door open until doors are in the fully opened position.

3. Door Closing Time: Shall be measured from start of door close until doors are fully closed.

4. Door open/close times shall be in accordance with the following table:

<table>
<thead>
<tr>
<th>Door Width</th>
<th>Door Open Time (Approximate Times)</th>
<th>Door Close Time (Approximate Times)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOOR OPEN TIME</td>
<td>DOOR CLOSE TIME</td>
</tr>
<tr>
<td></td>
<td>Side Open</td>
<td>Center Open</td>
</tr>
<tr>
<td>36 inches</td>
<td>2.8 seconds</td>
<td>1.9 seconds</td>
</tr>
<tr>
<td>42 inches</td>
<td>3.1 seconds</td>
<td>2.1 seconds</td>
</tr>
<tr>
<td>48 inches</td>
<td>3.5 seconds</td>
<td>2.2 seconds</td>
</tr>
</tbody>
</table>

5. Door speed and pressure shall meet ADA requirements. Door closing kinetic energy shall be reduced to 2.5 ft. lbs. or less when door protective device is rendered inoperative.

E. Control and Operation

1. The elevator controller shall be a non-proprietary (generic) microprocessor, SCR-DC device, or variable frequency AC drive manufactured by Motion Control Engineering or equal, capable of continuous operation in ambient temperatures between 30 and 104 degrees F.

F. Machine Room Equipment

1. General

   a. Equipment shall be arranged to allow a minimum of 30 inches working clearance around equipment. In the case of controllers, electrical switches, etc., working clearances shall be in accordance with the CEC.

   b. Install equipment so it is removed for maintenance and repair.

2. Traction Elevator
a. Geared hoist machines shall be the worm gear type with motor, brake, drive sheave and deflector sheave mounted on a common structural frame and located in the machine room.

b. Gearless machines shall be the direct drive type with the motor integral with the sheave. Drive may be either located inside a machine room or mounted inside the hoistway (machine room-less type). Kone MonoSpace, Kone EcoDisc, or equal.

c. Selectors shall be the solid-state type.

d. In order to prevent injuries to service personnel, provide guards around hoistway cables, sheaves and/or any cable pinch points.

e. Mechanically and electrically isolate elevator equipment from the building structure.

3. Hydraulic Elevators

a. Pump Unit: Pumps may be direct drive or belt driven dry pumps. Submersible pump units shall not be used. Provide TEFC premium efficient motor. Maximum motor RPM shall be 1,800.

b. Provide thermostatically controlled oil coolers on all units.

c. Provide a muffler on hydraulic elevators.

d. Provide a pair of gate or globe type shut-off valves in the hydraulic piping for each pump unit. One valve shall be in the machine room, and one valve shall be near the hydraulic jack.

e. Locate hydraulic control valve in the oil reservoir above the level of oil when the car is at the lowest landing.

f. Provide electronic soft start motor starting circuits on motors over 20 HP.

g. If necessary to return oil back to the hydraulic pump unit reservoir, provide a Wagner or equal, scavenger pump in each pit.

h. Hydraulic fluid shall be non-flammable.

i. When the elevator mechanical room is not adjacent to the elevator shaft then all piping outside the elevator shaft and room shall be installed with double containment.

G. Hoistway Equipment

1. Guide Rails: Planed steel-tee-sections of suitable size and weight for the application. Fasten to building structure with brackets at intervals not exceeding 14 feet zero inches on center.

2. Buffers: Spring type for speeds of 200 fpm or less and oil type for speeds of
greater than 200 fp

3. Jack: Shall be double wall with PVC exterior casing.

4. Excavation for Jack
   a. Drill excavation in each elevator pit to accommodate installation of plunger cylinder unit.
   b. Install casings with waterproof seals at pit floor and with waterproof, high pressure seal at bottom of casings.
   c. Provide a second (inner) casing with welded waterproof, high-pressure seal at bottom and set inside outer (initial) casing.

5. Electrical Wiring: wiring shall be run in labeled duct or rigid conduit. Provide 10 percent spare wires on hoistway wiring. Label spares in the controller.

6. Counterweight: Provide counterweights installed in a steel frame guide. Provide roller guides for traction elevators. Protect counterweights in the pit with a steel guard. The counterweights shall be installed behind protective wire mesh fencing to separate the side counterweights from the entire hoistway.

H. Entrance Equipment

1. Doors: Passenger and service elevators shall be equipped with minimum 1-1/2 hour fire rating.

2. Frames: Stainless steel, welded construction with permanently attached raised/Braille plate located on each jamb centered at 60 inches above finished floor.

3. Door Panels: 14-gauge stainless steel construction with two guides per door panel.

4. Sight Guards: 14-gauge stainless steel with same finish as door panels.

5. Sills:
   b. Elevators over 6,000 pound capacity: extruded nickel silver.

6. Sill Support Angles: Steel Angles designed to support elevator sill fastened to building structure at 18 inches on center.

7. Service Doors: Power operated vertical bi-parting doors.


I. Car Equipment

1. Car and/or counterweight safeties: instantaneous type for car speeds of 150 fpm or less and the type B, flexible guide clamp for speeds of 150 fpm or more.

2. Roller guides: Utilize spring action with adjustable stops for passenger elevators. For applications exceeding 6,000-pound capacities, slide guides may be used.
3. Provide work lights and GFI convenience outlets on the top and bottom of the elevator car.

J. Car Enclosure

1. Design of passenger elevators base requirements shall include the following items: (see the Project Program for special requirements)
   a. Plastic laminate panels on side and rear walls.
   b. Satin stainless steel car doors and transom.
   c. Fluorescent lights above a suspended ceiling.
   d. Stainless steel handrail on side and rear walls.
   e. Ventilation.

2. Service elevator interiors shall be stainless steel walls and doors.

3. Provide pads and pad hooks on walls.

4. Provide emergency lighting and rechargeable battery for car illumination and power for alarm bell.

5. Cabs shall be non-combustible.

K. Telephone

1. Telephone shall be vandal proof, hands-free, two-communication systems with audible and visual components to interface with the University wide telephone systems.

2. The telephone shall be connected by a shielded twisted pair wire in the traveling cable. Terminate phone connection in Machine Room telephone junction box.

L. Fixtures

1. Provide lobby status panels only when required by code. Include position indicators with two inch high floor designations including direction of car travel signal, in service lights, emergency power switches, hoistway venting switches, and jewel indicator.

2. Provide hall lanterns at each floor on multi-car installations. For single car installations, car direction signs, which travel on the car, may be provided.

3. Incorporate the “In Case of Fire Safety” pictograph on hall push button stations faceplate.

4. Illuminate signal fixtures with LED lamps, tamper-proof fasteners.
1.2 ESCALATORS AND DUMBWAITERS

A. Design of escalators and dumbwaiters shall be handled on a case-by-case basis. The design and installation of these systems shall be done by a manufacturer of these systems and shall be reviewed and approved by the University’s Representative. No proprietary equipment shall be installed.

END OF SECTION 14
DIVISION 15 – OPERATION AND MAINTENANCE MANUALS

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1.14 DETAIL INDEX
OPERATION AND MAINTENANCE MANUALS:
Furnish the specified number of complete sets of operating and maintenance instructions bound in a hardcover binder and indexed. Start compiling the data upon approval of list of materials. Final inspection will not be made until booklets are approved by the University's Representative.

These sets shall incorporate the following:
- Complete operating instructions for each item of ventilating and plumbing equipment. Test data and air balancing reports as specified.
- Typewritten maintenance instructions for each item of equipment listing in detail the lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
- Manufacturer's bulletins with part's numbers, instructions, etc., for each item of equipment for properly stripping and assembling.
- Temperature control diagrams and literature.
- A complete list or schedule of all major valves giving the number of the valve, location, and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule.

CODE RULES AND SAFETY ORDERS:
Provide all work and materials in full accordance with the latest rules and regulations of the California Code of Regulations, Title 24, Building Standards; the State Fire Marshal; Safety Orders of the Division of Industrial Safety; the National Electric Code; the Uniform Plumbing Code, published by the Western Plumbing Officials Association; the Uniform Building Code, Volume II; Uniform Mechanical Code and other applicable laws or regulations. Nothing in these plans or specifications is to be construed to permit work not conforming to these Codes. Furnish without extra charge any additional material and labor required to comply with these rules and regulations.

PERMIT:
Before starting any welding or cutting work involving the use of gas or electric welding equipment in an existing building, the Contractor shall be required to obtain a permit from the Campus Fire Marshall. This permit shall be issued without cost to the Contractor and may be applicable to more than one (1) building. The Contractor shall be responsible for reporting to the Campus Fire Marshall either by telephone or in person at the beginning and end of each day's work.

TESTS AND ADJUSTMENTS:
Test the installation in accordance with the following requirements and all applicable codes.

- Notify the University's Representative at least two (2) calendar days in advance of any test.
- All piping shall be tested at completion of roughing-in, or at other times as directed by the University's Representative.
- Isolate from the system all existing piping systems and new or existing equipment which may be damage by test pressure. Test only new piping. Final connection between new and existing piping shall be tested at normal system operating pressures.
- Perform operation test under simulated or actual conditions, including one (1) foot of complete plumbing.
- Should any material or work fail in any of these tests, it shall be immediately removed and replaced by new material, and portion of the work replaced shall again be tested at no extra cost to the University.
Instruct University's operating personnel during operating adjustment period.

Lubricate each item of equipment, including motors, before operating.

**TEST SCHEDULE:**
No loss in pressure or visible leaks shall show after four (4) hours at the pressures indicated:

<table>
<thead>
<tr>
<th>System Tested</th>
<th>Test Pressure PSI</th>
<th>Test With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste, Drain and Vent</td>
<td>10’ of head</td>
<td>Water</td>
</tr>
<tr>
<td>Vacuum</td>
<td>150 PSI</td>
<td>Air &amp; Soap</td>
</tr>
<tr>
<td>Deionized Water</td>
<td>100 PSI</td>
<td>Water</td>
</tr>
<tr>
<td>Industrial &amp; Domestic Hot and Cold</td>
<td>150 PSI</td>
<td>Water</td>
</tr>
<tr>
<td>Gas</td>
<td>100 PSI</td>
<td>Air &amp; Soap</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>150 PSI</td>
<td>Water ea. Joint</td>
</tr>
</tbody>
</table>

Flush Deionized water lines with distilled or deionized water after test and approval.

**STEAM/CONDENSATE SYSTEM METERING:**
Condensate return metering is an acceptable method of measuring steam usage.

The condensate meter shall be installed in the mechanical room in an accessible location.

a. Manufacturer: Hersey Measurement Company, or equal (No known equal).
b. Model: Niagara Liquid Meter, Series MTX< Model 414 with model 840 read Switch.
c. Vendor: Miligan-Spika Company
   P.O. Box 2149
   Oakland, Ca. 94621

**CHILLED WATER SYSTEM METERING:**
Measuring chilled water may be accomplished by one of two options:

Option #1: Chilled water can be monitored via the campus Energy Management System provided all chilled water controls have been properly installed.

a. Manufacturer: Staefa controls System Inc., or equal (No known equal).
b. Needed Components:
   - Temperature Sensors (Staefa FT_TSOS/cl)
   - Primary CHW Valve (Staefa M3P100F)
   - Annubar Flow Meter
   - Differential Pressure Transmitter (Dietrich Standard 1151DP)
   - Gage Pressure Transmitter (Kele P200GTE)
   - Flow Switch (McDonnell Miller FS-3)

Option #2: Mechanical BTU meter, installed in the mechanical room in an accessible location.

a. Manufacturer: Hersey Measurement Company, or equal (no known equal).
b. Model and necessary components:
   - 7020 BTU calculator
   - Niagara Liquid Meter – type 211
   - 100 OHM Platinum RTD temperature sensors.

**NATURAL GAS METERING:**
The metering device shall be installed at service connection to building in an accessible location.
a. Manufacturer: American Meter Company, or equal (no known equal).
b. Model: AL series with Digital readout (Mechanical display)

DOMESTIC WATER METERING DEVICE:
The metering device shall be installed at service connection to the building prior to backflow assembly. Monitoring device to be installed in a secure accessible area (mechanical room desired)
a. Manufacturer: Data Industrial, or equal (no known equal)

LIFTING EYE (OR INSERT):
Provide a lifting eye or insert in structure over any pump pit or sump located in the building in order to aid in future removal of equipment. Size to suit size and weight of equipment.

PLUMBING SYSTEMS:

SOIL, WASTE AND VENT PIPING SYSTEM:
Pipe and Fittings:
  Underground beyond 5 feet of the building. Extra heavy vitrified clay pipe.
SECTIONS 16 – 20

RESERVED FOR FUTURE
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(REV April 25,2018)

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SECTION DIVISION 21 – FIRE SUPPRESSION

1.0 FIRE SUPPRESSION SYSTEM

1.1 GENERAL

A. New buildings constructed at UCR are required to be completely sprinkled by an approved fire suppression system even if not required by codes. Furnish all labor, materials, tools, equipment, and services for Fire Protection Systems, as indicated, in accordance with provisions of Contract Documents. Fire Protection Systems shall include the following:

1. Water based:
   a. Wet-pipe sprinkler system.

2. Products:
   a. Pipe, fittings, and supports.
   b. Alarm and signal devices.
   c. Fire system valves.
   e. System accessories.
   f. Sprinklers.

B. All work for fire suppression systems shall be strictly and efficiently coordinated with work for all other trades on the project.

C. Sprinkler systems shall be designed to provide the appropriate density based upon a hazard occupancy classification. In those cases where code does not specifically identify the hazard occupancy classification, the University’s Designated Campus Fire Marshal (DCFM) shall determine the hazard classification. Sprinkler & Standpipe systems shall be hydraulically calculated based on area/density method or other methods as specified in NFPA 13.

C. Fire lines shall be separately connected to the potable water main and not combined with domestic water service to the building. Buildings over 50,000 square feet shall have a minimum 6-inch pipe from the main to inside the building.

D. The maximum permissible designed flow velocity through automatic sprinkler piping shall be 32 feet per second. Increased pipe sizes shall be provided if that would avoid installing a fire pump. The minimum starting pressure at the most remote sprinkler head shall be not less than 7 psi.

E. The University is required to comply with the CBC and the Regulations of the SFM for fire suppression installation as a minimum level of quality for approved materials and methods.

F. Fire suppression for computer rooms shall be the standard sprinkler system.

G. The University does not permit automatic fire sprinkler systems to be fabricated in combination with systems for heating or cooling, such as water source heat pumps connected to fire sprinkler piping.
H. Standpipes shall be sized for 500 gpm flowing at 100 psi at the most remote roof outlet to a maximum of 1,000 gpm. The allowable pressure provided by the Fire Department’s pumper truck shall not be more than 150 psi.

I. Welding shall be inspected in accordance with California Building Code Chapter 17 and be fully compliant with the remainder of the Campus Standards and Design Criteria for quality, materials, and installation techniques.

J. Sprinkler system design for Group L Occupancy shall not be less than 0.19 gpm/3,000 square feet.
   1. Portions of a Group L or B lab building but not classified as Laboratory Occupancy shall be provided with sprinkler protection designed of not less than 0.12 gpm/3,000 square feet.
   2. Standpipe system with a Group L or B lab building shall be a Class III combination manual system. Hose valves shall be provided in each stairwell and at the entrance to the L or B Lab Occupancy.

K. Reduction in area of operation when use of quick response sprinkler heads as defined in NFPA 13 will not be allowed.

L. University’s Valve Application requirements:

<table>
<thead>
<tr>
<th>Service</th>
<th>Size Range</th>
<th>Acceptable Types</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire System</td>
<td>NPS-2 and less</td>
<td>Ball</td>
<td></td>
</tr>
<tr>
<td>Fire System</td>
<td>NPS 2½ and up</td>
<td>Rising-stem</td>
<td>Resilient Wedge</td>
</tr>
</tbody>
</table>

M. Use of piping and fittings lighter than schedule 40 and butterfly valves is not allowed at the University. Thin wall pipe shall not be used.

N. Design system for earthquake protection, CBC, seismic zone D, E, F.

O. Sprinkler heads shall be centered in suspended ceiling tiles.

P. Sprinkler heads exposed to exterior environment shall be corrosive resistant.

Q. When design sprinkler systems in R-1 occupancy building, consult with the DCFM (prior to shop-drawing submittal) regarding CSFM interpretation of sprinkler in attic (NFPA 13 vs. NFPA 13R).

R. Space use above ceilings/corridor:
   Refer to diagram on next page.
1.2 QUALITY ASSURANCE

A. Quality assurance, general:

1. Provide complete fire protection systems as described in the Contract Documents and according to criteria of authority (ies) having jurisdiction (AHJ).
a. Where system requirements as described in the Contract Documents exceed those of the AHJ, meet requirements of both.
b. Where discrepancies exist among the AHJ and Contract Documents, the most stringent requirements shall take precedence.

2. Do not downsize piping indicated to serve future areas.

B. Authorities Having Jurisdiction:

1. Campus Fire Marshal.

C. Referenced Criteria (applicable as referenced by AHJ and Owner's insurance carrier):

1. Latest edition of referenced criteria applies unless an earlier edition is specifically indicated by the AHJ.
3. Underwriter's Laboratories (UL).
4. CBC 2016 and CFC 2016 with State Amendments.

D. Installer qualifications:

1. Fire Protection Installer shall be licensed, and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.
2. Use workmen skilled in this trade.
3. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS D10.9.

E. Piping and Fittings: See Section 20 11 00.

F. Outside Utilities: See Section 20 10 10.

1.3 SYSTEM DESCRIPTION

A. Design requirements:

1. Design fire sprinkler systems.
2. Design fire sprinkler and suppression systems.
   a. Obtain water supply fire flow and pressure test data from the Campus Fire Marshal prior to designing the system.
   b. Design to 90% of the available water supply.

1.4 SUBMITTALS

A. Product Data:

1. Wet-pipe sprinkler system.

B. Project Information:

1. Submit detailed data and complete layout of fire protection systems approved by authorities having jurisdiction and prepared in accordance with the requirements for Working Plans described in applicable NFPA standards.
   a. Include calculations prepared in accordance with the requirements for Hydraulic Calculations described in applicable NFPA standards.

2. Architect reviews for project information and general conformance with contract
C. Contract Closeout Information:
   1. Letter stating spare parts have been delivered.
   2. Operating and maintenance data.
   3. Owner instruction report.
   4. Test reports:
      a. Certification that tests as indicated in FIELD QUALITY CONTROL (Part 3)
         have been successfully completed and approved by authorities having
         jurisdiction.

1.5 JOB CONDITIONS
A. Arrange and pay for permits, fees and inspections required.

2.0 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Alarm and signal devices:
   1. Base:
      a. Viking.

B. Optional:
   2. Fire-Lite Alarms/Notifier.
   4. Potter Roemer.
   5. Simplex Access Controls.
   6. United Electric Controls.

C. Alarm-test device:
   1. Base:
      a. Viking.

   2. Optional:
      a. Grinnell.
      b. Victaulic of America.
      c. AGF Manufacturing Inc.

D. Fire protection systems, water-based:
   1. Base:
      a. Viking.

   2. Optional:
      a. Central Sprinkler.
      b. Firematic Sprinkler Devices.
      c. Globe Fire Sprinkler.
      d. Potter Roemer.
      e. Star Sprinkler.

E. Sprinklers:
   1. Base:
      a. Viking.
2. Optional:
   a. Firematic Sprinkler Devices.
   b. Globe Fire Sprinkler.
   c. Reliable Automatic Sprinkler.
   d. Star Sprinkler.
   e. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS - GENERAL

A. Submit other pipe materials, joining methods, and equipment not specified, but accepted by applicable NFPA standards and approved by authority(ies) having jurisdiction, in accordance with Section 00 26 00.

B. Use only new material of first class construction, designed and guaranteed to perform service required.

C. Provide fully operational systems.

2.3 PIPE, FITTINGS, AND SUPPORTS

A. Pipe and fittings - General:
   1. Meet or exceed applicable NFPA standards and Section 20 11 00.
   2. Working pressure: working pressure rating of pipe and fittings shall not be less than 175 PSI.
   3. The following are not permitted:
      a. Light wall and Schedule 5 pipe.
      b. Plain end, pressure fit type fittings.
      c. Hole cut mechanical tee fittings.
   4. Corrosion Resistance Ratio (CRR) of all pipe used:
      a. less than one.

B. Above ground pipe normally containing water:
   1. Examples: Wet-pipe fire protection systems.
   2. Sprinkler piping 4 IN and greater:
      a. Black steel, Schedule-10:
         1) Welded joints.
         2) Mechanical coupling joints:
            a) Rolled groove type (cut grooving not allowed).
            b) Mechanical locking (push-on) type.
   3. Sprinkler piping less than 4 IN:
      a. Black steel, Schedule-40:
         1) Threaded joints.
         2) Welded joints.
         3) Mechanical joints:
            a) Cut or rolled groove type.
            b) Mechanical locking (push-on) type.
   4. Seamless copper tubing:
      a. High temperature soldered joints.

C. Pipe, below ground:
   1. Same as outside utility fire protection piping (See Section 20 10 10).
D. Fittings:
1. Threaded:
   a. Black cast iron, Class 150.
   b. Black malleable iron.
   c. Galvanized malleable iron.

2. Flanged:
   a. Black cast iron, short body, Class 125.
   b. Galvanized malleable iron.
   c. Gaskets: Full face of 1/8 IN minimum red sheet rubber.
   d. Flange bolts: ANSI-B18.2.
      1. Hexagon head machine bolts with heavy semi-finished hexagon
         head nuts, cadmium plated.

3. Welded:
   a. Black steel, standard weights.

   a. Malleable iron, 500 PSI working pressure.
   b. Coupling gasket material: Butyl rubber.
   c. UL listed.

5. High temperature soldered:
   a. Wrought copper.
   b. Cast bronze.

E. Pipe supports:
   1. All-purpose type, UL listed and FM approved.
   2. Manufacture: Comply with Section 20 05 29.
   3. Supports, hanger rods, inserts and clamps acceptable to NFPA.

2.4 ALARM AND SIGNAL DEVICES

A. Alarm and signal devices, general:
   1. UL listed and FM approved.
   2. Coordinate electrical requirements with electrical installer.

B. Alarm devices:
   1. Alarm pressure switch:
      a. Shall signal Fire Alarm System Control Panel upon sensing change of
         pressure in fire system valve.
         1. Switch shall automatically reset when pressure returns to normal.
      b. Service: Normal.

   2. Local alarm devices:
      a. General:
         1. Provide local alarm on systems of sufficient size as indicated in
         2. Use alarm bell and visible light alarm on system.
         3. Devices shall be weatherproof.
b. Alarm bell, electric:
   1. Shall provide audible alarm signal upon activation of fire protection system.
   2. 10 IN weatherproof bell.
   3. Provide backer plate to prevent birds and insects from entering inside of bell housing.

c. Visible light alarm:
   1. Semi-flush, 24 volt DC.
   2. Tamper-resistant white lexan lens, with "FIRE" imprinted in red.
   3. Light shall be mountable on either ceiling or wall.

C. Signal devices:
   1. Valve tamper switch:
   2. Water flow detector:
      a. Shall signal Fire Alarm System Control Panel when water flows in system.
      b. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
      c. 175 PSI rated.
      d. Suitable for working pressure of 150 PSI with sensitivity adjusting screw.

2.5 FIRE ALARM SYSTEM CONTROL PANEL
A. Fire alarm system control panel: Provided under Electrical Specification Divisions.

2.6 FIRE PROTECTION SYSTEMS, WATER-BASED
A. Wet-pipe fire protection sprinkler system:
   1. Description: Automatic system shall employ closed sprinklers attached to a piping system filled with pressurized water.
      a. Normal operation:
         1. Actuation of sprinkler allows water to flow through actuated sprinkler.
         2. Water flow in zone sends signal to Fire Alarm System Control Panel.
      b. Failure of sprinkler allows water to flow through sprinkler.

2.7 FIRE SYSTEM VALVES
A. Fire system valves, General:
   1. UL listed and FM approved.
   2. Body: Ductile or cast iron.
   3. Pressure rating: 175 PSI non-shock cold-water working pressure.
   4. 2 IN and smaller: Threaded.
   5. 2-1/2 IN and larger: Flanged or grooved.
   6. Trim to meet NFPA requirements.
   7. Trim to meet performance as indicated in descriptions of fire protection systems.

2.8 MANUAL VALVES
A. Isolation valves:
   1. Gate valves:
      a. 2 IN and smaller: V-49.
b. 2-1/2 IN and larger: V-50.

2. Butterfly valves:
   a. 2 IN and smaller: V-55.
   b. 2-1/2 IN and larger: V-51.

3. Butterfly valves with tamper switches:
   a. 2-1/2 IN and smaller: V-59.
   b. 3 IN and larger: V-61.

B. Check valves 2-1/2 IN and larger: V-53 or V-54.

2.9 SPRINKLERS

A. Sprinklers - general:
   1. Provide UL listed sprinklers of style and type required for service indicated.
   2. Orifice: Sprinklers in systems sized from pipe schedules shall have 1/2 IN nominal orifices.
   3. Finish of exposed parts: As indicated.

B. Sprinkler types: Fusible link.

C. Sprinkler styles:
   1. Upright:
   2. Pendant:
   3. Pendant with escutcheon:
      a. Finish: Chrome.
   4. Recessed pendant:
      a. Deflector: 1 to 1-1/2 IN below finished ceiling.
      b. Escutcheon: Two-piece with 1/2 IN adjustment.
      c. Removal of escutcheon and ceiling tile shall not disturb sprinkler or drop assembly.
      d. Finish: Chrome.
   5. Flush pendant:
      a. Escutcheon: 1/2 IN adjustment.
      b. Finish: Chrome.
   6. Concealed pendant:
      a. Ceiling plate flush with finished ceiling.
      b. Housing: 1/2 IN adjustment.
   7. Horizontal sidewall:
      a. Finish: Chrome.
   8. Horizontal sidewall, extended coverage:
      a. Finish: Chrome.
2.10 SYSTEM ACCESSORIES

A. Pressure gauges: See Section 20 05 19.
   1. UL listed and FM approved.

B. Spare parts:
   1. Sprinkler cabinet, Wall mounted:
      a. Provide spare sprinklers of each type and sprinkler wrench for each type in
         quantities required by NFPA-13.

C. Sprinkler guards:
   1. UL listed.
   2. Heavy duty welded wire.
   3. Red baked enamel finish.

3.0 - EXECUTION

3.1 GENERAL

A. Coordinate with other trades to ensure adequate space for equipment and piping placement.

B. Review plans, specifications and shop drawings of other trades to coordinate work.

C. Do not begin installation until after Agency approvals have been submitted to Architect.

D. Test systems in accordance with System Standards, manufacturers' instructions, and
   applicable NFPA publications.

E. Install systems in accordance with System Description, manufacturers' instructions, and
   approved shop drawings.
   1. Modifications to system design or arrangement after approval of drawings may only
      be made after receiving written approval of Architect and authority(ies) having
      jurisdiction.
   2. Such modifications do not include minor relocations in piping or sprinkler placement.
   3. Make revisions in accordance with NFPA.

F. Firestop penetrations in accordance with Section 20 05 29.

G. Field quality control: Give advance notice and arrange for field tests and inspections by
   authority(ies) having jurisdiction.

3.2 PIPING, SPRINKLERS, AND SUPPORTS

A. Piping - general:
   1. Install sprinkler piping within first 6 IN of space under roof construction.
      a. Where conditions of construction require piping installation at a lower
         elevation, route piping to avoid interference with work of other trades.

   2. Offset, crossover and otherwise route piping to install system in available space.

   3. Install chromed escutcheons on finished-area sides of pipe penetrations.
      a. Secure escutcheons so they make contact with floor, wall, or ceiling.

   4. Pitch branch lines, cross mains, feed mains and risers to drains.
5. Paint fire sprinkler piping in accordance with Section 09 91 23.

6. Flush outside fire-main piping prior to connecting to inside system.

B. Sprinklers - general:

1. Install sprinklers to provide and maintain minimum 18 IN clear between bottom of deflector and top of storage, files, shelving, and cabinets.

2. Standard-application temperature rating:
   a. Sprinkler type:
      1. Fusible link: 155 degF.
      b. Where non-standard applications exist, use higher rating.
      1. Use sprinklers rated at least 50 degF higher than anticipated ambient temperature.


D. Testing - general:

1. Test sprinkler piping, including outside supplies, under hydrostatic pressure of 200 PSI for 2 hours.
   a. Prove system tight to satisfaction of Architect.
   b. Inside piping shall indicate no leakage.

E. Piping and sprinkler applications by room types:

1. Electrical rooms/closets:
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
   b. Provide sprinkler guards.

2. Finished rooms (rooms with ceilings):
   a. Sprinkler styles:
      1. Pendant with escutcheon.
      2. Recessed pendant.
      3. Flush pendant.
      4. Concealed pendant.
      5. Horizontal sidewall, standard or extended coverage.
   b. Suspended ceilings:
      1. Do not install sprinklers through ceiling grid.
      2. Install sprinklers so that escutcheons and ceiling plates do not cover ceiling grid.
   c. Locate sprinklers to coordinate with ceiling layout.
      1. Locate sprinklers centered in ceiling tile and in center of metal strip in linear metal ceilings, if such location makes added sprinklers necessary, provide added sprinklers as required to meet code.

3. Mechanical equipment rooms:
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
      1. Fusible link temperature rating: 200 degF.
   b. Provide sprinkler guards.

4. Telephone/Communication rooms/closets:
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
   b. Provide sprinkler guards.
5. Process area rooms (rooms without ceilings):
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).

3.3 FIRE PROTECTION SYSTEMS

A. Factory trained Engineer shall supervise installation of fire protection systems.

B. Factory trained Engineer shall provide following services:
   1. Supervise installation of fire protection systems.
   2. Instruct Owner's personnel in systems operations.

C. Test completed alarm systems including control and signal circuits wired by Electrical installer.
   1. Coordinate with electrical.
   2. Complete testing prior to substantial completion.

3.4 SYSTEM ACCESSORIES

A. Drains:
   1. Permit complete draining of systems without disconnection of piping.
   2. Drain consists of dirt leg, valve, and piping.
   3. Required locations:
      a. At low points of systems.
      b. At bases of riser.
      1) Drains shall extend to and terminate at building exterior.
   4. At offsets, plugs may be substituted for drains when approved by authority having jurisdiction.

B. Pressure gauges:
   1. Provide at following locations:
      a. At top of each sprinkler riser.
   2. Provide shutoff valve and drain for each gauge.

C. Sprinkler cabinets:
   1. Install adjacent to the fire sprinkler riser.

3.5 ELECTRICAL WIRING

A. Provide following:
   1. Wiring diagrams for devices.
   2. Supplemental fire detection systems and their wiring.
   3. Wiring not specified but required to provide an operating system.

B. Electrical Installer will provide the following:
   1. Alarm and signal device wiring:
      a. Tamper switches: Supervised wiring to Fire Alarm System Control Panel.
      b. Water flow detectors: Supervised wiring to Fire Alarm System Control Panel.
      c. Supervised wiring from water flow detector to outside alarm bell.

4.0 JURISDICTIONAL REFERENCES

4.1 REFERENCES

A. Referenced Criteria (applicable as referenced by AHJ):
   1. Latest edition of referenced criteria applies unless an earlier edition is specifically indicated by the AHJ.
3. Underwriter's Laboratories (UL).
4. CBC 2016 and CFC 2016 including all State of California Amendments.
DIVISION 22 - PLUMBING

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1.1 CAMPUS UTILITIES OVERVIEW

1.1.1 Compressed Air

A. Compressed air is available in the tunnel for use with pneumatic control systems or as a backup source only. Air compressors for pneumatic controls shall only be provided where central plant air in tunnel is not available. Pressure available in tunnel is 80 psi. Confirm if air compressors are required to be installed in the building. In either case, provide a receiver tank and a duplex set of air dryers/regulators.

1.1.2 Domestic (Potable) Water

A. Domestic water is potable water inside a building used for conventional uses such as drinking, cooking, lavatories, etc. Potable water is water delivered by the main that is safe for use inside the building. Industrial water is potable water used inside the building separated from the domestic water system by an appropriate backflow device. Industrial water systems need only be provided when directed. Code required backflow device protection shall be provided at each fixture.

B. Potable water on the campus is owned by the University. The campus underground piping system downstream of Riverside Public Utilities (RPU) meter and UC Riverside cross connection devices. The University has multiple connection points to the RPU system.

C. The water pressure on campus varies depending on elevation. Water pressure may vary from 140 to 70 psig supply pressure. Confirm for each project site.

D. Provide a shut-off valve with valve box for underground connection to street or underground service at any new connection point. This will be in addition to the shut-off valve inside the building. Make hot tap connection to the site main.

E. The University’s recharge sub-meter and backflow preventer shall be provided inside each building unless otherwise directed. Preferred location is inside the mechanical room, but the meter could be located outside, above ground in a maintenance yard or other approved location that will conceal it from public view.

1.1.3 Natural Gas

A. New gas services on campus shall be coordinated with the University or The Southern California Gas Company. Some underground pipelines are the University's property but most belong to The Gas Company. The Gas Company will provide at University's expense gas service piping, pressure regulator, and a gas meter to the building. The cost shall be from the project construction funds. Locate meter in a service yard or other inconspicuous location and provide earthquake valve. Coordinate with Landscape to provide appropriate materials to conceal the meter and regulator assembly.

B. Existing gas piping in the tunnel is the University's property. Nominally this system operates at 5-psig supply pressure. Confirm for each site.

C. Connection to new gas systems depends on the location of the campus downstream of an existing Gas Company meter. Provide University sub-meter at new building unless directed otherwise. University meter shall be DDC compatible, pulse outlet.
Provide earthquake valve and if needed a regulator, either outside building on grade or in the mechanical room. The gas meter shall be pressure and temperature compensating type.

1.1.4 Sanitary Sewer
A. Connect to existing University owned underground sanitary sewer on campus of adequate capacity. Sanitary sewer outside of buildings shall comply with UCR Campus Standard Details. Where UC Riverside has not adopted a standard detail, the standards of Riverside Public Utilities may be used. Minimum waste pipe size below grade or building slab shall be 4". Provide a two-way cleanouts on waste exiting the building.

1.1.5 Storm Drain
A. Connect building roof drainage to site underground utilities or extend underground to parking lot or street. Termination of roof drainage on grade shall only be used when approved by the University and in a location that will not affect any staff or student walkways.

1.2 INSULATION
A. Provide insulation on hot water supply and hot water re-circulating piping and domestic hot, water heating equipment at thicknesses greater than required by code in accordance with UC Riverside’s master specifications.
B. Exterior insulation shall be protected with aluminum jacket. Fittings shall have plastic covers. The insulation inside the fitting covers shall have the same or greater R-value as the piping insulation. See mechanical standards for additional insulation requirements.
C. Exposed insulation in mechanical or machine rooms or spaces shall be protected with plastic jacket. Fittings shall have aluminum fitting covers not plastic. The insulation inside the fitting covers shall have the same or greater R-value as the piping insulation. See mechanical standards for additional insulation requirements.

1.3 RESTORATION AND RETROFIT
A. Water supply systems that are to be capped shall have their supply (and return) piping removed and capped at an active main or branch line to prevent stagnation in an idle branch pipe.

1.4 BASIC PIPES AND TUBE MATERIALS AND METHODS
A. Limit the installation of dissimilar metals within piping systems. Provide brass or copper fittings in copper piping systems, not steel or cast iron. Provide steel and cast iron fittings in steel piping systems. UC Riverside uses Dielectric. Provide six-inch minimum red brass nipple and bronze threaded union instead of dielectric unions. Dielectric flange kits may be used.
B. Pipe shall be installed concealed, except at mechanical rooms with no ceiling. If approved to be exposed, pipe in public view shall be installed parallel to walls and ceilings. The installation shall present a uniform appearance, and long lengths of pipe shall be grouped together.
C. Manual air vents shall be located at high points in the piping system. Drain valves shall be provided at low points. Provide ball valves for drains and vents. Provide ¾" hose connection for drains. For larger piping systems such as main risers, 1½" valves with fire hose connections are appropriate for drains.
D. Transformer vaults, elevator machine rooms or shafts and electrical rooms shall have no water, waste, storm drain, nor any other pipe conveying water, except fire protection and piping serving...
the room.

E. Valves and fittings for piping located above or directly adjacent to electrical work or book storage areas shall be provided with drip pans.

F. Unions and flanges shall be at the inlet and outlet of apparatus and equipment, at valves, and elsewhere as required facilitating removal of valves and equipment. Access doors and valve boxes shall be provided for concealed equipment and valves to facilitate cleaning, operation and maintenance. Provide ball valves at all inlet and outlet of apparatus and equipment.

G. Mechanical room piping shall be arranged to maintain minimum 7'-0” headroom and 3'-0” clear passageways. Route piping along walls to floor sinks/drains in a layout to avoid potential tripping hazards.

H. Piping in mechanical rooms shall be exposed. Do not conceal or embed pipe in walls, floors, or other structures in mechanical rooms or run horizontally across roof unless provisions are made for future re-roofing.

I. All sizes, capacities and requirements shown for the equipment and services on the approved documents are minimum to be provided and sizes shall be maintained.

1.5 VALVES

A. University’s valve application requirements:

<table>
<thead>
<tr>
<th>Service</th>
<th>Size Range</th>
<th>Acceptable Types</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed Air</td>
<td>NPS 2 and less</td>
<td>Ball Valves</td>
<td></td>
</tr>
<tr>
<td>Compressed Air</td>
<td>NPS 2½ and up</td>
<td>Ball Valves with gear operators.</td>
<td>Rarely used. Consult with University before</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>NPS 2 and less</td>
<td>Ball Valves or Plug Valve</td>
<td></td>
</tr>
<tr>
<td>Natural Gas</td>
<td>NPS 2½ and up</td>
<td>Ball Valve or Plug Valve</td>
<td>Rarely used. Consult with University before specifying.</td>
</tr>
<tr>
<td>Pure Gas Systems (Oxygen, Nitrogen, etc.)</td>
<td>All</td>
<td>As recommended by the equipment vendor.</td>
<td></td>
</tr>
<tr>
<td>Water (Potable, Domestic, Industrial)</td>
<td>NPS 2 and less</td>
<td>Ball</td>
<td>Provide square nut or key for buried applications.</td>
</tr>
<tr>
<td>Water (Potable, Domestic, Industrial)</td>
<td>NPS 2½ and up</td>
<td>Non-Rising Stem Resilient Wedge Gate</td>
<td>Provide square operating nut for buried applications.</td>
</tr>
</tbody>
</table>

B. The University requires an isolation valve near the main riser and pipeline on each branch piping that serves each specific area of the building for supply systems serving the building. (For example, each specific area can be a floor, a single toilet room, a lab bench or module in open labs or a single lab) Locate these valves for easy access, allowing local isolation for repairs without affecting adjacent areas; e.g., back-to-back rest rooms shall be piped with separate isolation valves to shut-off only one rest room. Supply stops at fixtures shall be in addition to isolation valves.

C. Manufacturers listed have proven through the University’s experience to provide a product that meets the campus goals for long life and deferred maintenance.
Manufacturers listed shall be basis of construction. Other manufacturers may be submitted as a substitute and may require field-testing before University's approval. University decision shall be final in this case.

D. If model number is not listed, that does not mean that manufacturer does not have an acceptable product. A comparable model number, subject to UCR approval, shall be submitted.

E. Valves must be accessible. Provide access door for any valve located above a hard ceiling or in a wall. Laboratory valves must be grouped together and have identification. Accessible means accessible for maintenance and replacement not just operation. If there is any doubt, oversize the access panel.

F. Valves shall be accessible in mechanical rooms without climbing onto equipment; e.g., located above air handling units or boiler. Any valve if located 7'-0” above finished floor, shall have chain-gear operators provided.

G. Valve stem installation shall be horizontal or higher than the valve body.

H. Valves shall be installed for isolation at the following: equipment, plumbing fixtures, exterior hose bibs, trap primers, water heaters, check valves, backflow preventers, meters, flow limiting devices and strainers.

I. Valves shall be provided at future connection stub-outs.

J. Domestic Water Valve Types

1. These types include: domestic cold water valves, domestic hot water valves, domestic hot water return valves, and industrial hot and cold water valves in copper pipe.

2. Ball valves for use in domestic water applications (copper pipe) shall be full port, operate with flow in either direction, suitable for both throttling and tight shut off. Valves extensions are required when installed in insulated piping.

3. Where piping is larger than 2½” NPS, the use of flanged valves may be required. In these cases, the use of cast iron resilient seated gate valves is allowed. However, these valves shall not be used in hot water service.

K. Natural Gas Valves:

1. Earthquake actuated automatic gas shut-off valves are required downstream of each meter set.

1.6 METERS

A. Domestic water meter shall be all bronze construction, positive displacement, single jet, or turbine type. The meter shall have DDC compatible pulse type attachment for remote registering of flow in cubic feet or gallons. UCR has both on campus but gallons are preferred.

B. Natural Gas meters shall be pressure and temperature compensated. They shall read in cubic feet and be compatible with remote reading systems (pulse type).

C. Compressed air shall be metered only when directed by the University. The meter shall have DDC compatible pulse type attachment for remote registering of flow in cubic feet.
1.7 DOMESTIC WATER PIPING

A. Pipe sizing shall comply with the requirements in CPC appendix and ASPE Design Manuals. Submit calculations to the University’s Representative. Pipe velocity shall not exceed 8 feet per second. Provide lower design velocity if piping is within noise sensitive spaces (RC35 or less) or insulate the pipe for noise attenuation at those locations. Minimum pipe size shall be ½” for one plumbing fixture with a maximum flow of 0.5gpm and ¾” for larger than 0.5 gpm flow. The water closet shall be 1½”; for a shower or sink - ¾”; for a flush valve urinal - ¾”.

B. Pipe mains in laboratory and research buildings or other facilities when required by the project program shall be designed for the maximum calculated flow at the design stage. Future shall only be provided when required by the specific project program. Size cold water systems serving restrooms using flush-valve curves. Dedicated equipment branches and mains shall be sized based on flow requirements without diversity.

C. A pressure regulator station shall be provided at each building water service. Regulator shall reduce the pressure to below 80 psig, even if site pressure is flow tested below 75 psig. Water pressure shall not be reduced below 45 psig (or 35 psig at the farthest connection in the building). Coordinate with the University’s Representative to obtain the site water pressure. Provide multiple parallel pressure regulators. Comply with the campus standard details for installation requirements. The University may determine that water services of 1 ¼” and smaller services need not use the multiple parallel systems. Generally, this will only be service lines 1 ¼” NPS.

D. Determine the adequacy of the water pressure for the areas being designed and provide a separate unregulated riser for upper floors of multi-story buildings. If all other options have been exhausted such as oversized pipe, then a booster pump may be provided to meet water pressure requirements.

E. Provide a University water meter for each building. Provide strainer in line before meter.

F. Lab benches shall have separate isolation ball valves on hot and cold water supply and recirculation piping, allowing maintenance to isolate each bench without affecting adjacent areas.

G. Provide isolation valves and unions at equipment connections. Valve and union size shall be same as rough-in pipe size and not equipment connection size. Provide ball valves for isolation valves; do not provide integral stops with faucets to meet this requirement. Provide ball valves for lab sinks in lieu of angle stops. Angle stops shall be limited to exposed conditions; e.g., wall hung lavatory in a public rest room. Provide quarter-turn type angle stops. Exposed angle stops shall have loose key option. Riser from angle stops shall be braided stainless steel flexible type with screwed ends.

H. Underground piping systems which must cross over or under High Temperature Water (HTW) lines shall be protected with rigid conduit, ductile iron pipe, etc., and shall have adequate clearance and/or insulation to prevent damage to pipe or contents from elevated temperatures expected at the crossing. Routing of piping a longer distance is required to minimize crossing the HTW pipes. Above ground pipe crossings require 6” air space between insulation covers and no path for thermal heat transfer.

I. Do not pipe domestic water piping beneath concrete slabs.

J. Exterior hose bibs shall be provided at new buildings and plazas to wash down walks, loading docks and drives if reclaim water irrigation system cannot provide this function. Recessed wall box type with loose key stop and vacuum breaker shall be used on buildings.
K. Animal watering system (AWS) must be separated from the domestic water system with a reduced pressure principle device backflow preventer. The need for AWS and the quality of water to be utilized must be determined by the end users. Specific requirements for the zoning, number of water connections per room, control, etc. must be verified with the end users.

L. Water Hammer Arresters.

1. Water hammer arresters shall be provided on both hot and cold water lines serving fixtures and equipment using flushometer valves or quick-closing valves. One water hammer arrester may serve more than one fixture.

2. Design to minimize the number of quick closing devices in the system. Provide a diaphragm type shock absorber at solenoid valves, make-up valves, washers, sterilizes and flush valves or any other quick closing device.

3. Size and locate in accordance with Plumbing and Drainage Institute Manual WH-201. Show location on drawings and PDI size of water hammer arresters required.

M. Cross Connection

1. The basic principal guiding the use of backflow devices on the campus is the protection of the potable water supply from contamination at each point of potential contamination and each change in jurisdictional control. The campus is isolated by reduced pressure principle backflow devices at its points of connection to the Riverside Public Utilities (RPU) (This is a change in jurisdictional control). The buildings are to be isolated from the campus system. (This also is a change in jurisdictional control) Hazardous conditions within the building are to be isolated from the rest of the building. The University's water main system is large and complex and is under the care, custody, and control of the Facilities Services Administration. The Facilities Services Administration acts as the Campus' water department and has an obligation to protect the supply from contamination. There are no conceivable circumstances where it would be appropriate for anyone to connect to the system in a manner that was not designed and constructed only after complete review and approval by the Facilities Services Administration. As a minimum, strict adherence to these standards is required.

2. Due to the nature of the campus research process, many buildings require continuous water service. However, they rarely require peak demand during the annual certification testing of the backflow devices. For these buildings, provide multiple (usually dual) parallel backflow devices. This will allow annual testing without a complete shut down of water service. Dual backflow preventers shall be sized at 60% of peak demand. The use of dual devices will often allow the use of much smaller devices than would otherwise be used resulting in a more economical installation both in the initial construction and long-term operation of the system. Even for buildings that do not require continuous water service, parallel devices may provide a more economical alternative to a large device.

3. Locate backflow prevention devices so that they are accessible for testing and maintenance. Provide for an adequate drainage system near each device. Each device shall be located on a wall approximately 30" above the floor with 1’ clearance from walls (confirm with the current code). The lowest point of the device shall be installed not less than 12” above the floor or ground below the device. If reduced pressure device is installed more than 5'-0” above floor or grade, then a platform must be provided to test the device. Comply with campus standard details for installation of backflow devices.
4. Reduced pressure backflow preventers are also required on make-up water lines that serve all mechanical equipment, vacuum pumps, compressors, cooling towers, boilers, industrial hot and industrial cold water, sterilizers, autoclaves, cage washers, and as required on softeners, DI tanks, etc.

5. Research and laboratory buildings are required to have a RP backflow preventer on the domestic water service to the buildings as an added device to protect the underground campus water system. Preferred location is within the mechanical room in the building downstream of the water meter. Comply with campus standard details.

6. Laboratory fume hoods shall use industrial water if available, to supply water to hoods. If a potable water supply fixture is located inside the hood enclosure, a double check valve backflow preventer shall be provided on the supply line outside the hood. Vacuum breakers shall not be used inside the hood without a double check valve backflow preventer.

7. Any system with chemical pot-feeder and using make-up water shall have a reduced pressure principal device installed in the supply line.

8. Provide atmospheric vacuum breakers for service sinks.

9. University of California, Riverside Backflow Sizing Requirements:

<table>
<thead>
<tr>
<th>Device Size</th>
<th>Minimum Flow</th>
<th>Maximum Flow</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>½&quot;</td>
<td>4</td>
<td>14</td>
<td>Not generally used.</td>
</tr>
<tr>
<td>¾&quot;</td>
<td>5</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>12</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>1½&quot;</td>
<td>30</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2&quot;</td>
<td>55</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>2½&quot;</td>
<td>75</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>3&quot;</td>
<td>115</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>4&quot;</td>
<td>190</td>
<td>570</td>
<td></td>
</tr>
<tr>
<td>6&quot;</td>
<td>450</td>
<td>1350</td>
<td></td>
</tr>
<tr>
<td>8&quot;</td>
<td>750</td>
<td>2250</td>
<td></td>
</tr>
<tr>
<td>10&quot;</td>
<td>1250</td>
<td>3750</td>
<td>Not generally needed.</td>
</tr>
<tr>
<td>12&quot;</td>
<td>1700</td>
<td>5100</td>
<td>Not generally needed.</td>
</tr>
</tbody>
</table>

Notes:
- a. This table is based on sizing flow ranges between 4 and 16 feet per second and limiting pressure drop through the example RPPD to not more than 15 psi. Like all control valves, velocity through the valve improves performance and with spring-loaded valves as found in RPPD, there is a minimum velocity required to completely open the valves.
- b. There is no reason why the RPPD must conform to the pipe line size serving the building or the system. Indeed, as with most control valves, the RPPD will likely be one or more line sizes smaller than the line it is installed in.
- c. In making transitions from the main line size to the RPPD, it is important to avoid sudden transitions.
- d. Use the smallest RPPD that will satisfy the flow requirements and leave some room for expansion (if building expansion is part of the PPG). Example: Calculations show that the flow requirement for the system designed for 0.2- gpm/square foot is 83.45 gallons per minute. Two devices could be used (1½ and 2¾). The 1½" device is chosen because it is the smaller of the devices that will supply the flow and still have some room for growth (though none is anticipated).
N. Trap Primers

1. The University has established a policy to limit the use of potable water for trap primers.

2. Provide trap primers at public toilets using water from water closet flush valve tail piece. While this uses potable water it is very little and does not increase water use since it is downstream of the flush valve assembly that will only use 1.6 gallons per flush or less. All trap primers shall be valved and unioned for easy change out.

3. Waste water from lavatory or sink tail piece shall not be used as it can clog and require more maintenance.

4. Electric manifold type automatic trap primers shall be installed in mechanical spaces only.

5. Safety shower floor drains do not require trap primers. They will receive water during periodic testing or if they dry out Facilities Services Administration will pour liquid trap sealer down the drain.

6. Safety Shower drains, Shower drains, Mechanical room floor drains and floor sinks, Ice machine and Autoclave floor sinks, Freezer and Cold room floor sinks, Air Handling Unit floor sinks, Janitor room floor drain and indirect wastes do not require trap primers.

7. Floor drains in the laboratory areas, animal holding rooms, at Laser Tables, indoor trash rooms and any other location not listed in the paragraph above shall be provided with trap primers.

1.8 SANITARY WASTE AND VENT PIPING

A. Size piping in accordance with the California Plumbing Code (CPC). Calculations shall be submitted. Minimum pipe size for water closets shall be 4". Minimum pipe size for vents through the roof shall be 3". Do not use 2½" pipe, use 3" pipes.

B. Design slab-on-grade horizontal sanitary piping from water closets and urinals to be installed at a uniform grade of ¼” per foot (2%) to 5-feet outside the building. Other piping shall comply with code. Coordinate underground piping with structural foundation. Inverts shall be shown on plans relative to finished floor elevation. Minimum starting invert shall provide a minimum clearance of 1'-0” from the bottom of concrete slab to top of the pipe.

C. Laboratory, vivarium, or other special spaces using chemicals shall have a corrosion-resistant drainage and vent system, apart from the sanitary systems, carried outside the building to a sampling port prior to connection to sanitary sewage system. Adequate space shall be provided for future water treatment stations if ever needed. Flame Retardant Corrosion-resistant waste piping at lab benches and equipment shall have fused or mechanical joint fittings. Corrosion-resistant waste traps for equipment shall have drum trap with drain connection adapter and union connection. Provide a minimum of 4” waste pipe size to each animal holding room. Waste from animal holding rooms shall have more than code required clean outs because of the potential for debris in these lines. Where movable fume hoods are used, they shall discharge into an approved corrosion resistant floor sink through an approved air gap.

D. Lavatory and sink P-traps with clean outs are not required.
E. Maintain distance between piping as required by Health Department Standards.

F. If a grease interceptor is required, sufficient capacity shall be provided to assure cleaning will not be required more than once a month. Grease interceptor shall be located external to the building. Garbage or waste disposers shall not be piped to grease interceptors.

G. Horizontal drainage piping shall be installed in a practical alignment.

H. Fixture traps shall be provided with vents. Vents shall extend full size through roof and shall project eight inches above the roof. "Flag-poling" of vents is not approved. Special venting for island sinks is discouraged. If an island sink is required, it shall discharge into an approved floor sink below the counter. This floor sink shall be accessible and shall have at least a half grate.

I. Water having a temperature greater than 140°F shall not be discharged into the sanitary sewer.

J. No sanitary sewer or sanitary waste systems shall be pumped except as a last resort and then only with permission of the University’s Representative. A duplex pump system shall be used if a pumped system is approved. Slicer/grinder type pumps shall be provided for vivariums, kitchens, sports facilities and other wastes with potential for large solids.

K. No floor drains or floor sinks are allowed inside built-up fan systems.

L. Design for a slope for condensate drains from air handlers and other HVAC equipment shall be not less than 1” in 10-foot horizontal run. Provide threaded plugs at elbows to allow pipe to be cleaned. Provide vent in piping for condensate drain lines over 20’ long. Provide traps sized and designed per the standard details. Heights of traps shall be shown on drawings. Condensate drains shall not extend above the drain pan surface.

M. Drains shall be provided and plumbed for appropriate disposal of liquid waste in spaces where water and chemical mixing occurs. Provide floor drain in main janitor closet only.

N. Cooling Coil Condensate Drain (Above Ground): Provide floor sinks or roof receptors for air conditioning condensate drain. Floor drains are not acceptable. Provide on the plumbing drawings the air conditioning condensate drains. Size condensate drain piping based on the cooling capacity as follows:

1. ¾” for up to 2 tons (24 MBH)
2. 1” for up to 5 tons (60 MBH)
3. 1¼” for up to 9 tons (108 MBH)
4. 1½” for up to 25 tons (300 MBH)
5. 2” for up to 150 tons (1,800 MBH)

O. Cleanouts

1. Size cleanouts of same nominal size as the pipe they serve, except where they occur in piping six inches and larger, in which case they may be reduced to four inches in size. Make all Cleanouts accessible. For Cleanouts in finished portions of the building, locations are subject to the University’s Representative acceptance before installation.

2. The University’s requirements exceed minimum code requirements to allow for ease of maintenance and maintainability and to allow cleaning of the piping with a 50- foot snake. Cleanouts shall be provided for all floors.

3. Cleanouts locations inside facilities: Campus Standards are more stringent than code and must be complied with.
a. At each horizontal offsets  
b. At end of waste water or storm drains more than five feet in length  
c. At maximum 40 foot intervals of horizontal runs within the building.  
d. At base of vertical sanitary stacks.  
e. At each change of direction if the total aggregate change exceeds 90 degrees  
f. Provide cleanouts flush with finished floor.  
g. Above sanitary tees.  
h. In vent piping above urinals or at end of a battery of urinals.

4. Cleanouts Exterior to Buildings - Provide a 2-way cleanout with dual access plugs at each sewer connection outside the building. Cleanouts outside the building shall be in cast iron valve box marked “Sewer” with triangular cover. Provide threaded bronze or ABS cleanout plugs. Provide 24” x 24” x 4” thick concrete slab with top 1 inch above grade with cleanouts located near the center of slab. Provide cleanouts covers flush with concrete slab.

1.9 STORM DRAIN PIPING

A. Storm drainage systems shall be designed in accordance with the University’s Standards, and shall comply with the CPC in Addition to Campus Standards for sanitary sewer. Provide an overflow or secondary roof drainage system.

B. Piping shall be sized per tables in the CPC. For buildings with a secondary piping system spilling in an approved location or connected to underground piping, sizing shall be based on 4 inches per hour rainfall rate. Gutters and downspouts and wall scuppers shall be sized for 6 inches’ rainfall. Horizontal piping shall be designed at ¼” slope per foot. Submit calculations to the University’s Representative. Underground drains lines shall be installed at least 5 feet from parallel underground water lines.

C. Coordinate that the design of storm drain piping system has a redundant drainage point if clogging of the primary drain might allow water to enter a building.

D. Overflow or secondary drains shall not spill at a location such that when the drain is in use, it would affect people. Tie these locations to underground storm drain piping.

E. Roof drains shall not be less than 3 inches in size; except that canopies less than 100 square foot may use 2 inch size. Provide a minimum of two roof drains for roof areas over 999 square feet of horizontal projected roof areas.

F. Areaway drains shall be provided outside of the building. Trash has a tendency to accumulate in areaways and clog the drains, so drains shall be oversized at least one size. Slope any areaway away from the building. Layout of drains in large areaways, greater than 100 square foot, shall be with more than one drain or provide a trench drain. Areaway drainage shall not connect to subsoil drain.

G. A separate drainage system shall be provided for storm water. The number and size of drains shall be adequate to convey storm water from areas being drained at the same rate as water is collected in those areas. At least two drainage points shall be established for each roof or areaway drainage area.

H. Downspouts shall be connected to underground piping system or may spill on a splash block when near a catch basin or alternate drainage system that will direct water away from structure.

I. Subsoil drainage may be shown on plumbing drawings. They shall also be indicated and shown on architectural, structural and civil drawings. Piping design from the low point of the subsoil drainage system to the storm water building drain shall be shown on the plumbing drawings. Do not drain water from outside the building to interior sump pumps. If a sump pump
is required, it shall be located outside of the building. Areaway drains, rain leaders, downspouts, or other aboveground drainage points shall not be connected to subsoil drains.

1.10 FUEL PIPING (Natural Gas)

A. The Southern California Gas Company (The Gas Company) owns and maintains most natural gas fuel piping within easements on Campus property. Additional connections to the gas system must be included and will not be provided by The Gas Company without incurring a cost. Some of the natural gas lines on the campus, however, are the University's owned distribution system. The Design Team shall coordinate with The Gas Company and UCR D&CS. Include required fees associated with The Gas Company meter, Gas Company distribution piping extension or any changes in the construction contract. Line extensions shall be included in the construction contract or the contractor may hire The Gas Company and pay to install the pipe in a joint trench.

B. Verify system pressure requirements prior to design. The pressure varies according to location and system, and may range from 7 to approximately 60 psig. The design pressure loss in the gas piping system shall be such that the supply pressure at any piece of equipment is greater than the minimum pressure required for proper equipment operation.

C. A UCR remote reading pressure and temperature compensating gas meter for recharge billing of end users shall be installed for each building connected to the campus distribution system.

D. Provide earthquake emergency gas shut-off valves at each service to a building.

E. Connect downstream of an existing Gas Company meter. The University must approve any new gas services and meters.

F. Pipe natural gas at 8 to 14 inches’ water column (low pressure) or five psig (medium pressure), whichever system is cost effective. If medium pressure gas is used, install pressure regulator at the building or at each piece of equipment. The vent pipe shall be extended to outside of the building.

1.11 PROCESS AIR AND GAS PIPING

A. Compressed Air Systems

1. Compressed air is the most expensive utility produced and distributed by the Central Plant, but it is still more cost effective than separate compressors at each building on campus. However the Campus system is now fully utilized and should be only used as a back-up source.

2. To verify compliance with the California Code of Regulations (CCR), the University’s insurance company shall inspect air compressor installations. Each new tank must be accepted and stamped by the University's Insurance Inspector prior to Substantial Completion.

3. Most commercial air compressors are designed using the service factor rating of the motors. This practice leads to shortened motor life and shall be prohibited.

4. Often the contactors (motor starters) are sized as if they started only once a day instead of 10 times an hour that is more of a normal occurrence at the University. Provide a heavy-duty starter.
5. Often the compressors will run at near their maximum RPM for the pump model. This reduces first cost, decreases service life, reduces efficiency, and increases noise and vibration in the building. In general, the pump shall be upsized and the speed reduced.

6. Compressors can be sized to meet the assumed maximum instantaneous load in the building. This results in very large compressors. Often the assumptions about load patterns and load are faulty. A better method is to install larger storage tanks and regulators. Storage cannot be created in the absence of regulators. Provide storage near heavy, short duration loads.

7. Assumptions about required air pressure at point of use are also usually too high. Most air tools require and are designed to work on 80# air. Supplying them with greater pressure only increases waste. Instead of increasing the line air pressure to the tool because they have too small an airline, increase the pipe size.

8. Air tools are rarely used in research labs. Mostly, lab benches require low-pressure air for experiment purposes.

9. Regulators for the lab air shall be located on each floor so that air is transmitted at high pressure from the machine room. The regulators should be located inside machine rooms or pipe chases that are accessible for maintenance and adjustment. Accessories should include inlet and outlet gauges and shut off isolation valves. Bypasses are not required at regulators. Bypasses should be installed at filters to allow service.

10. Filters are a source of energy loss. There are quality filters that reduce both initial (clean filter) and final (dirty filter) line loss. Filters should always be on the high-pressure side of the system. The regulators on the floor level shall include screens to protect against debris. Most good quality regulators include these.

11. Air distribution shall be via a loop system on each floor. This will reduce pressure loss in the floor level distribution. It will allow for maximum flexibility in service and help meet changing space needs.

12. Piping branch take-off should be reinforced and mounted to the wall or lab bench. It is easy to loosen the pipe joint at these points and small leaks will result.

13. Refrigerated air drier must be inventoried and maintained. Compliance with environmental regulations has driven the cost of using refrigerated equipment up. Provide desiccant units instead for each air compressor or receiver.

B. Air Compressors

1. Air compressor shall be oil-less type. Units shall include the following as a minimum:
   a. Oil-less, positive displacement.
   b. If greater than 80 psi system, provide 2-stage compressor with air-to-air intercoolers.
   c. Alarm contacts to send low voltage signal to building DDC controls system.
   d. Matched motor and power loading such that overload will not occur at any operating pressure. Motor shall be TEFC, premium efficiency. Use of motor service factor is prohibited.
   e. Provide an electrical control panel in a NEMA 4 enclosure with starter(s);
automatic lead-compressor alternator (if multiple compressors), which will start the next compressor in sequence. If the lead compressor fails to carry the load; sequence control to start the next lag compressor and to prevent more than one compressor from starting at any one time; a hand-off-automatic selector switch; a 115-volt control transformer; and a fused disconnect switch (individual if multiple compressors). Also include safety shut down on high receiver water level, and compressor shut down/lag compressor start on high separator water level. Provide non-resettable hour meters for compressors.

f. For building with BSL3 laboratories or vivariums, provide a pair of Simplex air compressors (on compressor on one tank). For research and other 24-hour operation buildings, provide duplex air compressors (two compressors on one tank). Non-critical buildings can be provided with Simplex air compressor.

g. Provide valve ¾” point of connection for a portable air compressor connection. This standby point of connection shall be installed such that it is possible to serve the building through its filtration system with the building compressors out of operation.

C. Compressed Air Piping

1. Compressed air for the general laboratories should be instrument grade, filtered to remove hydrocarbons and particulate. Compressed air for special applications may be provided on a more local basis to meet the required conditions. Instrument air shall meet ANSI/ISA S7.0.01-1996 quality.

2. Provide copper piping for compressed air distribution. Provide valves at each point of connection to the main. Provide additional service valves at each piece of equipment.

D. Gas (Laboratory) Piping

1. Nitrogen will be supplied as a gas to the laboratories from racked nitrogen bottles or from a liquid nitrogen source to be located outside. This liquid nitrogen shall also serve as the source for filling Dewars for laboratory use. Distribution shall be at the normal boil-off pressure boosted to approximately 35 psi with local regulators to reduce pressure to the desired level.

2. Equipment served by special piping systems shall be valved so that each piece of equipment can be isolated without interruption of services to any other equipment. Where projects involve renovation work, new materials shall be identical to existing and be installed in a similar manner. Designers shall arrange piping so that a minimum number of connections are required to existing systems.

E. Gas (Medical) Piping

1. Medical gases (above ground): Use Type L hard drawn seamless copper pipe, ASTM B819, chemically cleaned, degreased, evacuated, capped, and especially prepared for oxygen usage as required in NFPA 99. Use wrought copper fittings and solder.

2. Medical Acetylene (above ground): Use Stainless Steel only. Neither copper nor alloys with any copper content will be allowed.
3. Medical gas piping shall be served by ball valves (4" and smaller) rated at 400 psig WOG, with solder joints, conforming to NFPA 99. Each valve shall have a double o-ring stem seal, Teflon seat, service identification on handle (see valve tagging requirements in this document), and shall be a swing-away design. Approved manufacturers are Chemtron and Amico.

4. Medical gases, medical vacuum, and lab gases shall be tested to hold a pressure between 150 psig (minimum) and 200 psig (maximum). The test shall comply with NFPA Pamphlet 99, Standard for Health Care Facilities.

5. Specific piping systems shall be pressure tested in strict accordance with NFPA 99.

6. Specific attention is directed to the absolute prohibition of the use of oil-pumped compressed air or oil-pumped nitrogen, and the prohibition of the use of a hydrostatic test. The testing medium must be water pumped compressed air or vapor pumped nitrogen.

F. Vacuum Pumps

1. Vacuum pumps for research and laboratory buildings shall be dry screw type.

2. Motors shall be premium efficiency and TEFC type. Do not use service factor of motor.

3. Units shall be selected for operation at less than 1800 RPM.

G. Medical Center Vacuum Pumps

1. General: Vacuum system is to be packaged duplex central vacuum pump systems capable of passing fluids and soft solids through the vacuum pump directly to waste. Units are to be factory-tested prior to shipment. Certified test data, performance curve, and spare part lists are to be included in the Operation and Maintenance Manuals. Provide vacuum pump system the following:
   a. Single stage, oil-free, positive displacement.
   b. Alarm contacts to send low voltage signal to building DDC controls system. Provide high air temperature shutdown, low oil level shutdown and exhaust filter change with alarm controls.

H. Vacuum Piping

1. Vacuum Piping Systems shall be designed to prevent extraneous liquids in the system from exiting out through the vacuum hose cocks into the labs. Horizontal branch lines shall grade down 1-inch per 40 feet towards the mains and shall enter into the top of the mains. Hose cock shall connect into the top of the branch lines, and back-to-back hose cocks shall not be allowed. Vertically dropped lines shall be used only where no other routing method is available, and all remaining piping shall be pitched back to the vacuum source. If terminal vacuum lines are to drop vertically to terminal outlets, such outlets shall be trapped with convenient access and shall be accompanied by written instructions describing when and how to clear the trap.

2. The exhaust from the vacuum piping systems shall be discharged outdoors and remote from air intakes or other openings in the building.
Protect from the entry of insects or debris in exhaust and intake. Provide a 12” long drip leg, full line size, and a ball valve at the exhaust port of each pump. Drip pockets are also required at the foot of exhaust risers.

3. Particular consideration shall be given to the sizing of vacuum exhaust lines so as to minimize backpressure on the pump. Determine the noise level of the exhaust. If necessary, provide a silencer to keep below the acceptable noise level for the location.

4. The laboratory vacuum system shall be capable of maintaining a vacuum of 19” of mercury at the furthest inlet. If deeper vacuums are required, they will generally be handled with a local vacuum pump. The system shall be selected for an operation range of 22” to 24” of mercury. The vacuum system shall be based on 0.5 scfm at each vacuum inlet terminal. The pipe size shall be based on a total of 3” of mercury for the total piping system pressure drop.

5. Account for system diversity in usage. The following chart (provided by Busch) is one reference.

<table>
<thead>
<tr>
<th>VACUUM LABORATORY USE FACTOR CHART</th>
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<tbody>
<tr>
<td>1 - 5</td>
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<tr>
<td>6 - 12</td>
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<tr>
<td>13 - 33</td>
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<tr>
<td>34 - 80</td>
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<tr>
<td>81 – 150</td>
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<tr>
<td>151 – 315</td>
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<td>316 - 565</td>
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<td>566 - 1000</td>
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<tr>
<td>1001 - 2175</td>
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<tr>
<td>2176 - 4670</td>
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<td>4671 +</td>
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</table>

Sizing should be based on 0.5 SCFM per terminal at the operating pressure.

- 0.5 SCFM at 20” Hg = 1.5 ACFM
- 0.5 SCFM at 25” Hg = 3 ACFM
- 0.5 SCFM at 29” Hg = 15 ACFM

Caution must be used when specifying flow rates. Always specify the operating pressure. A system sized from a chart based on 20” Hg, but operating at 25” Hg will be 50% of the correct size. A system sized from a chart based on 25” Hg, but operating at 29” Hg will be 20% of the correct size.

6. Vacuum air piping shall pitch down in the direction of flow a minimum of 1” per 40 feet.

7. Provide the vacuum system with a suction filter upstream of main pump.

1.12 PROCESS WATER AND WASTE PIPING

A. Process Water Systems
1. Research equipment process cooling is sometimes required for laser, NMRs, mass spectrometers, and other sensitive equipment. University Policy prohibits once through cooling systems.

2. Adequate drainage facilities may also be required. Drainage connection must always be indirect and sometimes require gravity flow. Use floor sinks or other large open-site drains to handle the large intermittent discharges. Use of the domestic water system is not acceptable for process cooling.


B. Pure Water System

1. Pure water systems shall be a central building distribution system. The level of water quality provided shall be a decision by the University. The requirement for a very high-quality central distribution system will be expensive to install and cost prohibitive to maintain on a long-term basis. Most buildings are better served by a medium grade central system that utilizes local point-of-use polishing equipment for specific needs. For details of the system see Central Plant’s “Water Purity Production Equipment and Performance Specifications” at the end of this section.

2. Pure water piping shall be sized for a range of 5 to 8 feet per second or to insure a turbulent flow. Piping system shall be looped for continuous flow. System shall be designed to avoid dead legs.

3. Clearly define sizing parameters of the systems including total daily consumption, peak system flow, hourly system flow, distribution flow to each floor or zone, and maximum flow per outlet. The water system design shall consider future requirements if required by the Project Program. Pure water systems normally have a large diversity between low- and high-flow conditions with multiple peaks sometime occurring throughout the day. Each floor or zone must be balanced in the field to provide a predetermined quantity of water so that every research function is satisfied.

C. Laboratory Corrosion-Resistant Waste and Vent Piping

1. Changes in direction and clean outs shall conform to the requirements of waste piping in this Section.

2. Fused plastic is the preferred system for all new university corrosion resistant waste systems.

1.13 PLUMBING FIXTURES

A. Number of plumbing fixtures to be provided, shall be analyzed and submitted for review. The actual number of occupants per floor shall be determined in accordance with CBC & CPC. Requirements found in the 2016 CPC Chapter 4 shall be used.

B. Plumbing fixtures for a toilet room shall be wall-hung except as directed. Use of wall hung lavatories shall be approved with the University during design of the facility. Water closets and urinals shall have exposed flush valves. Public restroom flush valves and lavatory faucets shall be Sloan Regal 1.6 GPF flush, valve 3980095 polished chrome. Fixtures shall be water saving type.
C. Public restroom lavatories shall have counter top lavatories with grid drains. Provide 0.5-gpm aerator with lavatory faucets to meet Title 24 requirements. Push button metering faucets shall not be used on campus. Hot water does not need to be provided for public restroom lavatories. Sinks, lavatories and washbasins shall have quarter-turn chrome-plated stops. Provide at least one set of hose bibs with vacuum breaker (hot and cold) under the lavatories in each public toilet room; where a mop sink is within 75’ of the restroom provide only a cold water hose bibb in the restroom. Exposed branch water supply piping in toilet rooms and custodial rooms shall be chromium plated. Service sink in custodial closets shall be floor type.

D. Consult ADA requirements for accessibility design requirements. For wall hung lavatories for ADA use, specify chair carriers.

E. The laboratory furniture supplier shall generally provide plumbing fixtures and fittings for laboratory furniture. Coordinate with laboratory consultant and provide additional fittings and vacuum breakers.

F. Provide at least one floor drain in each multiple fixture toilet room near the water closet(s). Provide floor drains in mechanical rooms in addition to any floor sinks required for specific equipment. Provide a large, 12” deep floor sink near the drain of fire suppression sprinkler systems. Provide floor sinks within 5’-0” of mechanical equipment which has water connections or needs drains for condensate or humidifiers. Floor drains shall be provided in animal rooms as required by the DPP. Animal room drains shall have an 8” diameter strainer with a 4” trap with integral clean out. Coordinate with University if lockable bronze drain cover is required. Provide floor sinks for indirect waste. Floor sinks shall be provided with at least a half grate.

G. Eye wash and emergency shower shall comply with the regulations set forth in CCR Title 8, Sections 3400 (d), and 5162 and ANSI 2358.1, 29CFR1910.151. Emergency eye or eye/face wash equipment shall be provided in all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may be exposed to a substance which can cause corrosion, severe irritation or permanent tissue damage or which is toxic by absorption. The eyewash station should be within a travel distance no greater than 100 feet from the hazard. Use of hot water with a mixing valve for tepid water is not required at the UCR campus. Do not provide flush mounted folding eyewash stations with concealed shower valves. Required testing has resulted in hidden leaks at packing glands on these valves and significant damage to walls. Provide exposed, easily serviced shower valves for eyewash stations.

H. Campus laboratories must have at least one emergency eye or eye/face wash located within the laboratory. Hand-held drench hoses are not considered eyewash units. They may be used in addition to equipment that is described as meeting the standard above.

I. Provide recessed wall hydrants or hose bibs with recessed door at exterior walls to allow wash down of hardscape areas (loading docks, sidewalks, etc.). Locate hydrants based on a 50 feet hose being used with it.

J. Comply with the USGBC LEED Credit WE 3.1 to reduce domestic water use. Provide low flow water closets, ultra low flow urinals and low flow restrictors on faucets and showers to use 20% to 30% less than the water baseline calculated for the building after meeting the Energy Policy Act of 1992 fixture performance requirements.

K. Provide sensor operated flush valves with batteries. Sloan Regal 1.6 GPF flush valve 3980095 polished chrome campus standard.
1.14 PLUMBING PUMPS

A. A domestic hot water recirculating line with a circulation pump shall be provided for domestic hot water systems when the farthest fixture is greater than 75 ft. from water heater. Where recirculation is provided, provide automatic flow limiting valves in the branch circuits. Provide flow limiter with shut off valve and strainer.

B. Provide sumps and pumps of appropriate type, size, capacity and head(s) to meet Plumbing Code and project requirements. Select each pump so that the operating point on the characteristic performance curve for the impeller size to be furnished will be not more than 5 percent below the point of maximum efficiency for the impeller to be furnished.

C. Generally, pump motor shall be 1800 rpm or less. Small inline water circulators may operate at other speeds.

D. Inline water pump shall have shaft in horizontal plane. Provide factory assembled and tested pumps constructed of bronze materials suitable for domestic water service. The University has standardized on pumps manufactured by Grundfos Pumps Corporation. The standards on pumps for domestic water include 6 ½” dimension flange-to-flange with 2- bolt bronze companion flat-face flange.

E. Water pumps shall have mechanical seals or be water lubricated (e.g. Grundfos circulating pumps)

F. Submersible sump pumps are prohibited on Campus (submersible pump use requires University written approval): Provide factory assembled and tested submersible type pumps for operation under water. Pump shall be complete with cast-iron casing, bronze impeller, stainless steel shaft, sealed heavy-duty ball bearings, water-cooled hermetically sealed motor, built-in automatic reset thermal protection, float switches, and waterproof three- conductor cables and grounding plugs. Provide high water alarm and check valve. Zoeller, Weil or equal.

G. Provide subsoil drainage sump pumps, duplex column type with automatic controls to start the second pump in the event the first pump fails. The capacity of each pump shall be sufficient to meet the 100% requirements of the facility. Provide high water alarm and check valve.

H. Sewage pumps, duplex column type with automatic controls to alternate the operation from one pump to the other pump, and to start the second pump in the event the first pump cannot handle the incoming flow. The capacity of each pump shall be sufficient to meet the 100% requirements of the facility. Provide high water alarm and check valve. Zoeller, Weil or equal.

I. In the extremely rare instance after all other options have been exhausted where the University approves the use of a domestic water booster pump it shall be variable speed drive based system. While the University generally prefers built up systems as they can be more efficiently integrated into the space available in the machine rooms, booster pump systems may be prepackaged. Pump sizing shall be optimized to consider low- and high- flow conditions. Provide a pressure tank for low flow conditions. Provide Goulds AquaForce or equal. Provide system sized to support usage on the floors above the level that can be served by the pressure from the water main. Do not size a system to serve the entire building.

1.15 DOMESTIC WATER CONDITIONING EQUIPMENT

A. Generally, unconditioned potable water is used throughout the building. However, where there are special needs for softened or otherwise treated water, provide systems as described herein. Required for autoclaves and glass washers

B. Comply with Water Purity Production Equipment and Performance Specification written by the University’s Central Plant personnel. This document can be found at the end of this section.
C. Water conditioning systems shall have totaling water meters on the inlet line and on the conditioned water supply line.

D. Verify water pressure at the conditioning system. Feed pressure at the inlet shall exceed the manufacturer’s recommended minimum pressure by 20%.

E. Water softeners shall have duplex resin tanks, a single brine tank that shall not exceed 48” in height, and an automatic regeneration system.

F. Provide sufficient floor space adjacent to the water softener for storage of bags of salt. UCR obtains bags of salt on pallets. Space shall be adequate for two pallets. Locate the equipment near a loading dock or other acceptable means for unloading salt with a pallet jack. Provide path from loading dock to softeners without passing through vivariums or occupied spaces.

G. Culligan or Campus vendor in contract Conditioning Systems shall supply water softening or conditioning equipment.

H. Domestic water supply to water softener shall be provided with dual reduced pressure principal backflow devices set in parallel. Size each RPP BFP at 2/3 of maximum flow rating.

I. Valves shall be provided to allow maintenance on one assembly without shutting down the building system.

1.16 DOMESTIC WATER HEATERS

A. The following domestic hot water temperatures shall be used for design purposes

<table>
<thead>
<tr>
<th>ROOM SERVED</th>
<th>DESIGN TEMP</th>
<th>SITE SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet room, custodial room</td>
<td>110°F</td>
<td>105°F</td>
</tr>
<tr>
<td>Laboratories</td>
<td>120°F</td>
<td>110°F</td>
</tr>
<tr>
<td>Showers</td>
<td>120°F</td>
<td>110°F</td>
</tr>
<tr>
<td>Kitchen and laundry facilities</td>
<td>140°F</td>
<td>140°F</td>
</tr>
<tr>
<td>Entering water temperature</td>
<td>60°F Varies</td>
<td>---</td>
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</tbody>
</table>

B. Water heaters shall be set at 140°F and provided with mixing valves to distribute water at lower temperature required.

C. Where a building is provided with High Temperature Water (HTW) from the Campus distribution system, and the building has showers, a kitchen, or other large hot water usage, then building heating water (typically 150 °F to 180 °F) shall be the source for heating the domestic hot water. Use a gas fired water heater for other applications. Electric water heater may only be used when approved by the University. HTW shall not be used directly to heat domestic water. In certain applications, where the demand for industrial hot water is very large, the University may allow the use of HTW as the heating source.

D. Water heaters shall be sized in accordance with the latest ASHRAE Handbook chapter on “Service Water Heating.” Provide water heater with pressure and temperature relief valve piped full size of outlet to an indirect drain. Provide an expansion tank in the cold water pipe between the water heater and the pressure-regulating valve.
E. If a dishwasher or laundry washer requires a higher temperature, coordinate with the Project Manager for consideration of a booster heater application at the equipment requiring the higher temperature.

F. Under counter instantaneous type water heater are not acceptable for use on campus.

G. Electric water heater with single heating element, glass-lined steel tanks, and high efficiency type insulated with polyurethane foam insulation, replaceable anodes, with adjustable range thermostat to allow hot water settings between 100 and 140°F. Electric water heater shall only be used for small loads. Electric water heaters shall be commercial grade when available in size required.

H. Gas fired water heater, glass-lined steel tanks, high efficiency type insulated with polyurethane foam insulation, with adjustable range thermostat to allow hot water settings between 100°F and 140°F. Provide posted operating instructions for water heater. Gas fired water heaters shall be Commercial grade, low NOx, high efficiency type.

I. Hot water heaters shall be storage tank with double wall tube bundle heat exchanger. Tank shall be ASME Code Section VIII, Division I Construction of 316 stainless steel. Tubes shall be 316 stainless steel with 304 stainless steel tube sheets. Refer to Campus Standard detail for additional requirements.

1.17 POOL AND FOUNTAIN EQUIPMENT

A. In general, the University avoids installing fountains. While they are attractive, they are a large and generally non-funded O&M expense.

B. When provided, the pool equipment room must be accessible. Small, top-access "pit" is not acceptable. The equipment shall be located in a locked room near the fountain.

C. Fountains shall be provided with a large main drain for rapid emptying. Fountains are often a target for vandalism (usually soap) and the only effective means to remove soap contamination is to drain and hose out the fountain.

D. A large capacity hose bib with vacuum breaker shall be provided near the fountain to allow easy cleaning.

E. Fountain pumps shall be all bronze, close coupled to the motor.

F. Strainers shall be top access basket type separate from the pump.

G. Suitable means for chemical feed shall be provided in the pool equipment room. Outdoor fountains depending on the design can be a farm for algae.

H. Makeup water shall be protected by a reduced pressure principal backflow device.

END OF SECTION 22
WALL MOUNTED :: INSTITUTIONAL

Model 1025G
Outdoor wall-mounted, barrier-free drinking fountain with single-bubbler and push-button stainless steel valve assembly. 11-gauge fabricated-steel with galvanized finish.

Model 1431
Two-bubbler, enameled iron, barrier-free fountain provides a bullet proof durability. Bubbler heads locked to main bowl prevent against vandals and provide efficient water flow for twice the users as single bubbler fountains.

Model 1109.14BP
Heavy-duty, barrier-free, 14 gauge Type 304 Stainless Steel construction and specialized integral mounting plate offer even more protection with a sturdier design. Satin finish resists stains and corrosion.

"Hi-Lo" electric water cooler provides 8 gph (30.28 lph) chilled water, stainless steel skin. Features vandal-resistant bubbler heads, waste strainers and bottom plates. Grille slots are designed to eliminate sharp edges and are backed with a foam filter to protect the fan motor and high displacement compressor from debris.
# DIVISION 23 - HVAC

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1.1 CAMPUS HEATING AND COOLING OVERVIEW

A. Chilled water (CHW) is produced at the Central Plant and stored in an open (to atmosphere) thermal energy storage (TES) tank. The mean water level of the tank is 165 feet above sea level. Chilled water is pumped to various parts of the campus within the existing campus ring tunnel, tunnel extensions, and pipe trenches or direct buried underground. New walkable utility corridors (tunnels) or accessible trenches shall be provided to extend piping from the existing utility corridor (tunnel) when required by the Project Program. Nonmetallic pipe can only be installed direct buried underground.

B. High Temperature Water (HTW) is produced in the Central Plant from high-pressure steam and circulated by pumps to various parts of the campus within the existing campus ring tunnel or in an accessible trench. Buildings using HTW shall have heat exchangers and high-pressure control valves to convert HTW to a building’s water-heating system. Expansion of piping, anchorage and guide locations shall be fully designed throughout the new piping system in accordance with ASME B31.1 pressure piping. HTW piping shall never be direct buried.

C. The Central Plant produces steam from fuel fired boilers and reclaim heat from the cogeneration system. Steam is not piped from the plant and is used for making HTW, driving steam turbine chillers and steam turbine driven generator. If steam is needed at a building, it is produced at the building.

D. The restrictions on the types of HVAC systems listed in this document shall be used for new and existing facilities. Under normal situations, only proven technology shall be acceptable. Newer, “state-of-the-art” systems will be considered on a project-by-project basis. Projects with available chilled water shall always use it for building cooling. Refrigerant packaged or split systems may be used when approved by the University and for buildings remote from chilled water system. Window or through-the-wall units shall never be used.

E. Chlorofluorocarbon (CFC) and Hydro chlorofluorocarbon (HCFC) refrigerants shall not be used for any new HVAC equipment on campus. Any existing buildings being renovated and which contain CFC refrigerant shall have the refrigeration system changed to a newer non-CFC and HCFC refrigerant. The UC Riverside (UCR) Environmental Health and Safety (EH&S) Ozone Depleting Substances (ODS)/Refrigerant Emissions Program facilitates compliance with the South Coast Air Quality Management District (SCAQMD) and the United States Environmental Protection Agency (USEPA) regulations which apply to stratospheric ODS’s, such as CFCs and HCFCs used in stationary and motor vehicle refrigeration and air conditioning systems.

F. Beyond meeting the normal requirements of the program needs, the following functional attributes shall be given special design consideration.

1. Energy efficiency
2. Simplicity of control design
3. Accessibility, ease of operation, and simple maintenance, combined with minimal maintenance frequency.

G. Designs shall incorporate energy conservation features, such as variable air volume distribution systems and variable frequency drives (VFD) for fans and pumps, and heat recovery by use of coils and pumps.
H. Mechanical systems chosen for use on campus must consider long-term ownership, operation, and maintenance characteristics. System materials and construction methods shall be chosen based on a useful life of 40-50 years. Items shall not require major component replacement for a minimum of 20 years.

I. The Campus CHW and HTW master plan is to connect new projects, additions, and renovations to these central plant systems. Deviation from this shall only be when directed in writing by the University’s Representative upon submission of a reviewed and approved life-cycle cost analysis that makes use of University-specific considerations such as limited access to capital for replacement, and limited maintenance funding.

J. Backup systems shall be provided for projects where critical research, experiments, etc., require un-interruptible cooling and heating. Coordinate with the Project Program for decisions pertaining to standby fuels or back-up systems.

1.2 HVAC DESIGN CRITERIA

A. Climatic Design Parameters

1. Location - Riverside, CA (UC Riverside Campus)
2. Latitude - 33.9737° N
3. Longitude - 117.3281° W
4. Elevation - (Range) Varies from 970’ to 1,400’ above sea level:
5. Climate Zone - 10 (CA Energy Code)

B. Design and load calculations shall be based on methods and data from the most recent issue of ASHRAE Fundamentals Handbook or ASHRAE Load Calculation Manual. Load calculations shall be done using an approved computer program such as Carrier HAP or Trane Trace program.

C. Design parameters and sizing criteria shall be as follows unless otherwise directed in the project program and Request for Proposal (RFP):

<table>
<thead>
<tr>
<th>DIVERSITY AND SAFETY FACTORS</th>
<th>OFFICES, LECTURE HALLS, CLASSROOMS, ETC.</th>
<th>VIVARIUM</th>
<th>LABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer design dry bulb &amp; mean coincidental wet bulb</td>
<td>88°F DB &amp; 68°F</td>
<td>96°F DB &amp; 69°F WB</td>
<td>96°F DB &amp; 69°F</td>
</tr>
<tr>
<td>Summer design wet bulb</td>
<td>70°F wet bulb</td>
<td>72°F wet bulb</td>
<td>72°F wet bulb</td>
</tr>
<tr>
<td>Winter design</td>
<td>40°F</td>
<td>37°F</td>
<td>37°F</td>
</tr>
<tr>
<td>Indoor Design Summer:</td>
<td>72°F &amp; 50% RH</td>
<td>70°F &amp; 50% RH</td>
<td>75°F &amp; 50% RH</td>
</tr>
<tr>
<td>DIVERSITY AND SAFETY FACTORS</td>
<td>OFFICES, LECTURE HALLS, CLASSROOMS, ETC.</td>
<td>VIVARIUM</td>
<td>LABS</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Indoor design Winter:</td>
<td>68°F</td>
<td>75°F</td>
<td>72°F</td>
</tr>
<tr>
<td>Design temp occurrence</td>
<td>2.5% per year</td>
<td>1% per year</td>
<td>1% per year</td>
</tr>
<tr>
<td>Minimum air changes</td>
<td>none</td>
<td>15 AC/hour for holding rooms</td>
<td>TBD</td>
</tr>
</tbody>
</table>

**Single room heat gain calculations**

| Internal loads: people       | none                                     | none     | none |
| Internal loads: Lighting     | none                                     | none     | none |
| Internal loads: Equipment*   | none                                     | none     | none |
| Envelope load                | Room peak                                | Room peak | Room peak |
| Infiltration/ventilation load| 20 cfm/person                            | 100% outside air | 100% outside air |
| Safety factor                | +10% sensible load                       | +10% sensible load | +10% sensible load |

**Floor/ahu block loads diversity**

| People                        | 0.80 x sum of room peaks                | 0.70 x sum of room peaks | 0.80 x sum of room peaks |
| Lighting (with lighting controls) | 0.80 x sum of room peaks                | 0.75 x sum of room peaks | 0.85 x sum of room peaks |
| Equipment                     | 0.80 x sum of room peaks                | 0.60 x sum of room peaks | 0.90 x sum of room peaks |
| Main duct and riser sizing   | 0.90 x sum of peak load                 | Sum of AC/hr or 0.90 x sum of peak load if greater | 0.90 x sum of peak load |

**AHU Block load heat gain calculations**

| Block load diversity -people  | 0.75 x sum of total room people (0.90 for CR & LH) | 0.50 x sum of total people | 0.65 x sum of total room people |
| Block load diversity – lights | 0.75 x sum of total room lights              | 0.50 x sum of total lights | 0.80 x sum of total room lights |
| Block load diversity – equipment | 0.60 x sum of total room equip. | 0.50 x sum of total equip. | 0.75 x sum of total room equip. |
| Duct sizing                  | 0.85 x sum of room peak load               | 0.75 x sum of room peak load or 0.85 x sum of AC/hr | 0.85 x sum of room peak load |
| Added fan capacity and motor sizing | 0                                        | No diversity                 | 0 |
| Added coil and pipe capacity to AHU block load | 0                                      | 0.85 x total AC rate or 10% of peak load if greater | 0 |
| Supply duct if outside - heat gain & leakage loss | 5%                                      | 10%                           | 10% |
| Morning warm-up add to heating coils in AHU | 10% if not 24/7                      | 10%                           | 0 |
* Calculated load may have diversity factor calculated with individual pieces of equipment or as a
group or not at all if it can be documented to the University that the diversity is applicable.

D. Provide shafts at least 25% larger than required for ductwork and piping for future use.
Provide access panels or doors to allow access to shafts for future installation of piping or
ductwork. On wet laboratory floors only, provide and stub out chilled water piping risers at
minimum of 1-1/2" supply and return pipe and provide valve and cap for future use. An
additional 15 gpm flow per floor or stub-out shall be included in the design of chilled water
piping only for stub outs.

E. Indoor design relative humidity listed above a design condition for calculations only.
Humidity is not required to be controlled for this project unless otherwise stated in the DPP.

F. Mechanical cooling shall be provided to the following spaces:

1. Lecture Halls
2. Classrooms
3. Computer facilities
4. Libraries
5. Animal Facilities
6. Laboratories
7. Offices
8. Other facilities where need is clearly demonstrated.

G. Mechanical cooling shall not be provided for toilet rooms.

H. Communication and/or telephone rooms (MDF and IDF rooms) with microprocessor
equipment shall be cooled to maintain conditions required by the equipment. Maintain
continuous and dedicated environmental control (24 hours per day, 365 days per year).
Note that the equipment may operate at a higher temperature than would be considered
for an occupied space. If the space is not an occupied space, the temperature shall be
based on the equipment requirements. Consider connecting to emergency power if
available. Rooms with telephone backboards, only, shall be exhausted to outdoors.

I. Elevator equipment rooms shall be conditioned to meet the elevator manufacturer
requirements. Solid-state controls will require mechanical cooling using a cooling only
Variable Air Volume (VAV) terminal unit or ventilation using previously cooled transfer
air.

J. Separate the areas requiring conditioned air from those requiring only ventilation.
Mechanical systems shall be separated accordingly. For purposes of providing energy
efficient environmental control and flexibility to changes in occupant use patterns, multiple
temperature control zones shall be used where appropriate to account for room orientation,
occupancy size or local heat loads. Specialty areas such as copy centers, incubators,
and sub-zero spaces shall be identified and control addressed.

K. Zoning of spaces shall follow good design practice with respect to core versus perimeter
spaces, exposure and shall comply with the following:

1. Exterior offices with same exposure may be on one terminal unit.
2. Corner offices with glazing on West, East or South exposures shall have
   separate zone.
3. Separate zones shall be provided for Executive, Dean and Chair’s offices,
   conference rooms, meeting and team rooms.
4. Normally non-occupied spaces such as mail, copy/fax, or break rooms may be on adjacent terminal units.

5. Conference rooms shall be controlled using occupancy sensing to ensure that when in unoccupied mode, the ventilation to the space is reduced to near zero or turned completely off if conditioned by a separate system.

6. Spaces that are not similar in occupancy and use shall not be zoned together.

L. Off-Hour Operation: During off-hours the environmental systems (lighting, heating, cooling, and ventilation) will be reduced to minimum levels consistent with safety. Room(s) with different operating hours shall be designed to avoid turning on large parts of the building HVAC system to accommodate use (i.e., computer rooms or fume hoods).

M. Space heating will generally require the use of the University’s HTW system with a secondary building low temperature (150°F or lower) heating water system. In buildings located a distance from the HTW distribution lines, or which are unsuitable for connection to the system, heating may be provided by local boilers, or in small buildings, furnaces. The primary fuel for such shall be natural gas. Gas fired boilers shall be provided with low NOx burners for 75,000 btuh and larger units. Maximum capacity of each boiler shall be selected such that it will not require continuous operator occupancy in the boiler room per SCAQMD requirements.

N. For buildings with boilers, design heating water systems at not more than 190°F with heating coils selected for a minimum of 40°F drop in temperature. For buildings connected to the HTW system, design for not more than 150°F heating water (lower temperatures may be used) and select heating coils for 55°F LAT with minimum 100°F LWT with 150°F EWT. Consider HTW to HW exchangers in series to maximize the temperature drop in the HTW system. This will help to maximize the HTW system capacity to serve the campus, as the existing piping mains are the limiting factor in heating distribution.

O. Equipment connected to the campus’ chilled water system, including all coils and heat exchangers, shall be designed for a minimum of 20°F rise in the chilled water temperature. As with the HTW system, the limiting factor in the chilled water system is the size of the piping mains. Consequently, the greater the temperature differential the more capacity there is to serve the campus. Temperature rises up to 40 degrees are acceptable. Partial-load capacity and temperature rise should be carefully examined to ensure that the temperature rise equals or exceeds the design value during partial-load conditions.

P. Electric rooms shall be ventilated only to maintain room at less than 95°F. Several buildings on campus have made use of basement electrical rooms with large louvered walls allowing maximum ventilation. Main building transformers should be located outdoors.

Q. Thermostats shall be installed at readily accessible locations. In offices and conference/meeting rooms, preferred locations shall be next to doors on strike side. In open landscape area/labs/classrooms, preferred locations are on columns or inside walls near return/exhaust grilles. Thermostats shall not be installed on outside walls, near supply diffusers or heat sources. Standard height shall be at 48” A.F.F to the center. If thermostats are installed over counters, then the height shall be at 44” A.F.F to the center. Thermostat placement shall consider the location of the supply air diffuser(s) in the room.

R. Additional Design Parameters

1. Occupant’s sensible and latent rate of heat gain to conditioned space: Refer to table in ASHRAE Fundamentals Handbook.

2. Lighting shall be based on actual lighting designed by the Electrical Engineer.
An estimate of lighting load may be used during schematic and design development. Final calculations and equipment selections shall be updated to reflect the actual lighting to be installed.

3. Equipment heat gain shall be documented in design analysis. Manufacturer’s data sheets showing the equipment heat gains shall be included in design analysis if available. Data from ASHRAE may be used. Clearly document in design analysis loads, usage factors (if used) and assumptions.

4. It is important that loads for University-supplied equipment (not influenced by the design team) are appropriately identified. Equipment loads for offices, support spaces, and specific space or room application (i.e., computer rooms, laboratories, etc.) shall be as realistic as possible, recognizing both current (move-in day) requirements and potential allowance for future changes if required by the project program. Overstated equipment loads will result in oversized systems, thereby increasing construction cost, and can potentially sacrifice energy efficiency (i.e., a lightly loaded motor is less efficient than a fully loaded motor). Understated equipment loads can result in systems that cannot meet functional requirements.

5. High-Heat-Load Equipment
   a. Unless requiring continuous direct user interaction, locate high-heat load equipment within separate rooms/partitioned areas.
   b. Control environment to highest temperature recommended by manufacturer, but not greater than 86°F.
   c. Equipment should be provided with water-cooled options, if available (user/lab consultant responsibility). Provide a separate cooling (a.k.a. condenser, or process) water system for each building.
   d. Provide direct exhaust of heat when applicable.
   e. Evaluate use of local fan coil unit for supplemental heat removal rather than utilizing central air system, when the supply air required for cooling exceeds the minimum air change or the mechanical exhaust rate. Local fan coils shall have the same temperature rise requirements for the chilled water as the main air handlers.
   f. Evaluate use of transfer air from an air change dominated lab to the equipment space when mechanical exhaust is greater than the supply required for cooling.
   g. Ported Equipment: Energy conserving measures for high-heat-load equipment also applies to ported equipment enclosures.
   h. Other Support Equipment: Where heat-producing refrigerators, freezers, centrifuges, etc., either line a service corridor wall or are located within a dedicated room, evaluate use of fan coil unit(s) for supplemental heat removal. In addition, provide continuous slot or multiple inlet exhaust openings above equipment. Local fan coils shall have the same temperature rise requirements for the chilled water as the main air handlers.
   i. Evaluate underfloor air distribution for equipment cooling.
   j. Evaluate rack-mounted, refrigerant-based cooling systems for computer clusters or racks.

S. Ventilation Design Parameters

1. Ventilation refers to air movement in a building space that frees the space from stale, stagnant air and provides a sense of cooling in warm weather.
The flow of ventilation air may be due to natural "stack" effect or the use of power fans. Use of natural "stack" effect in building perimeter spaces is encouraged.

2. At the same time as the campus has grown and space between buildings has decreased, the number and type of laboratories and other emissions sources have multiplied. Air intakes shall be located so that they do not introduce foul air (i.e., near cooling towers, exhausts, vehicle emissions, garbage dumpsters, generator exhausts, exhaust discharge from other buildings, etc.). Refer to the results of a wind tunnel analysis for preliminary design. Confirm the safety of the design as the project progresses with a confirming analysis of the wind tunnel test results to ensure that there are no issues.

3. Outside air (OSA) brought into a building for ventilation and indoor air quality shall conform to the latest edition of ASHRAE Standard (ANSI/ASHRAE Std. 62.1) and/or California Energy Code for Ventilation for Acceptable Indoor Air Quality:

   a. Ventilation – outside air (minimum)

   1) Classrooms - 15 cfm/person
   2) Laboratories - 20 cfm/person
   3) Lecture hall - 15 cfm/person
   4) Office - 20 cfm/person
   5) Locker rooms - 0.50 cfm/sf
   6) Corridors - 0.10 cfm/sf

   b. Exhaust air – minimum requirements

   1) Restrooms – 7 air changes/hour
   2) Janitor’s closets - 6 air changes/hour
   3) Mechanical rooms - 12 air changes/hour
   4) Where chemical use occurs, provide segregated areas with self-closing doors and deck to deck partitions with separate outside exhaust at a rate of at least 0.50 cubic feet per minute per square foot, no air re- circulation and maintaining a pressure differential with the surrounding space of a least 0.02 inches of water gauge on the average and .004 inches of water gauge at a minimum when the doors to the rooms are closed. This is required for USGBC LEED Credit EQ 5 indoor chemical and pollutant source control.

   5) Toilet rooms, janitor facilities, pantries, copy rooms, dark rooms, lunch rooms and other miscellaneous spaces require exhaust to remove odors and heat from occupied areas. Toilet rooms and janitor closets shall be connected to common exhaust systems and be designed to run interlocked with air handling unit providing the makeup air. Other exhaust may be connected to this general exhaust system, which shall be controlled to operate when central air handling equipment is operational.

   6) High volume reproduction/copy rooms (copiers with sorters) shall have a dedicated room exhaust and negative room pressure with respect to adjacent areas.

   7) Toilet rooms accessed from non-rated corridors shall use transfer ducts, have undercut doors and/or door grilles to pass 100 percent of the exhaust air with a maximum pressure drop of 0.05 inches WG.

   Airflow from a fired-rated egress corridor is a code violation and
shall not be used. Transfer air from an adjacent space with adequate relief airflow. If system is VAV, the minimum airflow setting must be adequate for exhaust air quantity.

8) Toilet room exhaust systems shall not be combined with any laboratory or special exhaust system.

9) Special contaminant control systems may be required for processes or functions including laboratory animal and research occupancies.

10) Where hazardous materials are used, maintain area under negative pressure with respect to areas of lower hazard (e.g. corridors, offices).

11) Painting studios shall have low floor level exhaust at 12 air changes per hour.

4. Air Circulation – minimum requirements
   a. Wet laboratory’s minimum design air change rate shall be 6 per hour and increased when required due to:
      1) Sensible cooling load
      2) Hood-dominated laboratory
      3) Toxicity or hazard shock
      4) Special requirements dictated by process and/or Biosafety Classification
   b. Wet labs and their support areas shall be 100 percent exhausted except where recirculation is permitted by the University with the appropriate biosafety cabinet(s). Recirculation is permitted only within a laboratory space and not to adjacent spaces. Makeup air shall be outside air plus return/relief air from non-wet lab spaces.
   c. Circulation of air from chemical wet laboratory is prohibited. Chemical laboratories shall be 100% exhausted. Filtered and tempered outside supplementary air at room temperature may be provided for fume hood exhaust volumes that are in excess of minimum requirements needed for room air change circulation, or temperature and humidity control. Air shall be supplied to scavenge fumes from the laboratory rooms to the exhaust locations. The circulation rate for non-chemical labs may be reduced during non-use periods for energy conservation.
   d. Air change rate in an individual laboratory space may be reduced to two air changes per hour for dry labs and four air changes per hour for wet labs, but not less than the minimum controllable turndown capability of the terminal unit when unoccupied for 20 minutes or longer. If an unattended research apparatus operates on a 24-hour basis, minimum air change rate may be set to that required for apparatus heat removal. Sufficient occupancy sensors that sense motion and use infrared technology shall be provided to sense occupancy anywhere within a laboratory space. Sensors shall overlap each other by 25%. Occupancy sensor shall also control lighting. Exceptions include:
      1) Those based on contaminant classification
      2) Vivarium’s
      3) Exceptions documented in the DPP
   e. Chemistry classrooms with fume hoods shall reduce the supply and exhaust air to a minimum of 0.25 cfm per square foot after being
vacant for 30 minutes. Maintain a setback/setup temperature during reduced airflow.

f. Laboratory exhaust system shall be a separate system from office area exhaust.

g. Dry lab design air change rate shall be not less than four per hour and not more than that required for space cooling.

h. Dry labs and their support areas shall have a minimum OSA ventilation quantity in accordance with applicable codes and standards. Total air shall be a function of the minimum air change rate or the space-cooling load.

i. When dry labs and or office/administration areas are served by the same supply system as the wet labs, the OSA requirement for these spaces may be satisfied if the mechanical exhaust is greater than or equal to that required to satisfy ventilation for personnel requirements.

j. Instead of exhausting relief air from non-wet-lab spaces, this air shall be used to satisfy the makeup air requirement for the wet labs.

k. To limit maximum air change rates, snorkels, chemical storage cabinets, and canopy hoods should be used for localized airborne hazard or concentrated heat rejection control in areas that do not lend themselves to normal fume hood use.

T. System Design Parameters

1. A stand-alone building is a building that is not connected to utilities in the campus “ring” tunnel or to utilities produced in the campus Central Plant. To facilitate operations and maintenance, space heating, and steam boilers shall be located in a mechanical basement or on the first floor. Provide generous service space for the boilers and anticipate expansions of the system.

2. Boilers: Unless dictated by a process requirement, heating loads will, in general, be relatively small. Low NOx industrial quality, steel, flexible-tube, water tube boilers having a full-load efficiency of not less than 85 percent shall be selected. Select boilers in modules of not more than 1,999,000 Btu/hour natural gas input.

3. Chilled Water System

a. The UCR campus chilled water TES tank is an open system and the average pressure to the plant from the tank is 42 psig. CHW is produced during the off-peak hours for use during SCE’s peak and mid-peak billing hours. The central plant boosts the chilled water system pressure and operates generally as follows:

1) Supply water temperature range: 39-42°F
2) Design temperature for building: 45°F
3) Average pressure leaving the plant: 60 psig
4) Design pressure loss for building: 10 psig (23.10 feet) maximum for the total pressure loss of piping, fittings, coils, equipment and valves.

b. Chilled water pumps are generally not required in campus buildings; as adequate differential pressure may be available in the CHW loop.
The design team shall check with the University’s Representative on estimated pressure available at the project site. Chilled water booster pumps, when provided shall have a high flow rate and low head requirements. If a pump is installed, provide a full-sized, normally closed pipe bypass with check valve around the pump. If the elevation of the highest point of the chilled water system or the top of the highest coil is above 142’ MSL, then a lift pump will be needed with a pressure-sustaining valve located in the return line to keep the line positively pressurized at the highest point in the system. Any chilled water pump shall be controlled using variable speed drive technology. Control shall use a static pressure sensor as the primary control to maintain adequate operating pressure.

c. Selection criteria for campus building cooling coils shall be as follows:

1) Supply Chilled Water Temperature: 45 F
2) Temperature Differential minimum: 20 F. Increased temperature differential benefits the utility infrastructure by maximizing the capacity of the TES tank.
3) Pressure Differential maximum: 4.33 psi (10 feet)
4) Fins: copper, maximum 8 fpi, minimum 0.0095-inch thick and flat. No waffle type fins allowed.
5) Minimum rows of copper tubes: 6 rows (units less than ±4,000 cfm may be less rows)
6) Tube thickness shall be minimum 0.035-inches.
7) Chilled water coil face velocities less than 450 fpm are cost beneficial and are a function of system diversity (average operating flow as a percent of design capability flow) and annual operating period. The following values shall apply:

<table>
<thead>
<tr>
<th>SYSTEM TYPE</th>
<th>MAXIMUM COIL FACE VELOCITY CORRESPONDING TO DESIGN CAPABILITY FLOW (FPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANNUAL OPERATING HOURS</td>
</tr>
<tr>
<td></td>
<td>8-5 M-F</td>
</tr>
<tr>
<td>Constant Volume</td>
<td>350</td>
</tr>
<tr>
<td>Variable Air Volume @ peak airflow</td>
<td>450</td>
</tr>
</tbody>
</table>
8) Use of series-connected cooling/dehumidifying coils should be considered. Approach to outside temperature of return water at part load conditions is important to the University's thermal energy storage system.

d. Two-way single seated control valves must be used for control at building chilled water coils. Larger coils have made good use of industrial quality, v-port ball valves. Provide normally closed control valves to secure chilled supply water from returning to the central plant. Provide automatic flow limiting valves. Provide pressure gauges and thermometers on the inlet and outlet of the coil(s) and on the building supply line. Provide a BTU flow meter in the building supply line.

e. Tunnel, trench or direct buried main line or loop pipe size shall be as directed by the University to accommodate future construction and master planning.

f. Piping in utility tunnel and trenches shall be welded steel pipe.

g. All chilled water piping shall use ball or flanged resilient wedge gate valves as appropriate for the line size.

h. Branch piping to building shall be sized on building block load. Gallons per minute (gpm) shall be based on a 20° F temperature difference. Size pipe based on a maximum of four feet pressure loss per 100 feet using the Darcy-Weisbach equation for the appropriate pipe material.

i. Check if existing pipe taps are available for connection. Capped branches with valves are installed in the tunnel and/or with direct buried piping for use by future buildings. If not, connection to existing shall be hot tapped with valve, or connection could be made during scheduled weekend quarterly CHW shutdowns.

j. New or replacement cooling coils connected to the University's Central Plant chilled water system are required to be sized for a minimum temperature rise of 20°F.

k. Air separators and expansion tanks are not required in buildings using central plant chilled water. Stand-alone buildings with chilled water shall have air separator located on the suction side of the pump.

4. Air distribution systems: Air shall be introduced into each space at less than 50 fpm in the occupied zone, and at RC values less than current ASHRAE limits found in ASHRAE Handbook chapter “Sound and Vibration Control.” The Mechanical Engineer shall work closely with the Architect to achieve good natural airflow patterns through building spaces. If “stack” effect cannot be achieved by natural building configuration, then motor-driven fans shall be used. Air de-stratification fans equipped with variable speed control shall be considered for spaces with high ceilings. When cooling is not currently intended for the space, the size of the distribution system shall be sufficient to adequately cool the space (as if cooled air were being introduced).

1.3 HVAC SYSTEMS

A. HVAC system for Laboratory Buildings

1. Laboratory or research buildings shall be designed with “once through,” 100% outdoor air systems that automatically compensate for filter loading. Wet lab air will not be recirculated. The system shall be outfitted with pressure-independent VAV or constant volume Phoenix Control Corporation valves and a duct mounted,
hot water heating coil. The HVAC system shall be designed to maintain the proper temperature, differential pressure, outdoor air exchange rate, and acoustic criteria within the space, and humidity if required by the DPP. Lab buildings air system shall operate continuously year round. Lab spaces shall be controlled by air valves that will maintain pressure differential within one second of pressure changes in system.

2. The HVAC system capacity shall be based on the larger of the two main parameters:
- The amount of fume hood exhaust versus the required space cooling loads. The ventilation rate shall also be sufficient for the removal of contaminates to be used in the building.
- The lab exhaust systems, where there is no mixture incompatibility, shall be arranged with multiple fans connected to a manifold to maintain 100% of exhaust design conditions at all times. Exhaust air from vented biosafety cabinets (BSCs) shall be provided with their own exhaust fan. Biosafety cabinets have special design requirements for the greater pressure-drop needs of the self-contained HEPA filter. Exhaust from central sterilizers, cage-wash equipment, and glass wash areas may have a separate exhaust system or may be combined with fume hoods exhaust system. Wet exhaust ductwork shall be pitched for drainage back to source.

4. Select fan motors for the horsepower required for fan operation at present peak airflow cfm with dirty air filters. Dirty air filter shall be calculated at 1.5 times the clean air pressure loss of each filter.

5. Laboratory systems may operate for longer periods and at higher airflow densities on a unit area basis than non-laboratory systems. Efficient supply air distribution is of equal, if not of greater, importance than non-laboratory systems.

6. In fume hood or air-change-rate dominated labs, the terminal device for load control will influence energy efficiency. Consequently, constant-volume, reheat terminals are least efficient due to both overcooling and then reheating for space temperature control. This type of control shall be avoided or at least minimized.

B. HVAC systems for Vivarium buildings

1. The air-handling system design for an animal facility’s HVAC system shall be based on 100% outdoor air and shall automatically compensate for pressure variations due to filter loading and pressure changes. Vivarium air will not be recirculated. The system shall be outfitted with pressure-independent VAV air control valves and a duct mounted, hot water heating coil. Provide individual space temperature control. Relative humidity (RH) maintained between 30% and 70% year-round if required by the project program. Part-load psychometric calculations shall be submitted showing that RH does not exceed 70%, or additional controls need to be provided to maintain less than 70% RH. With proper design, past projects at UCR have shown that low humidity is not a problem that would require humidifiers. If humidifiers are needed in a specific room, then it is more cost effective, in the long run, to provide local humidifiers.

2. Individual control must be provided for each holding room, treatment room, procedure room, and operating room. Provide the ability to: (1) adjust the air change rate between three and twenty for each animal holding room, (2) change from offset negative to positive pressure in relationship to adjacent space, and (3) change airflow setting to an almost zero for room cleaning mode. The maximum and minimum set points shall correspond to maximum and minimum air change rates based on animal species and research performed as determined by the researcher. Animal holding rooms shall be designed to maintain an adjustable temperature set point in the range of 65°F to 85°F.

3. The HVAC system capacity shall be based on the largest of the four main parameters specified below:
a. Minimum ventilation requirements of 15 outdoor air changes per hour throughout animal use areas.

b. The amount of fume hood, biosafety cabinet or downdraft table exhaust required for meeting actual program requirements.

c. The required space cooling loads to meet environmental conditions specific to the type of animal.

d. Minimum ventilation requirements as required to support microenvironments in ventilated cage racks.

4. If microenvironments are employed for animal holding, the minimum ventilation requirement may be reduced to 10 air changes per hour plus the sum of the microenvironment airflow. System connection to microenvironments shall be designed to maintain the manufacturer-specified criteria.

5. Provide for animal holding rooms a “low” wall mounted exhaust air register with a “high” ceiling supply register. This requirement can be waived by the University if an airflow modeling analysis determines that a low return register is not necessary or it has been determined that ventilated cages will be used. Ductwork behind the low register shall slope to drain through grille. Duct and grilles shall be stainless steel.

6. HVAC systems serving animal facilities shall be designed with parallel HVAC system arrangements or standby equipment with capability to ensure continuous operation during equipment failure and scheduled maintenance outage. Parallel operation using two or more pieces of equipment, which operate together to meet full load, is the preferred choice.

7. In buildings housing both laboratories and other types of space with distinct occupancy zones in which the animal areas are segregated from other types of space, a separate HVAC system for the animal areas is mandated.

8. Select fan motors for the horsepower required for fan operation at 20% greater than the required present airflow cfm. Size individual exhaust and supply branches for the greater of the present airflow requirement plus 20%.

C. HVAC Systems for Hospital Buildings

1. Hospital or clinical centers are generally designed using recirculating-type HVAC systems with various percentages of required outdoor air. Air handling systems may be of the constant or variable air volume type if minimum total occupied air change rates are maintained. Systems shall automatically compensate for filter loading and pressure changes. Pressure independent hot water terminal heating devices shall provide individual space temperature control. The HVAC system capacity shall be based on the larger amount of total supply air required to satisfy either the specific outdoor air exchange rate or the space-cooling load.

2. HVAC system design for specialty areas such as intensive care, surgery suites, radiology rooms, cystoscopy rooms, treatment spaces, etc. shall be based on actual loads and design conditions. The A/E shall thoroughly review the DPP to understand the scope and magnitude of miscellaneous spaces. Program shall dictate if redundant systems are required.

D. HVAC systems for Administration and Classroom Buildings

1. Air handling systems for administrative, office, conference, classroom and other general use facilities are similar in design. They frequently employ VAV with terminal zone or room-heating units. The systems are recirculating type with ventilation rates designed to meet California Energy Code unless otherwise directed. Airside dry-bulb economizers provide free cooling when ambient
conditions permit. Provide enthalpy economizer for humidity critical buildings.

2. Air handling systems for these buildings are best kept simple and zoned consistent with the building use and occupancy schedules. Large conference rooms or assembly areas with intermittent use shall not be connected to units that supply routine office space.

3. Air handling systems in these buildings may have the following features:

   a. Single supply and return fans without redundant components
   b. Night setback and morning warm-up control modes
   c. Mixing plenums with minimum and maximum outdoor air damper to accommodate minimum ventilation and economizer operations.
   d. 30% efficient pre-filters and 85% efficient after filters
   e. Fully ducted return air system with building pressure controlled relief devices

4. Computer or data processing facilities are commonly found in administration buildings and require special consideration. HVAC systems for central computer rooms must meet any special requirements for temperatures, controlled humidity, and extremely high reliability. Refer to the DPP for specific requirements for the project to determine if needed, and if a separate cooling system is to be furnished.

E. Cold Rooms and Controlled Environment Rooms

1. Where there are two or more such rooms, provide water-cooled condensing units. When a continuously operating process cooling water loop is required to support laboratory equipment requirements, it is the cooling source of choice. An independent closed loop cooling water system to dissipate heat using a fluid cooler should be evaluated. Once through water cooling is prohibited.

2. When water-cooling is not feasible or practical, condensing units may be air cooled and located outdoors. Air-cooled condensing units located in the plenum above the cold room are not acceptable. If there is only one such room, consider a condensing unit located in a separate, exhausted equipment closet.

3. Cold rooms operate 24 hours/day regardless of laboratory occupancy. Consequently, the condensing unit heat sink must be a reliable source, available 24 hours/day all year long.

4. Equipment connections require pressure-regulating valves, relief devices, balancing valves, flow controllers, and temperature regulators to complete their installation.

5. Room refrigeration system and/or cooling system shall be on emergency power.

F. Semiconductor manufacturing buildings or rooms within other buildings shall be designed in accordance with SEMI Standard S6-93, “Safety Guideline for Ventilation”.

G. Clean rooms: The level of cleanliness shall be no greater than that required for protection of the process/product. The use of "mini-environments" and laminar flow hoods shall be evaluated for localized contamination control, with the general room environment maintained with a less stringent criterion. The use of fan-filter (HEPA) units shall be evaluated in lieu of centralized/ducted air re-circulation concepts.

H. Laboratory Hood Systems

1. In general, fume hoods shall be manifolded unless the contaminant is extremely hazardous or radioactive. Perchloric acid hoods shall not be manifolded. To ensure the safety of laboratory personnel and to avoid toxic fumes and odor buildup when a hood fan is shut off, it is preferable that hoods be operated continuously 24 hours a day. In this case, to minimize costs, it is
advisable to place several hoods on one fan or all hoods on a manifold ducted exhaust system.

2. The entire laboratory or research building shall have multiple manifold fans, the number of fans shall be determined by the A/E to accommodate physical, capacity restraints, and provide a backup fan. One of the fans shall be a backup for any other single fan.

3. Teaching laboratories shall not be designed for diversity. Research labs may be designed for diversity but only if there are a significant number of hoods to warrant the risk of designing for diversity, and if it can be demonstrated that hood usage will support diversity. The diversity factor shall not be less than 80 percent, unless approved by the University. Provide detailed justification to for approval.

4. Chemical fume hoods shall be sized for not less than 100 fpm in accordance with the risk or hazard involved. For normal applications, an average velocity of 100 fpm shall be maintained across the face of the hood with a wide-open sash. For extremely hazardous service, hood velocities shall be as directed. Flow rates may be reduced to 60 fpm when hood is unoccupied.

5. Air quantities for biological safety cabinets shall be in accordance with NSF Standard 49. Air quantities for Perchloric Acid and Radioisotope hoods or other special purpose applications shall be in accordance with the hazard or risk as determined by the University's EH&S representative and/or user, but not greater than 125 fpm.

6. Energy Conserving Hoods: Energy conserving hoods shall be evaluated in hood-dominated labs as permitted by the University's EH&S representative recognizing teaching and research applications. These include:
   a. Combination horizontal and vertical sash
   b. Vertical sash with 18-inch sash stop.
   c. Provision for bypass shall be commensurate with hood type.
      Bypass when employed shall not increase airflow above the "design conservation flow rate."

7. Variable Volume Hoods: In lieu of, or when energy conservation hoods are not permitted, VAV hoods shall be evaluated in hood-dominated labs. When occupied, supply and exhaust shall be modulated using air control valves in accordance with hood use and/or cooling but not less than six air changes. (Note: this may require the use of an auxiliary room exhaust.) When unoccupied, supply and exhaust shall be reduced to the minimum controllable airflow rate, but not less than three air changes. Use of central contaminant monitoring to reduce control air flow rates may be considered. Aircuity is one manufacturer of such systems.

8. Snorkels: Snorkels shall be used for control of localized airborne hazard control. Capture velocity shall be 100 fpm at distance of one times the diameter of snorkel.

9. Canopy Hoods: Canopy hoods shall be used to capture localized areas of heat generation/release. Hoods shall extend a minimum of 12 inches around heat-producing equipment and shall not be more than 4 feet above it. The face velocity through the exhaust hood shall be a minimum of 70 fpm.

10. Fume hoods shall be located so that traffic flow past the hood is minimal. Fume hoods shall not be located on "ghost" corridors or where air currents may be generated from opening doors. For safety reasons, fume hoods shall not be located in paths/doorways used for emergency exiting.

11. In the rare case when the hood usage is intermittent and where material used in the hood is very well controlled, it may be feasible to provide a dedicated fan. This will allow the fan to be shut off during periods when it is not used in order to save energy and reduce noise levels in the lab. Generally, such applications are extremely rare and shall not be used without the approval of the University.

12. It should also be kept in mind that hood use may change over time, and the
design should be as flexible as possible. Hood exhaust systems with multiple hoods and fans shall be designed in such a manner that makeup air and building static pressure cannot pull air backwards through idle hoods under any combination of hood usage.

13. Non-Perchloric acid hood fans and accessories such as back draft dampers, etc., shall have protective coating (such as Eisenheiss).

14. Venting of acid and flammable storage cabinets is required. It may be accomplished by a vent pipe from the cabinet to the hood exhaust duct or into the hood work surface, provided the vent opening is not in the bottom of the dished portion of the work surface and is located behind the rear baffle. This location shall create a suction that will carry vapors directly out of the hood and not allow them to build up within the hood interior. Penetrations through the work surface shall be sealed with appropriate chemical resistant caulking material.

15. Fume hood and BSC certification shall be performed as part of substantial completion requirements.

16. Radioisotope hoods shall be an independent system. If the project contains more than one radioisotope hood provide a manifold duct system of the hoods if feasible. Particle conveying ducts shall not be manifolded to fume (gas and vapor) conveying ducts.

I. Perchloric Acid Hood

1. Each Perchloric acid hood shall have an individual exhaust system (i.e., individual duct to individual fan). The ductwork shall go straight from the hood to the roof with no horizontal runs or sharp turns. “Wash-down” facilities shall be built into the hood and ductwork. An air ejector system or an exhaust fan may be used. An air ejector exhaust system eliminates the possibility of acid reaction with fan components and allows for ease of cleaning. If a fan is used, the blades shall be made of acid resistant metal or a metal protected by an inorganic coating. The fan shall be lubricated with fluorocarbon-type grease. Hood systems for Perchloric acid use shall be constructed from material resistant to Perchloric acid attack. This shall include duct, fan housing, fan wheel and shaft, and exhaust terminal material.

J. Hydrofluoric Acid Hoods

1. Ductwork shall be constructed from PVC or equivalent material. Horizontal runs and bends in ductwork must be kept to a minimum. The motor and blower housing shall not have exposed metallic parts.

1.4 HIGH TEMPERATURE WATER DESIGN CRITERIA

A. The University will provide direction regarding the availability of HTW for any project. The HTW System is used primarily to generate space heating and domestic hot water. However, decisions about the availability of HTW, the use of an alternate fuel, or the generation of steam are to be determined on a building-by-building basis.

B. Because generating steam requires an excessive amount of HTW from the distribution system, using HTW to generate steam shall only be when directed. Unless otherwise directed, steam generated from the HTW system shall not exceed 15 psig.

C. Engineering Experience

1. The High Temperature Water System used on Campus is a very specialized installation and requires a unique expertise. An Engineer’s capability to properly develop a successful installation is acquired through experience in specific areas related to higher pressures and temperatures and
the inherent maintenance and safety issues.

2. The University reserves the right to obtain evidence of an Engineer’s capability based on experience in working with HTW systems, either at the University or at other installations.

3. Submit detailed calculations used in the design of HTW extensions for review and approval prior to construction.

4. HTW piping must be designed in accordance with ASME B31.1 Power Piping which includes thermal piping stress analysis. The detailed analysis shall be submitted for approval by the University's Representative.

D. Provide details on the Construction Documents to fully describe the extent and arrangement of the work expected. This shall include but is not limited to:

1. Underground Piping: Drawings are to include plan and profile drawings showing pipeline elevations; existing piping along the route; existing and new boxes, manholes, anchors, expansion, guides, etc.; and details and elevations of manholes, connections, and pipe routing.

2. Mechanical Room Piping: Provide plans, elevations, and details showing necessary dimensions required to arrange the pipe, specialties, and equipment within the building.

3. Tunnel Piping: Provide plans, elevation, and details showing pipeline elevations, existing piping connection locations, anchors, expansion, guides, etc.; and location of other utilities that will be installed in tunnel.

4. Piping in accessible Trenches: Provide plans, elevation, and details showing pipeline elevations, existing piping connection locations, anchors, expansion, guides, etc.; and location of other utilities that will be installed in trench. Removable trench lids shall not exceed 3,000 pounds. Provide smaller lids or manholes at valves and expansion joints. Piping in the trench shall be mounted all at the same elevation.

5. Complete specifications and drawings for all equipment to be furnished on the primary and secondary side of the system.

6. Specifications and drawings completely describing the control system to be used on the project.

E. Approach Temperatures

1. By definition:

   \[ \text{Approach temperature} = (\text{HTW return temp} °F) - (\text{secondary supply temp} °F) \]

2. The maximum design approach temperatures shall be:

   a. HTW steam generators, 10°F or less
   b. HTW water-to-water converters and water heaters, 10°F or less

F. Design Parameters

1. All materials shall be selected for conditions of at least 400°F and 400 psig.

2. System Operating Temperature shall be based on 365°F leaving and a minimum temperature drop of 205°F between the supply and return. Use of series exchangers is encouraged to achieve greater temperature drop in the HTW system. The approach definition above applies to a system of exchangers if mounted in series counter flow.

3. Building heating hot water (HHW) supply temperature shall not be more than 150°F (lower temperatures are encouraged) and return shall not be more than 110°F (lower temperatures are encouraged). HHW temperature differential
shall not be less than 40°F (greater differentials are encouraged).

4. Fouling factors for heat exchanger tubes shall be 0.001 for HTW. Fouling factors for the shell shall be 0.005 for space heating heat exchangers, 0.001 for steam generators, 0.003 for domestic water heating, and 0.003 for industrial water heating heat exchangers.

5. Locate each heat exchanger with adequate clearance for emergency egress. Valves and controls are to be located near the head, fully accessible from a standing position (without ladder and without kneeling), and maintainable from a clear access zone which will not trap a maintenance worker if any part of the system fails to hold the hot media.

6. Pressure/Temperature ratings required for HTW equipment, valves and piping are higher than low-pressure steam and secondary heating systems. HTW equipment, valves, piping, etc., shall be selected for these higher rating requirements.

G. Maximum Pressure Drop

1. The maximum allowable pressure drop from the HTW connection to the building and entry into each mechanical room including piping, equipment, and controls shall not exceed 35 psig.

2. Control valves shall generally be sized for 25-psig pressure-drop. Control valve coefficient (Cv) shall be indicated on the drawings and shall be revised on record drawings to show actual valve Cv installed. A lower valve pressure drop may be used if line losses from the main connection to the building entrance will exceed 15 psig.

3. The maximum pressure drop through the tubes shall be 20 ft.

4. Submit calculations for pressure loss, valve selection and pipe sizing in design analysis.

H. Designing the Piping System

1. The maximum allowable pressure drop in branch lines from the main to building equipment and returning to the main shall be 1” w.g. per foot of pipe (about 3.6 psi per 100 equivalent feet of pipe).

2. HTW piping shall not be direct buried. Trench or tunnel shall be provided.

3. Minimum pipe size shall be 1” for HTW lines above grade and 2” for below grade.

4. Minimum size for drains and vents shall be 1” (drains) and 3/4” (vents).

5. Minimum pipe size for thermos wells shall be 1¼” pipe. This is the size of the pipe that the thermometer well may be installed into. The wells shall be ¾” or 1” threaded stainless steel wells of tapered pattern.

6. When selecting heavy wall pipe (i.e., Schedule 80), the designer must account for the smaller inside pipe diameter in design calculations.

7. Bypass: The University does not require or want a bypass around control valves. At branch connections to the main piping in the tunnel 4” and larger, a warm up and equalizing valve system bypassing the main valves shall be provided to allow smooth start-ups. The warm up valve system shall consist of two welded gate valves with a 1” globe valve between them. It shall be located on the return side of the system.

8. Use Fanning or other equally acceptable formulae to calculate flow, velocity, and resistance of the water piping. Piping shall be sized based on 175°F temperature drop and water at 330 psig. A 300°F HTW pipe-sizing chart is included in this section. Note that chart reads in btuh per degree rise.
9. In lieu of using the chart use the following:
   Sizing chart is based on 175°F delta change in temperature, 3 psi/100-foot pressure loss and maximum 7 fps velocity.

10. Heat Exchangers are to have relief valves on the shell that are piped to an indirect waste or safely to another approved location using full size relief piping.

11. HTW vent lines: Manual vent valves are to be installed at the highest point of the HTW system inside the building. Vent valves are also to be installed at the high point of each high temperature water converter (HTW side of each water and steam converter/generator) in both the supply and return piping.

12. Design to minimize shock: The length of HTW piping between the control valve and the converter/generator shall not exceed 10 feet.

I. HTW flow meter shall be installed to measure and report the HTW flow. Provide flow meter with Hart communication protocol. Meters shall have output of 4-20 ma for campus automation and include totalizer. Note that flow meters will require a minimum length of straight piping to allow the manufacturer to guarantee performance. The meter installation shall be designed for 20 pipe diameters upstream and 10 pipe diameters downstream of straight piping only. If these conditions cannot be met, some reduction allowance will be approved, but no less than 10 pipe diameters upstream and 5 diameters downstream of the meter. Provide with remote control panel. Provide with 300 lb. ANSI B16.5 flanges and graphite sensor seals.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Capacity</th>
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<tbody>
<tr>
<td></td>
<td>Sch. 40 MBH</td>
</tr>
<tr>
<td>1”</td>
<td>350</td>
</tr>
<tr>
<td>1¼”</td>
<td>610</td>
</tr>
<tr>
<td>1½”</td>
<td>1,050</td>
</tr>
<tr>
<td>2”</td>
<td>2,175</td>
</tr>
<tr>
<td>2½”</td>
<td>4,025</td>
</tr>
<tr>
<td>3”</td>
<td>6,550</td>
</tr>
<tr>
<td>4”</td>
<td>14,000</td>
</tr>
</tbody>
</table>
Frictional resistance of 300 °F water in Schedule 40 steel pipe.
J. HTW Pipe Hangers, Supports, Expansion Compensation, and Anchors

1. Anchor and support HTW piping to allow free expansion and movement without damage to piping, valves, and structures or connected equipment.

2. Piping expansion in HTW branch piping to buildings shall be provided by stainless steel, 600 lb., flexible hose of length to suit conditions or one piece bent expansion loops. **No mechanical expansion joints will be allowed in branch piping in the HTW system.** Expansion loops shall be formed by bending one continuous section of pipe and connected by welding at each end. See typical detail. HTW mains in tunnel may use expansion joints; check with the University’s Representative.

3. Pipe hangers, supports and anchors are to be designed as a complete support system for HTW piping. Provide roller supports with springs. Hangers shall be spring-hung to maintain contact with HTW pipe. See typical HTW pipe hanger details.

4. Provide details of connections, supports, hangers, anchors, guides, and accessories necessary to provide pipe support, restraint, and allowance for predicted movement.

5. Provide auxiliary structural steel supports as necessary to support, anchor, and/or restrain the pipe and accessories.

6. Thrust restraints shall not be welded directly to the pipe. Provide reinforced connections. See typical detail. Do not provide continuously welded connections of thrust restraints. Prepare for the welds so as not to reduce pipe wall thickness or impair strength. Provide gusset or filler plates between structural members and pipe as required. Change the slope of pipe only at anchors.

K. High Temperature Water (HTW) Piping, Valves, Fittings, and Gaskets

1. Strainer drain and vent valves shall be gate valves, welded or threaded in the drain line near the strainer, or near the vent connection to pipe main high point, full line size, ANSI Class 800 forged steel, welded bonnet. Provide union near valve to allow disassembly of strainer.

2. **Provide chain-wheel operators for valves over 6'-0" above finished floor** in mechanical rooms, accessible shafts and tunnels. Chain-wheel operators shall be located in a place where they will not interfere with normal access and shall be restrained at wall or column if necessary.

3. Flanges shall be ANSI class 300.

4. Piping shall be seamless steel ANSI Grade A106. Bolting shall be ANSI A193 grade B7 (Chromium-Molybdenum) with nuts conforming to ANSI A194 grade 2H. The specifications shall require that the contractor install the bolts using an anti-seize compound on the threads.

5. Flange Gaskets shall be spiral-wound with blowout ring. Flexitallic Style CG or RIR, or equal.

6. Valves are to be forged steel (2” and less) or cast steel (2½” and over).

7. Threaded fittings may be used at less than 2” size and with Schedule 80 piping. Threaded fittings shall be forged steel.

L. Water column level indicators shall be installed on HTW Steam Generators, condensate receivers, and make-up tanks. The unit shall be rated for the system pressure and shall include water gauge valves and drains.

M. Install strainers on the inlet side of every control valve. Strainers are to be full pipe size with directional arrow on body and where pipe size reductions occur, the strainer shall be the same size as the large end of the reducer.

N. HTW Manholes

1. In the rare instance that a new building will be connected to an existing directly
buried HTW line, branch line connections to the underground high temperature water main shall be in underground concrete manholes. Connections to the mains shall include gate valves in the manholes. Vents and drains lines shall contain a valve with a 6" long threaded nipple outlet. Vent and drain lines are to be as short as possible and not combined with any other pipe, nor routed to a wall.

2. HTW manholes (vaults) shall be poured-in-place reinforced concrete, constructed in accordance with Section 03 of these Design Standards with protected rebar. The manholes shall be square or rectangular with reinforced concrete footings, walls, and top. The bottom shall be open for drainage and shall have a four-foot deep gravel sump. Where deeply buried such that the entire top of the manhole cannot be removed, the manhole shall be constructed such that there is not less than 6'-4" of headroom.

3. Two entry lids shall be provided in the top of each manhole or manhole shall have a completely removable top. The entry lids shall be located at opposite corners of the manhole. Install the entry lids and manhole rings at ground level, with round reinforced concrete extensions down to the manhole ceiling.

4. Grade the ground surface/concrete surrounding the manhole lids to provide sloped drainage away from the lids with a gradual grading. Note that manhole rings, extensions, and connections to the vault shall be waterproofed to prevent ground water and surface water from entering the vault.

5. Install 3/4" diameter steel rungs, poured in the concrete walls, below each manhole lid for ladder access into the manhole. Arrange piping to provide a clear landing below each ladder, and clear access for emergency escape.

6. The manhole lids will be used for regular maintenance and shall have a minimum diameter of 30" with exceptions noted below.

   a. For valve removal one of the manhole lids must be large enough to remove the largest valve.

   b. If the 30" diameter entry is too small for valve removal, install a dual manhole lid instead. A dual lid shall be a 36" diameter or a 42" diameter lid (sized determined by valve removal needs) with a 24" diameter lid in the center of the larger lid. The 24" lid will be used for regular maintenance and the 36" or 42" lid will be used to remove and replace a large valve.

7. High temperature water manhole lids shall be provided with vent holes.

8. High temperature water manhole entry lids shall be cast iron or steel with "UCR HTW" stamped or welded on the lid.

O. HTW Tube and Shell Heat Exchanger and Generators

1. Howard’s Engineering Heat Transfer Products of Pico Rivera, CA, is the preferred manufacturer of HTW generators and heat exchangers; other manufacturers may be considered with prior approval from University. The term “converter” and “heat exchanger” are interchangeable in the Design Standards. Prior to fabrication, submit drawings detailing the material, coatings, connections, appurtenances, dimensions, and arrangement of the heat exchanger.

2. HTW heat exchangers shall operate with HTW in the tubes and secondary water or steam in the shell.

3. Provide over each heat exchanger a structural support system to allow head and tube removal and tube/shell cleaning. Install the heat exchanger with adequate tube removal space.

4. Thoroughly clean prior to shipping and apply an exterior coating suitable for the expected operating temperature. The coating shall include saddles and supports.

5. HTW space heating heat exchanger shells shall be sized to limit the overall shell length (including the thickness of the shell flange) to a maximum of 6 times the shell
diameter.

6. HTW/domestic water and industrial water heating converter shall be a storage tank with a double wall tube bundle. Tanks shall generally be vertical storage with angle legs or skirt support.

7. If soft water is available in the building, use it for make-up water to steam generators and space heating heat exchangers.

1.5 BASIC MECHANICAL MATERIALS AND METHODS

A. Mechanical Equipment Motors

1. Proper protection and control for every motor must be provided.
2. Extended voltage range motors will not be permitted. Motors must be rated for the voltage system to which they are connected. For example, 230 volt rated motors cannot be used with 208 voltage systems.
3. Motors less than ½ HP shall be 120 volt, 1 phase. Motors ½ HP and larger shall be 3 phase.
4. These standards require special construction by the motor manufacturer and shall be clearly noted that it is mandatory for University projects.
5. Bigger motors are not always better. Motors shall be selected such that the driven equipment brake horsepower requirement (including any applicable drive losses) is within 75 percent of the motor rating. In most applications, the motors will not operate at full load continuously. Motor efficiency begins to drop below 50 percent full load and power factor begins to drop rapidly below 75 percent load. Over-sizing can eliminate the benefits of premium efficiency motors, since this will result in operation in a less efficient range. The reduction in efficiency and power factor as a function of load reduction is not as severe when accompanied by a variable frequency drive (VFD). With VFD systems, it is acceptable and preferred to select motor to operate at greater than 60 Hz at full load. This provides better motor efficiency at lower Hertz, which is the majority of the time.

B. Starters

1. Starters for 3 phase motors shall have overloads on all three phases. Fused protection utilizing properly sized dual element fuses is required. Starter control circuits must have properly sized fuse protection.
2. Soft starting systems using VFD shall be provided for motors 25 HP and larger, even if the driven equipment is initially intended to be used at constant speed.

C. Fan Drives:

1. Direct drives fan motors is the University's first choice and shall be provided unless a selection is not available. Selections of direct drive with VFD provide a better selection and less maintenance than belt driven fans.
2. When belt drives are used, fan motors shall be selected to operate the equipment at the mid-operating position of adjustable sheaves. Where non-overloading motors are needed, the motor capacity rating at the most closed position of the motor sheave shall be selected. In no case shall motors be a smaller size than required to operate without overload. Adjustable sheaves shall only be used for start-up. Require contractor to replace with fixed sheave.

D. Variable Frequency Drive (VFD)

1. Fan and pump motors shall be provided with VFD motor speed control, for variable flow or variable volume systems.
2. A bypass switch (either automatic or manual) is not to be provided unless continuous
service of the driven device is required. When a bypass switch is used, furnish a means to prevent duct system over-pressurization. A suitable duct static pressure sensor shall be provided with manual reset control device.

3. Provide VFD with either a Siemens Building Technology or Johnson Controls interface chip, as applicable.

4. VFD’s in exterior locations shall be enclosed within a NEMA 3R control panel or behind a weatherproof door of air handling unit enclosure.

E. Electrical Requirements

1. Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment when available by manufacturer’s option.

2. Motors, controllers, disconnects and contactors shall conform to Electrical section.

3. Controllers and contactors shall have a maximum of 120-volt control circuits, and shall have auxiliary contacts for use with the controls furnished.

1.6 MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

A. Mechanical equipment, piping and ductwork shall be braced, anchored, snubbed, or supported to withstand seismic disturbances and remain operational. See also Section 13.

B. Anti-Vibration Isolators

1. Vibration isolators with seismic restraints capable of the code required lateral accelerated force shall support mechanical equipment mounted on any part of the building other than the slab-on-grade. Mechanical connections to equipment need to be isolated with flexible connections. Electrical connections shall also be flexible. If a concern arises regarding vibration transmission to adjacent areas, a joint around the equipment generating the vibration shall isolate the slab.

2. Anti-vibration bases or spring hangers shall support fans. Individual fans may have integral fan and motor bases, spring type.

C. Selection of the bases or supporting units shall be in accordance with ASHRAE and the vibration eliminator manufacturer’s recommendations.

1.7 INSULATION

A. Chilled water piping shall be insulated with foam glass type insulation and not fiberglass.

B. Exterior insulation shall be protected with aluminum jacket.

C. Exposed insulation in mechanical or machine rooms or spaces shall be protected with aluminum jacket to level of 10 feet above finished floor or walkway.

D. Insulation thickness required by the University’s master specification is thicker than code minimum and shall be required.

1.8 MECHANICAL RESTORATION AND RETROFIT

A. Water supply systems that are to be capped shall have their supply (and return) piping removed and capped at an active main or branch line to prevent stagnation in an idle branch pipe.

B. Air throw from supply air diffusers must not be directed towards the face of fume hoods. Re-orient the throw on existing diffusers where necessary for remodeling projects.
C. Retrofit projects are often constructed and occupied in multiple phases. The testing and balancing shall address the requirements of interim balancing to support partial occupancy of buildings. The health and safety of occupants and the environmental conditions must be suitable for continuous operation at all phases during construction.

D. Where existing HVAC equipment is to be reused, include a test and balance report be done prior to start of construction work. This will determine operating conditions prior to the Project starting and establish minimum operating conditions to be verified by final TAB report.

E. New piping systems shall be variable flow. Control valves shall be two-way. Whenever an existing system is constant flow, it shall be converted to a variable flow piping system.

F. Cleaning of existing ductwork shall be based upon the National Air Duct Cleaners Association (NADCA) specification.

G. Any renovation project that includes ductwork over 20 years old shall include duct cleaning.

1.9 BASIC PIPES AND TUBE MATERIALS AND METHODS

A. Limit the installation of dissimilar metals within piping systems. Provide brass or copper fittings in copper piping systems, not steel or cast iron. Provide steel and cast iron fittings in steel piping systems. Dielectric unions shall not be used.

B. Pipe shall generally be installed concealed, except at mechanical rooms. Pipe exposed in public view shall generally be installed parallel to walls and ceilings. The installation shall present a uniform appearance, and long lengths of pipe shall be grouped together.

C. Manual air vents shall be located at high points in the piping system. Drain valves shall be provided at low points.

D. Transformer vaults, elevator machine rooms or shafts and electrical rooms shall generally have no water, waste, storm drain, or any other pipe conveying water. If impossible, double wall pipes shall be used.

E. Valves and fittings for piping located above or directly adjacent to electrical work outside of electrical rooms or book storage areas shall be provided with drip pans.

F. Unions and flanges shall be at the inlet and outlet of apparatus and equipment, at valves, and elsewhere as required facilitating removal of valves and equipment. Access doors and valve boxes shall be provided for concealed equipment and valves to facilitate cleaning, operation and maintenance.

G. Piping shall be installed to insure proper drainage.

1. Steam mains and condensate mains shall be pitched down in the direction of flow, a minimum of 1" per 40 feet.

2. Steam branch lines to equipment shall be sloped at a minimum of 1" per 20 feet back towards the main.

3. Refrigerant suction lines shall slope at a minimum of 1/2" per 10 feet. Slope the pipe in the direction of gas flow (discharge line sloping to the condenser and suction line sloping towards the compressor).

H. Mechanical room piping shall be arranged to maintain minimum 7'-0" headroom and 3'-0" clear passageways. Route piping along walls to floor sinks/drains in a layout to avoid potential tripping hazards.
I. Piping in mechanical rooms shall be exposed. Do not conceal or embed pipe in walls, floors, or other structures in mechanical rooms or run horizontally across roof unless provisions are made for future roofing.

1.10 VALVES

A. University’s valve application requirements:

<table>
<thead>
<tr>
<th>Service</th>
<th>Size Range</th>
<th>Acceptable Types</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water, Condensing Water</td>
<td>NPS 2 and less</td>
<td>Ball</td>
<td>Process cooling water should be the same.</td>
</tr>
<tr>
<td>Chilled Water, Condensing Water</td>
<td>NPS 2½ to 12</td>
<td>Non-Rising Stem Resilient Wedge Gate, Flanged angle seated check</td>
<td>Process cooling water should be the same.</td>
</tr>
<tr>
<td>Chilled Water, Condensing Water</td>
<td>NPS 14 and up</td>
<td>Non-Rising Stem Resilient Wedge Gate or Flanged Butterfly Valve, Flanged angle seated check valves at pumps</td>
<td>Rarely used inside buildings. Consult with University before specifying.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service</th>
<th>Size Range</th>
<th>Acceptable Types</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Water</td>
<td>NPS 2 and less</td>
<td>Ball Valves, Ball Check Valves</td>
<td></td>
</tr>
<tr>
<td>Heating Water</td>
<td>NPS 2½ and up</td>
<td>Rising stem, OS&amp;Y Gate valves class 150. Flanged check valves</td>
<td></td>
</tr>
<tr>
<td>High Temperature Water</td>
<td>NPS 2 and less</td>
<td>Forged Steel Gate, globe, and angle valves class 800.</td>
<td>Globe valves generally limited to gauge root service. Angle valves used to solve space constraint issues. All valves to be OS&amp;Y</td>
</tr>
<tr>
<td>High Temperature Water</td>
<td>NPS 2½ and up</td>
<td>Cast steel flanged gate and angle valves class 300</td>
<td>Angle valves used to solve space constraint issues.</td>
</tr>
<tr>
<td>Steam, and steam condensate 150 psig and less</td>
<td>NPS 2 and less</td>
<td>Forged Steel Gate Globe, and Angle Valves Class 800, Bronze Angle valves class 300, Check valves of matching type.</td>
<td></td>
</tr>
<tr>
<td>Steam, and steam condensate 150 psig and less</td>
<td>NPS 2½ and up</td>
<td>Cast steel, flanged gate valves class 150, Check valves of matching type</td>
<td></td>
</tr>
<tr>
<td>Steam, and steam condensate 150 psig and less</td>
<td>NPS 2 and less</td>
<td>Same as for HTW Service</td>
<td>Never seen on campus outside of the Central Plant.</td>
</tr>
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<td>Steam, and steam condensate 150 psig and less</td>
<td>NPS 2½ and up</td>
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</tr>
</tbody>
</table>

B. The University requires isolation valves near the risers and main pipeline on branch piping that serves each specific area of the building for supply and return systems serving the building. (For example, each specific area can be a floor or a single lab).

C. Valves must be accessible. Provide access door for any valve located above a hard ceiling.
or in a wall. Laboratory valves must be grouped together and have identification.

D. Valves shall be accessible in mechanical room without climbing onto equipment; e.g., located above air handling units or boiler.

E. Valves shall be installed for isolation at the following: equipment, strainers, steam traps, control valves, and balancing valves.

F. Valves shall be provided at future connection stub outs.

G. Hot Water Heating, Chilled Water, and Condenser Water Valves

1. Ball valves for heating and air conditioning water service shall operate with flow in either direction, suitable for both throttling and tight shut off.
2. Gate valves must never be used for balancing service.
3. Drain valves shall be provided at low points.
4. Air vent valves
   a. Automatic air vent shall only be installed at the air separator in a diaphragm (bladder) expansion tank system.
   b. Manual air vents shall be located at high points in the piping system and at other locations that would hold air due to piping arrangement.

1.11 PIPING EXPANSION COMPENSATION

A. The piping system shall allow for expansion using expansion loops, swing joints, offsets, etc., as may be required. Provide seismic joints in piping crossing building seismic joint. Provide shut-off valves prior to swing ball joint on side of building that has the mechanical system so that it might remain in use should joint fail.

B. Anchor and support piping to allow free expansion and movement without causing damage to piping, equipment, or the building. Pipe expansion and contraction shall be controlled by expansion loops. Mechanical expansion joints will be allowed if other expansion method is not possible.

C. Pipe expansion joints shall provide for either single or double slip of connected pipes and for not less than the traverse required. Joints shall be designed for high temperature hot water working pressure not less than 300 psig at 400 °F and shall be in accordance with applicable requirements of EJMA-01 and ASME B31.1.

   1. Joint components shall be fabricated from material equivalent to that of the pipeline. Initial settings shall be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by joint manufacturer, but in any case shall not be more than 5 feet from expansion joint. An exception is for lines 4 inches or smaller, guides shall be installed not more than 2 feet from the joint.

D. Provide horizontal and vertical movement to match seismic joint design of building without pipe rupture.

1.12 STEAM AND STEAM CONDENSATE

A. Condensate Receivers: Size each condensate receiver for a minimum storage capacity of 10 minutes. Condensate pumps shall be removable from top of tank. Side mounted pumps are not acceptable.
B. Blowdown Tanks: All blowdown tanks shall be supplied with soft water for cooling to reduce calcium deposits in the tank and drain.

C. Steam and Steam Condensate Piping

1. Two pipe steam systems shall be provided. One Pipe steam systems are not acceptable.
2. Steam equipment connections shall be individually valved and trapped.
3. Steam and condensate piping shall not be installed below grade.

1.13 HEATING AND COOLING PIPING SYSTEM

A. Hydronic pipe sizing: Pipes shall be sized for a friction loss of 1.0 to 4.0 feet H2O/100 feet with minimum pipe size of 1/2 inch, except for control piping, which may be smaller, with a maximum velocity of 10 fps and minimum velocity of 2 fps (except for terminal reheat run-outs).

B. Provide separate piping for hot water and chilled water systems.

C. Provision for equipment blow-off and drainage shall be made by providing a sufficient number of access valves and by piping indirect wastes to the nearest floor sink.

D. Unions shall be required on inlet and outlet of all apparatus or equipment having threaded and/or soldered connections 2" and smaller. Brass union, brass coupler, or brass pipe connections shall be provided where dissimilar metals are used; for example, ferrous pipe to copper tubing. Flanges and gaskets shall be required on inlet and outlet or on all apparatus or equipment having threaded, welded, and/or soldered connection 2-1/2" size and larger.

E. Bushings and short nipples shall not be used. Pipe joints over or within 2 feet of electrical equipment shall be provided with drip pans and Teflon tape shall be used for threaded joint 3/8" and smaller.

F. Piping beneath concrete slabs shall be avoided. Piping penetrations shall be carefully detailed. Insulation through penetrations shall be continuous.

G. Use of coupled grooved piping for insulated piping systems is allowed when used with molded insulation fittings for the couplings, elbows, valves and fittings.

H. Pumps (Hydronic)

1. Standby heating pumps are required only for critical facilities and housing projects where the loss of heating would have a detrimental effect on the occupants or research projects. Standby chilled water pumps would only be required for critical facilities (vivarium and labs).

2. Primary/secondary pumping should be evaluated based upon size of system and extent of distribution systems. Primary/secondary pumping shall be considered for stand-alone buildings only.

3. Hydronic distribution pumps shall be centrifugal-type, overhung-impeller, separately coupled, vertical in-line pumps or base-mounted, end-suction or split-case, double suction pumps.

4. For small flows and low heads, in-line circulators may be used. This application is limited to low head, booster, secondary or zoned residential-type (or similar) systems. Typical limits are 80 gpm at 25 feet total dynamic head.

5. Pumps shall be selected for 1200 or 1800-rpm operation using premium efficient motors and for maximum efficiency corresponding to the design flow and head. Selection shall be made for high pump efficiency.

6. Motors brake horsepower (bhp) shall be selected within 75 to 80 percent of the motor nameplate rating. Should the bhp fall below this range and is greater than the rating of the next smallest motor, pipe sizing should be evaluated to determine if portions of pipe are increased in size whether the pump head and resultant bhp can...
be reduced to satisfy a smaller motor size.

7. Variable speed pumping shall be provided unless justified and approved by the University to provide constant speed pumping.

8. Vibration control is usually not needed when pumps are mounted on a basement slab. Pads, isolated from the slab, are acceptable. Inertia bases need to be considered when the pump room is near an acoustically important room.

9. Flexible connectors should also be minimized. Provide only when required by Acoustic Consultant’s recommendations.

10. Pumps shall have the following components to support maintenance operations:
   a. Mechanical seals when choice is available.
   b. Isolation valves on suction and discharge lines.
   c. Pipe strainer or suction diffuser with strainer on floor-mounted pumps, except for condenser water systems where a separate basket strainer shall be installed.
   d. Check valve on discharge unless system only has a single pump and is a single story building and pump is mounted on the lowest floor.
   e. Hand/Off/Auto switches are required for pumps.
   f. Pressure gauges on suction and discharge lines.
   g. Pump inertia base and vibration isolation when not installed on slab on grade.
   h. Pump head curves.
   i. Chilled water flow meter shall be installed to measure and report the CHW flow.

J. Automatic Flow Limit Valves
   1. Valves shall automatically limit rate of flow of system to required design capacity regardless of system pressure fluctuations. Valves shall regulate flow within 5 percent of their tag rating over an operating pressure differential of at least 10 times the minimum required for control. Individually selected and factory calibrated by the manufacturer for service intended. Tags shall be installed so they are visible outside of pipe insulation.
   2. When meeting component requirements herein, composite valves consisting of integral ball valve(s), automatic flow control valve, thermo wells, gage cocks, strainer, and fittings, or a combination thereof, are acceptable where certified by the manufacturer for specific service and installed in strict accordance with the manufacturer's recommendations.
   3. An allowance for pressure drop shall be included for automatic flow limit devices. These shall be selected for the lowest pressure range commensurate with the system resistance. The upper pressure range of the automatic flow limit devices shall be equal to the pump head (less the pressure drop of the controlled component and associated control valve). For example, if the pump head is 60 feet, coil ΔP is 20 feet, and control valve ΔP is 10 feet, the minimum upper pressure range would be:

\[
\frac{60 - 20 - 10}{2.31} = 13 \text{ psi}
\]

4. Therefore, a flow control valve having a range of 1-14 psid would be selected. A loss of two times 2.31 or 4.6 feet corresponding to the minimum valve of the range would be included in the system resistance calculation.

5. Manufacturer shall be Griswold Controls to match campus standards.

6. Manual balancing valves shall not be used except at split coils per coil detail.

K. Expansion tanks shall be provided only on hot water heating systems and other systems not directly connected to the Central Plant systems.

L. External Air Separation Tank
   1. The air remaining in a water system contains oxygen, which causes corrosion and...
contaminates the system. Corrosion within the system creates a reduction of efficiency and a significant increase in wear. The characteristics of this are poor operation, wasted energy, unnecessary maintenance costs and premature replacement of components.

2. Provide an air and dirt separator tank with low-pressure drop to reduce pump head and save energy costs. The University requires the air separation tank with less than one foot of water pressure drop.

3. Provide a Spirotherm Mfr. or equal air and dirt separation fitting complies with with the one-foot pressure drop requirement. Tank and fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and velocity not to exceed 4 feet per second through the unit at maximum system GPM. Units to include internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Provide integral high capacity float actuated air vent at top fitting of tank. Alternates must include cast iron float actuated air vent rated at 150 psig, which shall be threaded to the top of the fitting. Unit shall have the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and include a blowdown connection and valve.

4. Air separators shall be provided on all hot water heating systems. The air separator shall be located on the suction side of the pump.

5. Central Plant chilled water and HTW systems have expansion tanks and air separators existing at the plant and do not need them at buildings.

1.14 CHEMICAL WATER TREATMENT

A. Provide automatic feedwater conditioning equipment for steam boilers, hot water boiler systems, and steam and hot water heating systems connected to HTW generators and converters. Include water conditioning of make up and feedwater to steam boilers and HTW steam generators.

B. Coupon racks are not required at buildings unless directed by the University.

C. Chemical Feed Tanks

1. Chemical pot feeders shall be provided at each secondary heating system for buildings with HTW heat exchangers, and in stand-alone buildings for chilled water cooling systems and heating water systems.

2. Provide a minimum of a two-gallon by-pass chemical feed tank. Tank shall be piped on discharge piping to pump, across the pump shut-off valve. This location is to eliminate chemical slugging of pump seals. Chemicals shall be circulated throughout the total system before reaching pump seals.

D. Automatic Feedwater System

1. Feedwater systems shall have totaling water meters on the inlet line.

2. Verify water pressure at the feedwater system. Feed pressure at the inlet shall exceed the manufacturer’s recommended minimum pressure by 20%.

3. Automatic blowdown and chemical feed systems are to maintain a desired level of dissolved solids concentration in the water of the shell side of HTW steam generators with the use of a conductivity controller.

4. Feed water systems shall include a heated tank, and duplex or triplex feed water pumps.

1.15 REFRIGERANT PIPING AND SPECIALTIES

A. Refrigerant piping specialties shall include bull’s eyes, expansion and solenoid valves, suction and discharge pressure gages, valves, strainers, sight glasses with moisture indicators, and dryers.
B. Refrigerant piping shall never be installed below ground.

1.16 BOILERS AND ACCESSORIES

A. Hot Water Boiler:

1. Basis of design shall be hot water boilers as manufactured by Parker Boiler Co., series 201-LR, of the bent steel water tube design for firing on natural gas with low NOₓ premix type burners. Boilers shall be furnished complete and assembled, factory fired and tested with controls and trim mounted and wired.

2. Minimum thermal efficiency to be 85% and meet Southern California Edison Savings By Design equipment guidelines.

3. Boilers shall be provided with low NOₓ type burners and shall not exceed 1,999 MBH unless directed by the University.

4. Boilers shall be listed for use with type “B” vent stack materials by a nationally recognized testing laboratory. When acceptable alternate boiler suppliers are used that require external flue gas recirculation, provide a complete positive pressure type, UL listed chimney system, with barometric type draft control, from the boiler vent connection to the chimney termination.

5. Codes and Standards:

a. When boilers are specified for outdoor service, both the boiler assembly and the burner assembly shall be listed for outdoor service. Boilers shall be listed in the Directory of Certified Gas Fired Boiler Assemblies as published by the Energy Commission of the State of California.

b. Heating systems shall be designed to comply with requirements of the Title 24 of the State of California Codes. Boilers shall be provided with appropriate trim and interface terminals as necessary for compliance and operation as a heating system.

c. Boilers shall be installed only on a non-combustible base. If boilers are specified for installation outdoor on a roof, the boiler shall be provided with a factory mounted combustible roof base shield unless the underlying roofing and supporting structure are verified to be non-combustible.

6. As a minimum, in addition to code required and normally furnished control and trim items, boilers shall be furnished with control ground wire and any NEC required local fused disconnects near the boiler shall be provided.

7. Provisions shall be made in the design of the heating system and in the sequence of operation to provide for an adjustable system circulating pump off time delay whatever the boiler is deactivated.

B. Steam Boiler:

1. Basis of design shall be steam boilers as manufactured by Parker Boiler Co., model 9.5L, of the bent steel water tube design for firing on natural gas with low NOₓ premix type burners. Boilers shall be furnished complete and assembled, factory fired and tested with controls and trim mounted and wired.

2. Minimum thermal efficiency to be 84.8% and meet Southern California Edison Savings By Design equipment guidelines.

3. Boilers shall be provided with low NOₓ type burners and shall not exceed 10 bhp. Boilers and burners shall be certified to comply with SCAQMD rule 1146.2. NOₓ levels not to exceed 20 PPM NOₓ at 3% O₂ corrected.

4. Boilers shall be listed by a nationally recognized testing laboratory for use with type “B” vent stack materials. When acceptable alternate boiler suppliers are used that require external flue gas recirculation, provide a complete positive pressure type, UL listed chimney system, with barometric type draft control, from the boiler vent connection to the chimney termination.
1.17 BREECHINGS, CHIMNEYS, AND STACKS

A. The stack size shall be determined based on criteria in California Mechanical Code (CMC) or sized by a stack manufacturer's computer program.

B. Stack diameter and height shall be in accordance with manufacturer's recommendation and conform to NFPA 211.

C. Boiler stack may be double-wall metal vent piping tested and listed by UL for use with building heating equipment burning natural gas. The entire stack system shall be from one manufacturer.

D. Provide stack heads for boilers and water heaters on roofs with fume hood exhaust, or as determined by wind study. Stack heads provide vertical flue discharge without use of rain caps.

1.18 REFRIGERATION

A. Applicable equipment shall comply with SCAQMD rules.

B. Refrigerant systems are presently limited to HFC-410A and 407C (only for reciprocating systems) or HCFC-123 and HFC-134a (only for centrifugal systems). HCFC-22 Screw Machines are not to be considered. Applicable health and safety requirements for refrigerants shall be included in the design. These requirements shall include ASHRAE safety items noted in Standard 34. New refrigerant types that do not harm the ozone may be considered for use.

C. Evaporator coils located near heating coils, pressure relief devices, and fusible plugs shall have relief piping, sized and routed per the requirements of ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

D. Mechanical rooms that contain mechanical refrigeration shall be ventilated, and shall have sensors and alarms installed per ASHRAE Standard 15. Mechanical rooms containing refrigerant compressors, coils, tanks, piping, etc., shall not be used as return air plenums.

E. Mechanical Rooms, which contain mechanical refrigeration, shall not have devices, which produce an open flame per the requirements of ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

F. Provide refrigerant monitoring systems to comply with the latest code requirements for the type of refrigerant being installed. Provide contacts for connection to the DDC building management system for alarm of a refrigerant leak to the campus EMCS.

G. Chillers: Water-cooled units shall be selected unless the cooling requirements or other physical constraint dictate otherwise. Chiller type shall be based on achieving the best efficiency commensurate with design capacity and part-load performance. Absorption chillers shall not be considered. Chiller efficiencies or COPs shall equal or exceed the present Southern California Edison Savings By Design equipment guidelines.

1.19 REFRIGERATION COMPRESSORS

A. Compressor units shall conform to ARI 520. Provide factory-assembled compressor units driven by electric motors with valves, refrigerant piping, instruments and controls. Provide standard
equipment, optional equipment, and accessories specified in ARI 520. Entire unit shall be mounted on a welded steel base, and shall include an initial charge of refrigerant grade lubricating oil. Compressors shall operate at partial load conditions without increase in vibration over that normally experienced at full load; and shall be capable of continuous operation down to lowest step of unloading.

B. Controls

1. Multi-compressor units shall be provided with a lead/lag selector switch.
2. A pump down cycle of the non-recycling start type shall be provided for compressors 20 tons or larger.
3. Provide an alarm circuit to actuate in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Circuit shall activate bell, horn, or BAC as directed by the University.
4. Provide system capacity control to adjust output to a minimum of 20 percent of full load capacity without cycling operating compressor, and to automatically recycle system on power interruption.

1.20 PACKAGED WATER CHILLERS

A. Chillers shall be the highest efficiency available at the time of design and meet Southern California Edison Savings By Design equipment guidelines. Manufacturers, styles and specialties shall be proposed during the design development in coordination with the University.

B. Provide complete, packaged water chillers, each mounted on a single welded-steel base. Chillers shall be ready for operation after installation and field-testing. Equipment shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more, which must be removed for inspection, cleaning, or repair (e.g., motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads) shall have lifting eyes or lugs. Provide overhead attachment to building structure for chain hoist.

C. Provide insulation for surfaces subject to sweating, including the liquid cooler, suction line piping, water boxes, economizer, and cooling lines.

D. Reciprocating, Scroll, Air-Cooled Chillers

1. Conform to ARI 590. Base capacity and power ratings, at the conditions indicated and specified on the test requirements of ARI 590. Power input shall not exceed at full load capacity 0.8 kW/ton. For multi-compressor units, provide at least two independent refrigerant circuits. Chillers shall be capable of operating at partial-load conditions without increased vibration over normal vibration at full load operation, and shall be capable of continuous operation down to minimum capacity.

2. Coils shall be circulated and sized for a minimum of 5°F sub-cooling and full pump down capacity.

3. Liquid coolers (evaporators): Tubes shall be seamless copper. Refrigerant side design pressure shall comply with ASHRAE 15. Waterside design pressure shall not be less than 150 psig. On direct-expansion units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum capacity. For the waterside of liquid cooler, the performance shall be based on a water velocity ranging from 3 fps to 12 fps with a fouling factor of 0.00025.

4. Controls, Control Panels, and Gages:

a. Multi-compressor units shall be provided with a lead/lag selector switch.

b. A pump down cycle of the non-recycling start type shall be provided for each compressor 20 tons or larger.

c. Provide an alarm circuit to actuate in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control.
Circuit shall activate bell, horn, or BAC as directed by the University.

d. Provide system capacity control to adjust chiller output to a minimum of 20 percent of full load capacity without cycling operating compressor and to automatically recycle system on power interruption.

E. Split-System Water Chillers, Remote Condenser

1. Similar to packaged water chiller, except split system.
2. Provide refrigerant isolation valves at each piece of system.

1.21 PACKAGED COOLING TOWERS

A. Requirements for field erected cooling towers located at the Central Plant shall be as directed by the Central Plant Facilities Services Administration and not included in this document.

B. Cooling towers at stand-alone buildings shall be manufacturers, construction and styles approved by the University during the design development stage. The University will require cooling towers to be concealed with architectural features or walls. These walls may be part of a field erected cooling tower.

C. Cooling towers shall be selected for not less than 70°F entering wet bulb (EWB). Cooling towers shall be upsized nominally 25 to 50 percent to reduce tower fan horsepower (increase physical size one or two selections). A 25 to 50 percent tower upsize will reduce fan power requirements by 1/3 to 1/2 of that otherwise required.

D. Provide complete stainless steel construction and TEFC, premium efficiency, hostile duty motors.

E. Provide VFD for soft start and in lieu of 2 speed motors.

1.22 REFRIGERANT CONDENSING UNITS

A. Air-Cooled Condensers, Remote Type

1. Factory-assembled, design-tested, and rated in conformance with ARI 460. Condensers shall be ready for operation after installation and field-testing.

2. Size condensers for full capacity at 30°F temperature difference between entering outside air and condensing refrigerant. Entering dry-bulb outside design air temperature shall be 95°F. For design conditions, submit a cross-plot of net refrigeration effect of condenser against net refrigeration effect of compressor to establish net refrigeration effect and compatibility of equipment furnished. Sub cooling shall not be considered in determining compressor and condenser capacities.

3. Condenser Coils: Extended-surface fin-and-tube type. Condenser coils shall be constructed of copper tube and copper fins. Fins shall be hydraulically or mechanically bonded to tubes and installed in a stainless steel casing. Coils shall be circuited and sized for a minimum of 5°F sub-cooling and full pump down capacity. Fins shall be plate type.

1.23 HEAT EXCHANGERS

A. Plate heat exchangers shall have stainless steel plates; 150 lb. ASA rated flanged ports, ASME code Section VIII stamp on the unit, form U-1 in the O&M manual and computerized selection included in submittal and O&M manual.
B. HTW Tube and Shell Heat Exchanger and Generators refer to article 1.4 in this Section.

1.24 AIR HANDLING UNITS

A. The type and construction quality of air handling units (AHU's) approved for use in UCR buildings are based on several factors, such as: size, system features, building types, site restrictions, etc. The equipment must provide, throughout the system life, stable and continuous operation. Major unit components shall not require replacement until the system life of 20 years is realized.

B. Air handling systems that are generally small in capacity (less than 2,500 cfm), use return air, and are not serving critical program functions, may be factory-packaged, institutional-grade units.

C. AHU’s (greater than 2,500 cfm) that are recirculating or use 100% outdoor air shall be custom-designed, factory-fabricated and tested units.

D. AHU's designed for installation in existing buildings where access is restricted, or designed for new buildings where the construction phasing does not permit the installation of large factory-fabricated sections, may be custom-designed, field-erected and tested units using dual wall metal panels and air handling style doors.

E. The Design Analysis submitted shall define the type and quality of air-handling equipment proposed for use, complete with manufacturer's selection, dimensions, weights and accessories. The design analysis shall provide justification for equipment selection.

F. The Drawings shall show, in sufficient detail, the desired arrangement of each complete unit indicating components, access doors, casing openings, service clearances, and overall dimensions. Layouts shall include sections to define the overall height and vertical location of duct connections, dampers, louvers, etc.

G. Only 24” x 24” filter modules with face load filter racks shall be used within the AHU's.

H. Consider the location of the supply air fan in factory and field-constructed units with respect to coil banks. Excessive air velocity stratification across the face of a coil may affect the capacity, pressure drop, and water carryover characteristics. Thus, the location of the fan with respect to the coil bank is very important. Generally, if the air velocity across the coil does not vary by more than +/- 10% of nominal, essentially full capacity will be achieved and water carryover will not be a problem. However, if the air velocity stratification is greater than this, capacity reduction and carryover problems could occur. When space limitations dictate that the fans be placed in close proximity to the heating or cooling coils, the following criteria should be used to determine the minimum distance between fan and coil for field built-up systems:

1. Draw-through system: For single-width fans, the distance between the fan intake and coil should be a minimum of one-wheel diameter. For double-width fans, the distance between the fan intake and coil should be a minimum of 1/2-wheel diameter.

2. Blow-through system: More problems occur in this type of system. To minimize space requirements, it is desirable to place the coil as close to the fan as possible. The minimum distance for satisfactory operation shall be determined. This is a function of the dimensional relationship of fan to coil, the fan outlet velocity, coil face velocity, and coil pressure drop.

I. Blow-through designs are preferred by the University and therefore, fans within AHU's shall be located upstream of the cooling coil. Blow-through is the most efficient location for fan heat removal (equivalent to a 2 to 3°F temperature rise). In a draw-through arrangement, fan heat needs to be recognized either as a building load, which increases air quantity, or by depressing leaving coil temperatures a like amount, neither of which is energy nor cost beneficial. Draw-
through arrangements shall be limited to special applications, e.g., packaged supplemental cooling units for computer rooms.

J. Provide sound attenuators if required by the sound consultant within the AHU cabinet.

K. Fans:

1. Fans shall be individually selected for their specific application. Many different fan types and arrangements exist in the marketplace from a large variety of manufacturers. Select the fan so that it meets the functional needs of the system while providing stable, efficient, and quiet operation. Fan selections shall be based on the lowest reasonable speed while optimizing efficiency. Fan selections shall consider longevity of components, especially bearing life at maximum design conditions.

2. Fans must be fully accessible for service and routine maintenance.

3. Fan systems designed for parallel or manifold operation shall be protected against backward rotation of fan wheels with a motorized isolation, low-leak damper.

4. Provide fans having a certified sound and air rating based on tests performed in accordance with AMCA Bulletins 210, 211A, and 300. See AMCA Standard 99, Standard Handbook, for definitions of fan terminology. The arrangement, size, class, and capacity of fans shall be scheduled on the drawings for permanent records.

5. Fans shall be statically and dynamically balanced by the manufacturer and shall be provided with vibration isolation and seismic restraint. Fans shall not transmit vibration to the duct system or building structure. Fans 20 HP and larger shall be dynamically balanced in the field after the installation is complete.

6. Diffuser cones and inlet bells are not permitted in rating a fan unless they are an integral part of the fan design. Inlets and outlets of fans not duct connected, including fans in plenum chamber or open to the weather, shall have OSHA-approved guard screens to protect personnel. Guard screens shall not impair fan performance and, when bolted to equipment, will permit their removal for fan service and cleaning.

7. Fans shall be furnished complete as a package with motors, drives, curves, bases, and inlet and outlet fittings. Detached vibration isolation devices may be provided separately.

8. Fan type shall be predicated on its location within the AHU, and applicable noise and vibration criteria. Fans with backward inclined (BI) or air foil (AF) blades are preferred. Fan wheels with forward curve blades should be avoided and used only when due to size, BI or AF wheels are not available.

9. Vane axial fans should only be used when flow and pressure requirements cannot be met with centrifugal wheels and with approval of the University’s Representative. Prior approval for such designs will be based on noise, maintenance, application, and alternative design considerations. Generally, noise from vane axial fans increases need for sound traps and the pressure loss offsets the static gain.

10. Plenum (plug) fans are best suited to blow-through supply air and low-pressure return air applications, but can also be used for draw-through applications. Plug fans are the preferred fan for use at UCR. They are especially suitable for direct drive applications with a VFD.

11. Housed centrifugal fans are best suited to draw-through application and ducted exhaust systems.

12. Fan size shall be selected for the highest efficiency based on flow and pressure requirements. Fans for variable air volume (VAV) applications shall be selected to operate near peak efficiency at ± 70% of design flow (this will typically correspond to operation at 65 to 75 percent of fan wide open flow at design system flow). Fans for constant volume (CV) applications shall be selected to operate near peak efficiency at 100 percent design flow.

13. Fans within AHU’s shall be positioned to eliminate or minimize “system effects” in accordance with good design practice and/or manufacturer’s recommendations. For
plenum fans, a space not less than two wheel diameters in both width and in direction of airflow shall be provided.

14. For housed DWDI fans, if used within an AHU, shall have minimum clearance of one-half wheel diameter symmetrical within the enclosure.

15. In blow-through applications, housed DWDI fans shall incorporate an evasé on the fan discharge to recover a portion of the velocity head, as well as a diffusion plate to provide uniform flow entering downstream components. This is particularly important where the downstream component is the cooling coil.

16. For freestanding fans, a minimum straight length of one duct diameter shall be provided on the fan inlet. Fan rotation and discharge position shall be in accordance with ASHRAE/AMCA recommendations to minimize “system effects.” Abrupt changes in ducts or direction shall be avoided close to the fan connection.

17. Isolation dampers, when required, should be positioned a minimum of 1-1/2 duct diameters from the fan inlet and two diameters from the fan discharge. Isolation dampers shall be provided with actuators. Fan shall not start until controls have dampers opening. Start fan with dampers traveling toward opening to avoid backward fan rotations. Round, butterfly dampers are preferred based on low leakage and low loss coefficient.

18. Certified performance data including acoustical data shall be submitted for each fan at maximum design conditions. Data shall include published sound power levels based on actual tests on the fan sizes being furnished and conducted in accordance with current AMCA standards. Such data are used to define sound power levels (PWL) (10-12 W for each of the eight frequency bands). The acoustical design of the fan system must conform to the space noise criteria.

19. Fan curves shall be submitted which will depict static pressure, total pressure, brake horsepower, and mechanical efficiency plotted against air volume. Fan curves shall include estimate losses for field installation conditions, system effect, and actual installed drive components. Included losses shall be defined on the fan curves. Data may also be submitted in tabular form, but tables are not a substitute for actual performance curves. Single speed fan performance curves are not acceptable without additional curves or data to allow analysis of fan operation at different performance parameters.

1.25 UNITARY AIR CONDITIONING EQUIPMENT

A. Units shall be one of the top three most energy efficient units available, as listed by ARI at the time of selection.

B. Packaged Air Conditioners

1. The University must approve the use of indoor package air conditioners units prior to design. These units are normally noisy and would not be very applicable to any projects on campus.

2. Condenser coils shall be copper tubes and copper fins.

C. Packaged Rooftop Air Units

1. This type of unit may be used on remote buildings not served by Central Plant chilled water system. They shall be custom-built or industrial quality units, except for housing projects, unless approved by the University.

2. Evaporative coil shall be made of copper tubes with copper fins and stainless steel casing same as required for chilled water units. Because of the harsh salt-air environment at the UCR campus, condenser coils must be copper tubes and copper fins with stainless steel casing and supports or other approved coating method may be proposed.

3. Provide HCFC or preferably a newer alternative refrigerant. Provide service valves, replaceable filter dryers, etc., to ease maintenance of units.
4. Features detailed to be furnished with air handling units in Article 1.24 would still apply to projects with custom-built packaged units.
5. Provide maintenance clearances and easy access to each part of units.

D. Packaged Rooftop Make-Up Air Units
1. Make-up air units require interior wall construction to be stainless steel.
2. Provide units that will be constructed of materials that will withstand a salt-water environment on the UCR campus.
3. Manufacturers to be used shall be approved by the University.

E. Packaged Terminal Air Conditioning Units
1. Through the wall, Packaged Terminal Air Conditioning Units (PTAC) should never be used. University will direct in writing the use of PTAC units.
2. PTAC units shall be equipped with a timer that can be programmed to shut-off the unit when the space is not occupied. The timer can be part of the unit, or at the panel as appropriate.

F. Room Air Conditioners
1. Window and through-the-wall units should never be used. University will direct in writing the use of room air conditioner units.
2. Window air conditioning units shall be equipped with a timer that can be programmed to shut off the unit when the space is not occupied. The timer can be part of the unit, or at the panel as appropriate.

G. Split System Air Conditioning Units
1. When justified by a life cycle economic analysis, the University must approve use of split system air conditioner units for buildings other than housing projects.
2. Ducted split systems shall include suction and discharge service valves, crankcase heaters, liquid sight glass, filter drier, vibration isolation, lift traps, and solenoids.
3. Condensing units shall include motor-compressor, condenser, receiver, electrical control panel and all defrost components completely assembled on a steel rack, piped, instrumented, wired, run-in, and tested by the manufacturer. Refrigerant shall be HCFC or preferably a newer alternative refrigerant. The motor compressors shall be accessible hermetic with inherent 3 leg overload protection on 3 phases. The coils shall be copper fins and copper tubes with stainless steel casings. Accessories include moisture-liquid indicator, suction and discharge vibration eliminators with bracket supports, suction accumulator and purge valve.
4. Electrical controls shall be installed and wired by the system manufacturer and shall include system start switch, high-low pressure control switch, magnetic contactor, and where applicable, pump-down switch. Starter operating coil shall be 120 volts. Maintained type control contacts shall be used throughout. The compressor-motor shall automatically be protected against liquid slugging and overloading.
5. Evaporators: Fan-coil evaporator (cooler) units shall be adequately sized for the required load to prevent frosting. Units shall have direct expansion cooling coils in a horizontally cabinet supported from the ceiling. Coil shall have copper tubes hydraulically expanded into copper fins with a stainless steel casing. Pitch coils in casing to provide drain. Fan motor shall have built-in thermal over-load protection.

H. Computer Room Units
1. Liebert shall be the basis for design of computer room units. The need for supplemental cooling of computer labs shall be carefully evaluated prior to design. Need for units may not be necessary. Provide counter flow high ΔT cooling coil design for
2. Provide chilled water coil units when CHW is available.

### 1.26 HEAT PUMPS

A. Heat pumps, air-cooled or water-cooled, shall only be used after a detailed life cycle cost analysis and approval from the University's Representative. HTW or Natural gas is the preferred heating medium used on UC-Riverside campus.

B. Life cycle analysis basis shall include the University's requirement for 20-year equipment life. Include in study at least two compressor change-outs, cost of inventory of refrigerant and replacement if phase out is necessary.

C. Heat pumps shall include a condenser coil of copper tube and copper fins to protect from the salt water ambient air experienced on the UC-Riverside campus.

D. Heat pumps shall be designed based on providing one of the three most energy efficient units available at that time.

E. Noise level for condenser fans and outdoor compressors shall be determined and selection of equipment shall limit equipment noise even if mounted outside.

### 1.27 HUMIDITY CONTROL EQUIPMENT

A. Humidifiers shall be provided when required by the Project Program. Only air atomizing type shall be provided. These units use compressed air and cold water and therefore are energy savers. Cold water source shall be pure water. This may require a small pure water system provided just for the humidifier. Use the campus' supplier of small packaged system if central system is not available. Provide stainless steel drain pan under the humidifier nozzles and extend pan downstream the length recommended by the humidifier manufacturer. Casing walls and ceilings shall also be made of solid stainless steel sheets.

### 1.28 AIR HANDLER HEATING AND COOLING UNITS

A. Water Coils

1. Cooling coil face velocity shall not exceed velocities listed in these design criteria at present block load design conditions.

2. Coils shall be within a Type 304 stainless steel casing. To avoid galvanic activity, coil connections shall be copper or brass in a copper piping. Steel coil connections are only acceptable where the piping connection is of steel pipe. Maximum of 8-row coil is to be selected with fin spacing equal to or less than 8 fpi. Minimum of 2-row coil is required.

3. Coils are to be factory tested at 350 psi prior to shipment.

4. The installation of heating and cooling coils in AHU’s often creates long-term maintenance problems. Coils installed in either factory-packaged or custom-designed units, if not properly engineered, will not be serviced and will eventually fail to perform. The following issues shall be specifically addressed at each coil installation:

   a. Individual coils must be fully accessible on both the upstream and downstream sides to permit inspection and cleaning.

   b. Multiple coils are often required to provide the total capacity of individual units. Coils shall be a maximum of 10 feet long by 3 feet high and be capable of replacement without major rigging. Individual coils must be removable without disturbing pipe headers of other coils. Multiple coils shall be valved separately so that, if any individual coil fails, it can be isolated and drained while the remaining
coils stay in operation. Return header for multiple-stacked coils shall be piped reverse return to assist a balanced water flow at various load conditions. Provide a Griswold manual balancing valve for each coil.

c. Coils shall have integral vent and drainage ports. Heating and cooling coils must be designed to drain completely.

d. Even and consistent airflow across the entire coil surface is extremely important. Upstream mixing and the use of air blenders shall be carefully considered.

e. Coil bank supply and return mains shall have manual isolation valves so that the entire unit can be drained.

f. Pipe strainer shall be provided in the supply pipeline for each coil bank. Control and automatic flow balancing valves shall be installed on the return line of each water coil.

g. Factory-packaged units shall have offset coil pipe headers to allow individual coils to slide out of unit casings.

h. Where heating coils are combined with cooling coils, the heating coil shall be first in the air stream.

i. A 316 stainless steel drip pan shall be provided under each section of every cooling coil. Pans shall have a minimum slope of ¼” per foot with a double break in the metal and extend at least 12” beyond the leaving face of coil. Intermediate stainless steel drain pans shall be provided on coils over 36” high. The drain pan shall be equipped with drain piping of at least 1” size.

j. Drain piping shall discharge to an indirect waste through an air gap. The drain line shall run to an indirect waste outside the fan system enclosure and a special built-up trap shall be provided in the condensate drain line. The water seal of the trap shall be equal to 1-1/2 times the static pressure of the fan. See Campus Standard detail.

k. The space between and around coils must be at least 24” to allow cleaning. Provide access doors for cleaning and maintenance.

B. Convectors

1. Convectors are usually provided for heating source in campus dormitory projects unless otherwise directed.

2. Convector enclosure shall be furnished with a baked enamel finish and made of minimum 18-gauge steel with a sloped top if surface mounted or recessed if wall mounted. Provide individual temperature control using a self-contained control valve. Provide lockable access doors.

C. Fan Coil Units

1. Fan coil units shall only be provided when directed by the University.

2. ARI 440 with ARI seal, factory-fabricated. Provide tamperproof front panels if exposed to public, grease or permanently lubricated motor bearings and vibration isolators. Conform with requirements below:


D. Finned-Tube Radiation

1. Finned-tube radiation is usually provided for heating source in campus dormitory projects unless otherwise directed.

2. Provide factory-assembled units including hot water coil with plate fins. Hanger brackets shall have vertical adjustment for pitch of piping and shall have provisions for noiseless operation during expansion and contraction of piping. Enclosure and end caps shall be constructed of 18-gauge steel with baked enamel finish. Provide self-contained control valve with remote bulb mounted below fin-tube. Provide tamperproof access doors in enclosure.
E. Infrared Heaters: Gas fired infrared heater may be provided if the project space usage justifies their installation. Units shall have a spark ignition and vented to outside of building. Verify that adequate combustion air is available.

F. Unit Heaters

1. Unit heaters may be used to heat large non-public spaces that do not require make-up air.
2. Provide factory-assembled, propeller or blower type fan unit heaters arranged for horizontal or vertical air discharge. Each unit shall include hot water coil, fan, electric motor, housing, and air discharge vanes or diffusers. Horizontal discharge type units shall have adjustable deflectors for control of horizontal and vertical airflow. Each unit shall be provided with threaded mounting holes for attaching threaded hanger rods. Fan motor shall be controlled by wall-mounted adjustable thermostat with higher end of scale range factory set at 75°F. Controls shall be automatic On-Off type. Provide fan selector switches to provide automatic On-Off positions.

G. Unit Ventilators: The University shall approve the use of unit ventilators prior to design.

1.29 ENERGY RECOVERY EQUIPMENT

A. Use of state of the art and project-tested energy recovery equipment is welcomed on UCR projects to save energy. Discuss with the University the types and manufacturers available prior to design. Systems must be made of materials suitable for the UCR saltwater environment as discussed in this design standard. Life Cycle Cost Analysis or other approved resource may be required to be submitted to provide justification of an energy recovery unit.

B. Minimum 30% efficient filters shall be installed upstream of any heat recovery device.

1.30 DUCTS

A. Duct systems shall be designed to obtain lowest cost-beneficial pressure loss by limiting certain duct velocities, avoiding dynamic loss components where possible, and utilization of low dynamic loss components is required. High-loss fittings such as mitered elbows, abrupt transitions, and takeoffs and internal obstructions must be avoided.

B. Return air shall generally be ducted. Return air ceiling plenums may be used if limited to plenums that do not contain sprayed on fire proofing or other friable materials. Provide ducted return to each plenum. Use of openings in partitions above the ceiling shall not be used except from private offices or rooms to avoid pressure differential problems from plenum to plenum. Provide sound boots on return air grilles from offices and private spaces.

C. Supply air plenums shall never be considered.

D. Distribution system pressure losses shall be determined by total pressure. The use of the “static regain” is encouraged as a design method. However, other methods are acceptable provided it can be demonstrated that the results are comparable.

E. Horizontal duct distribution shall be routed to maximize long, straight runs without multiple penetrations through fire and/or smoke partitions. Multiple horizontal mains shall be of comparable length and configuration to equalize pressure losses. The overall object is to route ducts that will avoid or minimize architecturally and/or structurally-induced dynamic losses.

F. Do not locate terminal units or laboratory air valves over fixed seating in auditoriums, lecture halls, classrooms or other areas that have fixed seating or sloped or stepped floors. Locate terminal units in rooms with varying ceiling heights where the shortest ladder can be used even if additional ductwork is required. The design shall consider that the access to these units is from
G. Friction Losses and Minimum Duct Sizes

1. The objective is to design the pressure distribution duct (between the AHU and terminal units) for pressure drops of 1.5 inches WG or less for buildings with small floor plans, and up to 2.0 inches WG or less with large floor plans. Long duct runs shall be designed with special consideration of pressure loss since the maximum loss for any run shall be imposed upon the entire fan system.

2. Supply air ducts from cooling unit’s discharge up to the terminal unit (VAV box or air valve) shall be sized for friction losses between 0.15 and 0.25 inches WG/100 feet, but not exceeding a velocity of 2000 fpm. Constant volume systems shall be designed for the low end of the friction range and variable volume systems to the high end of the range for the full cfm without diversity. Minimum size duct to terminal units or air valves shall be eight inches in diameter but not less than terminal inlet or air valve size.

3. Supply air ducts downstream of terminal units or air valves, return air ducts, and general (e.g., toilet) exhaust ducts shall be sized for friction losses between 0.08 and 0.12 inches WG/100 feet, but not exceeding 1600 fpm. Minimum size duct shall be 8 inches by 12 inches, 12 inches by 8 inches, 10 inches by 10 inches, 10 inches square, or 8 inches round regardless of flow. If air inlet or outlet neck size is smaller than these minimums, the final run out of less than seven feet in length may be neck size.

4. Refer to requirements within Section 13 (Special Construction) for sizing ductwork on noise sensitive projects or rooms.

H. Duct Construction

1. Construction of ductwork shall be in accordance with SMACNA 2005 edition for the appropriate duct pressure classification. Pressure classification shall include a 1.25 safety factor. For example: Maximum duct operating pressure is calculated to equal 2.75" with 1.25 x 2.75 = 3.44" or rounded up to 4" pressure class. Provide variations in duct size and additional duct fittings as required to clear obstructions and maintain clearances.

I. Duct Configuration

1. Round ducts shall be used to the maximum extent possible. As duct size increases, flat oval shall be considered. Rectangular ducts shall be limited to areas of space restriction with a maximum aspect ratio of 3:1. Everything should be carefully coordinated with structural, sanitary sewer, fire risers, etc. If due to a structural clearance constraint, it appears that the duct aspect ratio must be increased or the duct cross section reduced the upstream transition must have included angles of less than 60 degrees and the downstream transition must have included angles of less than 30 degrees.

2. Ducts exposed outside to elements shall be constructed to shed water. Round duct is the preferred. If rectangular duct is used, it must be with the approval of the university and provision shall be made to slope the top to shed water.

3. Do not use square elbows either with or without turning vanes. Radius elbows shall be used for rectangular ducts. Elbows may be short-radius with vanes or long radius (throat radius 1½ times duct width). Short radius elbows with vanes will fit the same space as a square elbow with significantly less pressure loss. Radius elbows with vanes shall be designed per ASHRAE and constructed per SMACNA guidelines.

4. Use of five-piece elbows in round stainless steel ductwork is acceptable.

J. Flexible Ducts

1. Flexible ducts shall be avoided or limited in the critical path that determines the total fan static
pressure as flex duct has twice the resistance of smooth duct. Flexible ducts are not allowed within concealed spaces. Ductwork above a T-bar ceiling is not considered a concealed space.

2. Flexible ducts having a maximum length of 3 feet may be used on inlets to terminal units having internal fans.

3. Flexible duct may be used for connections to supply ceiling diffusers from terminal unit to diffuser without any length limitations provided the pressure loss does not increase the total fan static calculations. (In other words the flex duct is not in the longest run with the highest pressure drop). Hard turns, offsets, or kinks will not be allowed in flexible duct.

4. Flexible ducts shall not be used as a replacement for elbows. Rigid duct of adequate diameter shall be used to reduce resistance.

5. Provide duct support at maximum of four feet apart.

6. The total bending from one point of connection to rigid ducting and to the terminal unit (diffuser) of flexible duct shall not be more than 135°.

K. Fume Hood Duct System

1. In general, fume-conveying ducts shall be sized for velocities ranging from 1000 to 2000 fpm with velocities increasing from hoods to the exhaust fan(s).

2. Inefficient duct design such as numerous right angled bends, right angle branch entries and multiple branch entries made in the same location can drastically reduce hood performance and require excessive fan horsepower. These practices shall be avoided to ensure more efficient, less turbulent airflow. One way to do this is to imagine that a fume hood system is laid out the same as a sawdust conveying system.

3. Velocities at fume hoods ducts shall be in the range of 1000 to 1500 fpm.

4. Hood connections for walk-in or other specialized configurations shall be sized in accordance with the above velocity criteria. Hood exhaust volume control valves shall be pressure independent and shall be located in horizontal runs as far from the hood as practical for sound attenuating reasons.

5. When elbows are necessary, they shall have proper centerline radius (1½ times the diameter of the ducts) to minimize eddying and resistance to air flow.

6. In general, duct material shall be 16 or 18-gauge Series 316L stainless steel, continuously welded with "MIG" or "TIG" method, including volume dampers that shall have a minimum thickness of 1/8".

7. If it is determined that no corrosive material will ever be used in the hood, other duct material may be used with the University approval. Parts inside the air stream shall be constructed of inert non-metallic material and shall comply with CMC Standard, No. 10-1 Nonmetallic Ducts Class 1 Ducts. Fume hood duct system upstream of fans shall be airtight. The "Duct mate" flanged joint system is an approved alternative. Screwed slip joint connections sealed with silicone sealant are not acceptable.

8. Design of exhaust systems must take into consideration the characteristics of the materials being exhausted; for example, gases, particulate, corrosiveness, toxicity, reactivity, flammability, etc.

L. Duct Lining

1. Use of lined ductwork shall be avoided. Extra elbows, oversized duct, and quieter fans shall be used before sound attenuators or liner. Sound attenuators shall be used before liners. If required by acoustical consultant to meet the University's noise criteria, then ductwork may be internally lined with acoustical duct liner. Liner shall be fungi and bacteria resistant to not breed or promote growth.

2. Dimensions on plans for ductwork with duct liner shall be "inside clear dimensions" and shall be so noted.
A. Dampers

1. Splitter dampers shall not be used.
2. Manual volume dampers shall be provided to balance the airflow. Locate dampers as far from air inlet and air outlets to avoid noise generation into the space.
3. Control dampers installed in AHU’s for mixed air control shall be sized for face area velocities of 1400 to 1600 fpm. Control dampers where airflow must be reduced to no flow shall be industrial model low leakage type with external linkage.
4. Provide a single-blade volume control damper with locking quadrant in the hood duct for multi-hood systems. Damper shall be located where occupants will have difficulty changing the setting.
5. Maximum leakage for control dampers shall not exceed 25 cfm per square foot of damper face area at 2-inch w.g. pressure difference. Provide stainless steel jamb seals for dampers used to shutoff airflow.

B. Fire and/or Smoke Dampers

1. Automatic Smoke-Fire Dampers: Smoke damper assembly shall include pneumatically or electrically powered operator.
2. Fire dampers and/or fire/smoke dampers shall be installed in locations required by code and/or as directed by the Campus Fire Marshal. Combination fire/smoke dampers shall be auto-reset via the fire alarm panel. No pipes or conduits shall pass through any fire or smoke damper.
3. The operating temperature of the fire-damper actuating device shall be approximately 50°F above the normal temperature with the duct system, but not less than 160°F. The operating temperature of the actuating device may be increased to not more than 286°F when located in a smoke-control system.
4. Smoke dampers shall be the same as multi-leaf fire dampers for rectangular ducts and butterfly type for round ducts. Layout ductwork at egress corridors to minimize fire/smoke dampers, utilizing California Building Code exception that ductwork can cross-corridor without dampers.
5. Duct penetrations in firewalls shall be protected in accordance with CMC with an approved fire damper, and/or automatic smoke damper or other listed protection material. Automatic smoke dampers must operate with the fire/smoke alarm system and automatically reset when directed by the central panel. Drawings shall detail control sequence for smoke and fire/smoke dampers. Coordinate with Electrical Engineer to provide electrical power to smoke dampers and control connection from fire alarm panel.
6. Duct mounted/fan mounted smoke detectors shall be wired into the building fire alarm system.

C. Outside Air Intake and Louvers

1. Air intakes are to be located away from exhausts, vehicle emissions, cooling towers, flues, etc. Louvers shall be drainable, stormproof type. Intake louvers shall be sized for a maximum free area velocity of 500 fpm. Exhaust louvers shall be sized for a maximum pressure drop of 0.1-inch WG with a maximum of 1,000-fpm velocity.
2. Roof hoods, louvers and fresh air intakes shall include bird screen. Louvers shall be as detailed in Section 08, “Openings.”

D. Sound Attenuators (Traps)

1. Sound attenuators (traps) shall be installed wherever noise control (NC) levels in the occupied space cannot be reduced to Campus Standard NC levels by other means. Attenuators shall be installed in the air handling unit and not in the ductwork unless approved by the University.
2. Generally, efficient fan selection together with fan installation that minimizes “system effects” will result in the least noise generation. It is a design objective to avoid the use of dissipate or “passive” sound attenuators in order to eliminate the associated pressure losses. If required, passive attenuators shall be packless type.
3. Inherently, fans generate noise, most of which may be naturally attenuated via the distribution system. When additional noise control is required, the cost benefits of active noise control (ANC) for canceling low-frequency noise at the AHU discharge, in conjunction with perforated double-wall duct construction for high-frequency attenuation, shall be evaluated against the use of passive sound attenuators. It shall be noted that ANC does not add duct resistance.

4. Use acoustical treatment of ducts, but not lining, and AHU surfaces to attenuate noise on AHU inlets. Change in airflow direction may achieve adequate attenuation. Where passive attenuation is required, pressure drop through attenuators shall not be in excess of 15 percent of the total external static pressure of the air handling system (maximum 0.3 inches w.g.).

5. Provide sound attenuators constructed of galvanized sheet steel casing and sound-absorbing material covered with an internal perforated zinc-coated metal liner. Provide factory-fabricated attenuators that will reduce the rated sound pressure level of the fan. Sound absorbing materials shall be faced with glass fiber cloth and held in compression to prevent settling. Outer casing shall be not less than 22 gauge.

   a. The internal perforated metal liner shall be not less than 24 gauge, with perforations no larger than 5/32 inch in diameter, providing a net open area less than 22 percent of the surface.

   b. Attenuators shall be airtight when operating at internal static pressure not less than 2 inches’ water gage. When attenuators are submitted for approval, provide manufacturer's certification of the sound reduction values. Sound absorbing material shall conform to ASTM C 1071, Type I or II.

   c. Attenuators in 100% outside air system shall have a stainless steel internal lining.

6. Provide suitable duct-transition sections for connection to ductwork. Duct shall not transition down, increase size of attenuator area to match duct.

7. Attenuators shall be externally insulated same as duct connected to.

8. Attenuators are heavier than a regular duct section. Provide support and seismic bracing for attenuator separate from ductwork.

9. Modules may be installed to provide an attenuator bank. The modules shall be banded together with nut and bolts or metal straps and tack welds along the length of each adjoining surface to provide structural rigidity. Modules must be properly sealed together at each end in the air stream to prevent leaks.

1.32 FANS

A. Exhaust fans are to be located at or near the termination of the discharge of the exhaust system.

C. Minimum sound power level ratings shall be determined and indicated on drawings.

D. When laboratory fan discharge is vertical and open to the weather, a plugged drain can be provided on the bottom of the fan housing. Plug shall be stainless steel. No drain line shall be provided because of hazardous fumes.

D. Flexible duct connections shall be installed where ducts connect to fans or other units that may cause vibration.

E. In-line fan, if approved for use, shall be flanged for ease of service.

F. Laboratory and/or Fume Exhaust Fans
1. Rooftop penthouses are the best location for air exhaust equipment. Penthouses shall be ventilated provided the environmental requirements for equipment such as VFD’s and DDC control panels can be maintained; otherwise, mechanical spot cooling shall be provided.

2. Inline fans with motors or drive exposed to exhaust air streams are not permitted.

3. Fan systems designed for parallel or manifold operation shall be protected against backward rotation of fan wheels with a motorized isolation, low-leak damper.

4. Exhaust blower motors shall be located on the roof so that a negative pressure will be maintained in the ductwork and prevent escape of toxic material through holes and cracks in the duct.

5. Exhaust fans shall be selected such that inlet velocities are in the range of 2000 to 2500 fpm. Where fan inlet velocity is greater than duct velocity, transition to higher velocity shall be not less than two diameters upstream of fan connection. Ductwork shall not enter the blower motor from an elbow. Provide minimum of five times the fan wheel diameter of straight duct.

6. Exhaust stacks shall be designed to direct the exhausted air above the wind envelope such that the exhaust will be carried away from the building and diluted. A minimum stack height of ten feet above a flat roof with minimum terminal exhaust velocity of 3,500 fpm is required.

7. If the roof is peaked, it is recommended that the ducts penetrate the roof near the peak, and terminate two feet above the peak.

8. Laboratory hood discharges will never be made below the highest point of the building. The discharge stack shall be located in the prevailing downwind direction of air intake point.

9. Exhaust stack height may be determined by a wind study if that is part of the project requirements. Discharge from exhausts shall be analytically designed to ensure adequate dispersion and dilution to mitigate effluent gas impinging on air intakes of the emitting building and nearby buildings.

10. Design of exhaust system outlets and air intakes must prevent the return of exhaust to the laboratory through windows or the fresh air system. Minimum parameters are that discharge shall be 50 feet horizontally away from outside air intake and a minimum of 10 feet vertically above it.

11. The University does not accept use of horizontal fan discharge outlets, fixed cap outlets, mushroom cap outlets and rotating cap outlets. Airstreams shall exhaust upward.

12. Dilution air introduced in the exhaust manifold upstream of the exhaust fans may be required in order to maintain design discharge velocities.

13. Special consideration shall be given to those fans handling explosive vapors or radioactive material.

14. The pressure drop from the fan outlet into the discharge stack and out the high velocity discharge nozzle must be carefully calculated. The pressure loss can be quite significant and must be included in exhaust fan selection. Because of this high-pressure loss, the use of high plume type fans may provide a more economical solution for fume hood exhaust and a safer air discharge without an energy usage penalty.

15. Utility sets are normally used for fume hood exhaust fans. Fume hood fans may be roof mounted high plume fans in lieu of utility sets with a stainless steel discharge stack and nozzle.

G. Toilet and Miscellaneous Exhaust Fans

1. Provide direct drive fans if possible. Use solid state speed controller or VFD for capacity adjustment.

2. Exhaust fans shall normally be located on the roof or mechanical penthouses. Upblast discharge is required.

1.33 AIR TERMINAL UNITS

A. Provide air terminal units or variable air volume (VAV) boxes for offices, classrooms and non-critical spaces. Provide fan powered terminal units if required by the program.
B. Variable air volume terminal units shall be pressure independent and shall adjust to any air flow between zero and the maximum catalogued cfm.

C. Design layout of VAV terminal boxes may include noise-attenuators if required to meet the University’s NC criteria within the occupied space.

D. Units shall be selected at 80% or lower of nominal terminal unit cfm, provided the noise criterion is not exceeded.

E. Provide a heating coil having one row or more for all terminal units including interior offices unless it is serving a cooling only space such as elevator equipment, computer server, or telecom data room.

F. Select reheat coils for 100°F LAT with minimum 40°F WTD with 150°F entering.

G. To reduce terminal air noise level across units closest to AHU, lower the pressure differential by installation of a manual volume damper upstream of terminal units.

H. Provide bottom access panels or door for inspection, adjustment, and maintenance of reheat coils without disconnecting ducts.

I. Single-Duct Terminals: Single-duct terminals shall be selected to limit total pressure loss to 0.4 inches WG with a two-row coil. A higher-pressure loss will be permitted for terminals at the head end of the system (closest to the AHU), provided they do not become the critical pressure loss path or noise source. Terminals with reheat coils having more than two rows should not be used if they become the critical path. Where these situations arise, terminals shall be upsized to permit use of two-row coils.

J. Dual-Duct Terminals: Dual-duct terminals shall have integral blender (mixing) with total flow measurement, and shall be selected to limit maximum total pressure loss to 0.5 inches WG. Higher-pressure loss will be permitted for terminals at the head end of the system and not in the critical flow path.

K. Terminal unit heating coils or reheat coils in 100% outside air systems shall be minimum 0.0075" copper fin with maximum of eight fins per inch and 0.025" copper tubing with a stainless steel frame due to the salt air at the UC-R campus. Air systems with recirculated air may have aluminum fins.

L. Fans powered terminal units: Sound ratings shall be determined and indicated on the drawings. Provide fan disconnect switch and camlocks on fan access door. Terminal selection shall be at maximum of 75% of nominal CFM range.

1.34 AIR OUTLETS AND INLETS

A. Locations of diffusers, registers and grilles shall be coordinated as not to interfere with light fixtures and sprinkler heads and also be located in accordance with the following:

1. Supply and return grilles shall create efficient cross ventilation in the room.
2. Exhaust grilles in restrooms shall be located near water closets.
3. Transfer air inlets in restrooms shall be located as farthest from exhaust grille.
4. Airflow within the room shall minimize the effects of door operation.
5. Return grilles shall be located near windows to offset heat gain/loss.

B. Air distribution within the laboratories is critical. Supply diffusers shall be positioned such that air discharge does not affect the operation of the fume hoods. Air distribution shall be by a Laminar Flow Ceiling Panel. The terminal velocity shall be 50 fpm at 2 feet from the face of any fume hood.
A. Filter face velocity shall correspond to cooling coil face velocity within ±5 percent. Gaskets shall be provided to prevent infiltration of air around filters.

B. Thirty-percent efficient (MERV 8) 24” x 24” x 4” thick pre-filters shall be provided for all buildings. Ninety-five percent efficient (MERV 14) after filters shall be provided for research, vivarium and laboratory type buildings. Final filters for office or classroom type environments shall be 85% (MERV 13); this is required by USGBC LEED Credit EQ 5 indoor chemical and pollutant source control. A higher efficiency final filter may be required based on end use application. After filter and final filters shall be rigid types, not less than 12 inches in depth, 24” x 24” to be compatible with the University’s replacements. For ease of replacement and stocking, filters other than 24” x 24” shall only be used when approved by the University.

C. A diaphragm-actuated direct reading dial type differential pressure gauge shall be installed with static pressure tips across each filter section. The differential pressure gauge shall be similar to Dwyer 2000 Series with appropriate operating range.

D. Filter banks shall be designed to prevent saturation of filters from outside air intake. Provide moisture eliminators and/or 3’-0” deep plenum with a drain in front of filters.

E. Filter frames shall be constructed of corrosion-resistant material. Provide sealant around edges of frame.

F. Filters shall be rated based on ANSI/ASHRAE 52.1 standard test method.

G. Provide filters for outside air and/or return air. Provide replaceable (throwaway) and/or high efficiency type. Filters shall conform to UL 900, Class 2.

H. Polyurethane filters shall not be used except for fan coil units.

I. High Efficiency Filters shall have a mean efficiency of 60 to 95% when tested in accordance with ASHRAE 52.1. Filter assembly shall include holding frame and fastener assembly, filter cartridge, mounting frame, and retainer assembly. Reinforce filter media with glass fiber mat. Pressure drop across clean filter shall not exceed 0.50 inches of water gage. Precede high efficiency filters with a UL Class 2 replaceable type pre-filter.

J. High-Efficiency Particulate Air (HEPA) filters may be required in some laboratory spaces (e.g., clean rooms, etc.) and will be noted in the Detailed Project Program (DPP). Install a filter or filter housing only if directed. Where filters are required, the housing shall be located to allow for easy filter changing by the bag-in-bag-out technique. Exhaust fans and/or Air Handling Units shall be sized accordingly to handle the increase pressure drop across the filter.

1.36 HVAC INSTRUMENTATION AND CONTROLS

A. Provide instrumentation and control systems to maintain the required HVAC conditions and monitor equipment operation. Control systems shall be complete, including equipment and appurtenances,
and ready for operation. Control systems shall be furnished, installed, tested, calibrated, and started up by, or under the supervision of trained technicians certified as qualified and regularly employed by the manufacturer.

B. For major projects on campus, the Automatic Temperature Control (ATC) shall be either “Apogee” by Siemens Building Technologies, or “Metasys” by Johnson Controls, Inc. The most recent revision level software of either manufacturer shall be used as a basis of design and installation. Include upgrade of software at any time up to the end of the one-year warranty.

C. For housing projects, a standalone generic electric/electronic control system shall be used.

D. The control system shall be connected to the Building Automation Control (BAC) system. The BAC shall communicate over the campus communication system, either Ethernet or fiber optic cable. If neither exists at the location of this project, then a modem shall be provided. The BAC shall communicate with the HVAC/Refrigeration Shop computer and with the Campus Central Plant control room computer. At the Central Plant, the system shall communicate through a serial interface to the Wonderware Corporation protocol graphic software. This interface shall be a program language, which communicates with the Wonderware program in the Central Plant, without the aid of a translator box.

1. Each BAC being put on line shall have the capability of supplying data to the Central Plant Wonderware graphic screens to support the building systems. The cost of programming these screens shall be included in each project.

2. These screens are for monitoring, start-stop and trending the major systems of this building. Screens shall include the following:
   a. Trending of chilled water temperature entering and leaving the building and gpm water flow.
   b. Trending the temperature of high temperature water entering and leaving the building and gpm water flow.
   c. Monitoring, alarm and start-stop of each air handling unit on a separate screen.
   d. Laboratory exhaust fans alarm and start-stop.
   e. Trending of building heating water system operation. Start-stop of the building heating water exchanger and pumps. Provide alarming for high temperature in the building heating water system.

3. Screen programming at the Central Plant control room shall be programmed by a person or company member who is in the business of programming Wonderware software with a minimum of five years of documented experience. The company selected shall ensure that all work is coordinated with Management at the Central Plant. Copies of the latest version of the existing Wonderware application shall be obtained from the Central Plant’s system integrator. All changes to the program shall be archived and provided to the Central Plant, and the system integrator.

4. HVAC shop computer shall use the control manufacturer’s graphics program.

E. The building temperature control system for a new building shall include a workstation computer with the control manufacturer’s standard graphics for monitoring, adjustment, testing and maintenance. Hardware shall be latest technology of the current model year for a commercial business installation. Include Ethernet fiber optic connection, CD-ROM, color monitor, keyboard, mouse, ink-jet printer, surge protector, and Windows operating system.

F. Actual room numbers shall be used in programming, graphics and record As-Built documents.

G. Controls installer shall assist and be present during the testing by balancing personnel. Adjusting control devices during testing, adjusting and balancing to override controls for
simulating situations is necessary for testing, adjusting and balancing the HVAC system.

H. Building Control Systems

1. Building control of primary systems including AHU’s, fans, pumps, and heat exchanger equipment shall be Direct Digital Controls (DDC) and interconnected to the Campus central system.

2. Control of packaged equipment, where applicable, such as air conditioning units, air compressors, vacuum pumps, chillers, and boilers, etc., shall be integral stand-alone microprocessor with seamless integration and interconnection to the building system for monitoring unit operation and adjustment of set point.

3. Simplicity in design shall carry through into the installation of automatic HVAC controls. Devices and wiring shall be installed such that they may be easily located, identified, and tested in the field. Controls and instrumentation shall be installed with consideration for ease of access and maintenance.

4. Control dampers less than 12 square feet or maximum of 48” wide blades and valve actuators on ½” to 2” chilled water or hot water heating control valves shall have electronic operators. Larger than 2” chilled water control valves may have electronic operators. Large control dampers shall have pneumatic operators with electronic transducers to the DDC for control. HTW control valves shall always be pneumatically driven and shall be provided with integral I/P transducers and positioners. Dampers and valves shall incorporate “positioners” to improve the accuracy of control.

5. Terminal units (VAV boxes) and reheat coils shall be DDC controlled utilizing electrically driven valve and damper actuators without spring returns.

6. Demand-controlled outside air rate utilizing multiple CO2 sensors shall be incorporated in academic buildings. Control shall limit CO2 to 1000 ppm or as allowed by the latest edition of ASHRAE Standard 62. VOC sensing should be evaluated in conjunction with CO2 sensing. Spaces with a design occupant density greater than or equal to 25 people per 1000 square feet shall have CO2 sensors in addition to outside air intake and return air to air handlers, this is required by USGBC LEED Credit EQ 1 Outdoor Air Delivery Monitoring.

7. In VAV systems, return air fan control shall be based on measuring of the supply airflow. The control system shall then maintain the return air fan control based on the necessary cfm offset to keep the building under a slight positive pressure. Return air fan airflow shall also be measured.

8. Define the sequences of control for HVAC systems and other applicable systems. Control diagrams for each system shall be provided to graphically indicate the systems, show the location of control devices and instruments, and define the set points for control elements.

9. The control company diagrams and sequences shall be included with final record drawing set on the same sheet size as the contract drawings.

10. Legends for control symbols and abbreviations shall be included for control diagrams.

11. Program equipment as defined by the Project Program (PPG or DPP) shall be connected to the DDC to monitor integral equipment alarms.

12. The DDC shall generally be capable of the following points for the indicated system. Provide point list on contract documents. For systems not listed, coordinate with the University Representative.

   a. 100% outdoor air units:
      1) Supply fan status and alarm
      2) Start/stop/auto operation of fan(s) at selecting facilities
      3) Air flow in cfm or VFD drive speed
      4) Coil(s) or supply air discharge temperature
      5) Outside air temperature
      6) Downstream static pressure
      7) Motor current from VFD
8) High static pressure alarm
9) Smoke detector alarm

b. Recirculating AHU’s:
1) Supply and return fan status and alarm
2) Start/stop/auto operation of fan(s) at selecting facilities
3) Air flow in cfm or VFD drive speed
4) Mixed, outside air and return air temperature
5) Coils discharge temperature(s)
6) Downstream static pressure
7) Motor current from VFD
8) CO₂ return air in ppm
9) CO₂ outside air intake in ppm
10) CO₂ locations throughout building
11) High static pressure alarm
12) Smoke detector alarm
13) Outside air, return and relief damper position

c. HVAC pumps:
1) Pump status (on/off/alarm)
2) Differential pressure and pressure ranges
3) Fault status of variable frequency drive (VFD)
4) Motor current from VFD

d. Boilers:
1) Supply and return water temperature or steam header pressure
2) Heating water system flow alarm (if applicable)
3) Boiler alarm
4) Hot water reset valve (if applicable)

e. Heat exchangers:
1) Heating water supply and return temperature
2) Control valve position
3) Pump status
4) HTW supply and return temperature

f. Where Central Plant CHW system is serving a building, provide the following:
1) CHW flow meter
2) Temperature sensors
3) Connection to the Campus Central Control System
4) BTU/hr used, trended, and monthly usage stored for past year

g. Where HTW equipment shall operate, provide with:
1) HTW flow meter
2) Temperature sensors
3) Pneumatic control air for HTW valve actuator (electric not acceptable).
4) Connection to the Campus Central Control System
5) BTU/hr used, trended, and monthly usage stored for past year
6) HTW controls shall be wired through the emergency power system, if available.

h. Terminal units:
1) Terminal unit cfm
2) Room temperature
3) Thermostat set point temperature
4) Reheat coil valve position

i. Exhaust fans:
1) Fan status and alarm
2) Start/stop/auto operation

j. Building system functions.
1) Primary chilled water supply and return temperature and flow
2) Primary high temperature water supply and return temperature and flow
3) Refrigerant monitors alarms
4) Cold or warm room temperature alarm
5) Sump and sewage pump high-level alarms
6) Medical/lab air compressor pressure and dew point alarms
7) Medical/lab vacuum pump pressure alarms
8) Emergency generator alarm, fuel oil tank level and leak monitor alarms
9) Gas storage alarms
10) Liquid sensors (electric vaults/rooms)
11) Oxygen and nitrous oxide pressure and alarms
12) Building static pressure
13) Outdoor air temperature

k. Other areas:
1) Animal rooms: temperature, humidity, air-change rate, and lighting on/off status
2) Computer rooms: temperature and humidity, if humidity control is provided.
3) Critical health care and lab spaces: temperature and humidity
4) Temperature status/alarm for temperature sensitive areas.

13. Interlocks shall be designed for slow closure if possibility of water hammer or air pressurization could occur.
14. The control system installer shall assist and be present during the testing by balancing personnel. Adjusting control devices during testing, adjusting and balancing to override controls for simulating situations necessary for testing, adjusting and balancing the HVAC system.
15. Submittal shall include print out of control programming being written for the project.
16. Large additions or major remodeling projects will require the use of DDC system.
17. Small remodeling projects shall use electric or electronic systems compatible with existing controls within the building being remodeled. Mechanical equipment (air handlers, pumps, chillers, etc.) will require a compatible extension of the building automation system in the building.
18. Compatibility with existing systems shall be studied carefully and documented. Remodel/renovation projects with existing HVAC DDC shall include complete programming to show compatibility. This may require upgrading of existing program.
19. Communication protocol for building automation systems shall be compatible with existing systems.
20. Control Power Sources

a. Provide an emergency power circuit for the control panels and individual room controls where emergency power generators are available and operating the primary HVAC system. Breaker circuits shall be designated specifically for control power functions. Provide uninterruptible power supply (UPS) for control panels serving laboratory air handling units, laboratory exhaust fans, clean room air handling units and steam boilers.

b. Provide separate individual transformers and fuse protection for each laboratory redundant air handling unit and exhaust fan systems. A blown fuse or burned up transformer shall not cause more than one AHU or EF to shut down.

c. Provide control transformers supplying 24V AC control power for zone controls. Install transformers as needed to meet the requirements of the individual controllers.
d. Coordinate to provide control transformers supplying 24V AC control power for zone controls. Install transformers as needed to meet the requirements of the individual controllers. Label transformers not in control panels. Provide disconnect and fuse protection for each transformer.

e. Uninterruptible Power Supply: A self-contained UPS suitable for installation and operation at the Controls Panels shall be provided sized to provide a minimum of 15 minutes of operation. Equipment connected to the UPS shall not be affected in any manner by a power outage of duration less than the rated capacity of the UPS. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.

21. Control Panels

a. Controllers, relays, switches, etc., located in equipment rooms shall be mounted in enclosed control panels with hinged locking doors. Key locks for panels shall keyed to match Campus standard.

b. The location of each panel is to allow convenient access for maintenance. Panels shall be mounted in equipment rooms, not in offices or public access areas.

c. Power supply shall be dedicated circuit. Provide locking circuit breaker and label breaker “ATC Panel in Room No. xxx.”

d. Power control switching must be located inside the panel. A power switch shall never be mounted on the panel face.

e. Provide point-to-point wiring diagrams for control panels.

22. Building ATC Controller (ATCC)

a. The building’s Automatic Temperature Control Controller (ATCC) shall be housed in a panel of the appropriate enclosure to fit the requirements of Control systems. For standard applications, a NEMA 1 shall be used. For panels located in a moist atmosphere or near pumps or water service, provide NEMA 12 enclosures. Exterior shall be NEMA 4x.

b. The ATCC panel shall include the following features: The panel shall contain battery backup for CMOS RAM memory and the real time calendar clock. The battery shall have a minimum installed life of eight years. In the event of a power failure, the ATCC’s application database, stored data, and real time clock calendar shall be maintained for a minimum of six months.

c. The ATCC shall be a real time, multi-tasking processor, capable of executing many tasks simultaneously.

d. The ATCC shall contain the complete building operating system and operate as a stand-alone system. Failure of the central system computer or PC disconnect shall not affect the ATCC.

e. The ATCC shall continuously scan multiple ports for field data and continuously update a current list of field data in RAM. The operator is to be able to rapidly retrieve this information by using the Central PC or Central Computer.

f. The ATCC shall be capable of communicating over the Ethernet trunk, coaxial cable or modem to the Central Plant or HVAC shop control computers.

g. The ATCC shall be capable of receiving a new program or database from the Central PC or Central Computer.

h. A manual control menu shall be provided to allow the operator to start, stop, adjust values, set to local control, or release points to automatic mode.

i. The Network Trunk shall be installed into each controller location to provide access to the network at any point.

23. ATC Controller (ATCC) Software and Operation
a. The controller software shall be Microsoft Windows NT compatible to the current revision level.

b. Diagnostics: The system shall self-diagnose ATCC failure automatically without necessary query by the operator. In the event of communications failure or power failure, the system shall notify a local operator of the specific occurrence.

c. ATC Contractor in cooperation with the Facilities operations shall do programming of the systems.

24. Control Valves

a. Maximum rated shutoff pressure of the valve shall exceed the rated deadhead pressure of the pump that supplies it. Valve leakage rating shall be 0.01% of rated valve flow coefficient (Cv) for soft-seated valves and 0.05% for metal-to-metal seated valves.

b. It is recommended that CHW and HW control valves be selected having a Cv that will result in design flow pressure loss of 20% of total system ΔP, 50% of coil pressure drop, but not less than 10 feet (4.33 psi), whichever is greater. Cv shall be specified to match flow control range.

c. Turndown: For good control, particularly on AHU coils where close temperature control is required, valves having not less than a 100:1 turndown ratio shall be provided. On terminal unit reheat coils and duct mounted heating coils, the control manufacturer’s standard turndown ratio valves are acceptable.

d. Valve positioners shall be provided for control valves except that at terminal units and reheat coils, positioners are not required.

e. Use of three-way valves shall be for heating hot water system and be limited to location approved by the University. Use of a three-way valve in the Central Plant’s chilled water system is prohibited.

25. HTW control valves shall have the following characteristics:

a. The control valve shall be normally closed, failing to the closed position on loss of control air.

b. HTW control valve shall have remote control for opening and closing through the Campus automation system.

c. The control program shall ensure that the valve on initial opening shall take a minimum of one hour (adjustable) to go from closed to full open to keep from shocking the system.

I. Sequence of Operation

1. The sequence of operation shall be started during the design development phase of a project. Sequence shall state in layman’s terms the operation of the equipment. It shall include operating equipment and safety shutdowns whether provided as a part of this work or not. Sequence of operation shall be shown on the drawings. Sequence shall be specific in operation sequence and give initial starting parameter set points.

2. Circulating fans (except smoke control, lab fume hood exhaust, and supply air fans) shall cease to operate upon activation of the fire alarm system.

3. Typical Laboratory

a. Constant volume

1) Controls for constant volume application shall be two-position for volume control modes (occupied and unoccupied), and modulating for...
thermal control.

2) Each exhausted hood or group of snorkels shall have an exhaust valve capable of maintaining the flow rate (± 5 %) for both occupied and unoccupied modes.

3) Controls shall be DDC unless a portion of the system is pneumatic for VAV hood control and/or pneumatic terminal control has been evaluated as project cost beneficial.

4) Supply air terminal shall provide reheat (single duct, CV, reheat) or mix cold and hot air (dual duct) to maintain room temperature.

5) Air-change rate shall reduce to minimum when lab is unoccupied.

6) Laboratory pressure relation to corridor shall remain negative or positive as required by lab/type function in both the occupied and unoccupied modes.

b. Variable Air Volume

1) Controls for VAV hood application shall be DDC with a control panel for each lab.

2) Controls shall be fully modulated in response to hood sash position to maintain constant design airflow face velocity (± 5 %) for all sash positions. Speed of response to a change in sash position without causing an adverse effect on hood operator shall be not more than one second.

3) Supply air terminal shall modulate volume and/or reheat, if applicable, to maintain room temperature.

4) A modulating auxiliary room exhaust valve shall be connected to the lab control panel and shall operate in response to both changing variable supply and exhaust rates.

5) Air change rate shall reduce when lab or hood is unoccupied.

6) Laboratory pressure relation to corridor shall remain negative or positive as required by lab type/function over the entire modulation range.

1.37 TESTING, ADJUSTING AND BALANCING

A. Provide specific testing of piping and most ductwork. Final connections to existing piping and ductwork shall be tested under operating conditions and pressures. New piping shall be tested at higher pressures prior to making the final connection to existing piping.

B. Testing, adjusting and balancing (TAB) work shall be included in the Contract as a Sub-contractor to the General Contractor and not the HVAC Sub-contractor. The HVAC and Control Contractor shall fully cooperate with the TAB Contractor’s work.

C. Testing and balancing shall be performed in complete accordance with the latest of either:

1. AABC Testing and Balancing Heating, Ventilating and Air Conditioning Systems and AABC Test and Balance Procedures, or -

2. NEBB Testing, Adjusting, Balancing of Environmental Systems and NEBB Measurements and Assessment of Sound and Vibration, or -


D. If the project contains a BSL3 suite of rooms, it shall require extensive certification testing and commissioning. Those requirements include, but are not limited to, the following:

1. Verification
a. Suite envelope integrity
b. Equipment operation
c. Supporting system components and instrumentation
d. Sequential functioning of all dampers and valves

2. Electrical system
a. Tested under different conditions: Normal, Full load and Back-up power.
b. Outlet and circuit breaker labeling

3. Computer systems
a. Failure, backup and redundancy
b. Response to emergency events
c. Card key access, door interlocks

4. Temperature control
a. Data accuracy
b. Seven day stability monitoring
c. Under ±10°F challenge, 10 minute recovery

5. Leak testing
a. During construction - envelope integrity testing shall include floor flooding within suite.
b. Post construction - testing of envelope with fog testing and perimeter monitoring of penetrations, doors, and openings under normal condition, fan failure condition, and dynamic condition with door opening and closing.
c. filters, housing and external ducting

6. Differential pressure
a. Testing between each BL3 room and non-BL3 areas
b. Seven day stability testing
c. Filters: normal and full load conditions to establish fan and minimum pressure drop performance
d. Dynamic testing of all rooms, fluctuations <0.005 inch w.g.

7. Air balancing, distribution and air flow patterns
a. Supply and exhaust air flows measured and recorded
b. Design and actual air exchange rates compared
c. Airflow pattern distribution observed with fog or tracer gas and then disappearance from and containment within all rooms under: Normal Conditions, Supply Fan Off and Exhaust Fan Off.
d. Air exchange rates with fog or tracer gas under: Normal Conditions and Fan Failure Condition.
e. Biological safety cabinet certification: With ventilation on and Verification with exhaust fan off (failed condition).
f. Chemical hood Certification testing to comply with: ASHRAE 110, Aerosol (DOP) containment tests, and Face velocity flow sensor calibration.

8. Sterilizer
a. Steam control valve operation, b.
Sterilization operation,
c. Exhaust air
d. Door interlock operation.

9. Alarm and communication systems
   a. Alarms: local and remote for Evacuation, Warning, and Equipment
   b. Smoke detector and strobes
   c. Intercom and telephone
   d. Cardkey access

10. Noise levels:
    a. <45 dBA.
SECTION DIVISION 24

RESERVED FOR FUTURE
DIVISION 25 – INTEGRATED AUTOMATION

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SECTION DIVISION 25-INTEGRATED AUTOMATION

PART 1- GENERAL

1.1 SYSTEM ARCHITECTURE

A. All environmental, utility, and process controls should be directly controlled and monitored by Energy Management System (EMS) devices on the campus controls network. Where the only available unit digital controls are integral to equipment, BACnet over Ethernet is the preferred protocol for data connections. The controls contractor bears full responsibility for identifying, coordinating and resolving all communication and protocol issues necessary to create a functioning building controls network for this Project.

B. Where a partial mechanical system remodel leaves existing EMS devices in place which reside on the campus EMS network, the same manufacturer’s compatible controls should be provided, and the existing controls extended and/or integrated to create a seamless building control network with a single workstation and programming tools.

C. The controls contractor shall be responsible for installing and configuring all cabling, routers, and devices needed to create a standalone network capable of achieving the specified Sequence of Operation (SOO) without connection to UCR’s campus Ethernet.

D. UCR will provide a point of connection and assigned IP address(es) on the campus’ Ethernet network, to permit a supervisory node on the Project’s control system to be connected to any existing server(s) in other buildings, for purposes of client workstation license support, database backups, global data collection, or demand limiting strategies.

1.2 SYSTEM OPERATION

A. All EMS processor logic for terminal equipment control shall be resident in controller-level field hardware, except as needed for global strategies (such as scheduling) at the building supervisory controller level. Control of mechanical equipment cycles according to the SOO shall be accomplished via standalone logic at the application-specific controller level.

B. Critical sequences affecting life safety or equipment hazards (such as high static pressure shutdown, smoke alarm, quarantine, entrapment conditions etc.) shall be achieved with hard-wired interlocks with status reported to EMS. Supervisory-level programming may not be used for safety-related interlocks.

C. All fire/smoke isolation dampers in ventilation systems shall include open/closed position status dry contact switches wired to EMS and configured as alarmed points. Locations shall be depicted in as-built records and graphic displays.

D. Automatic command and control of equipment shall only be by means of hardwired output signals from standalone EMS controllers (via relay contacts or 0-10VDC analog). Data connections provided for non-critical equipment monitoring may not be used for programmed duty cycling of equipment.

PART 2 – PRODUCTS

2.0 PREFERRED MANUFACTURERS’ DEVICES
A. Energy Management System (EMS)
   i. Siemens Apogee
   ii. Johnson Controls Metasys
   iii. Alerton Envision

B. Laboratory Airflow Control System (LACS)
   i. Phoenix – Venturi valves
   ii. Siemens – Venturi valves

C. Electric Actuators for valve and damper controls
   i. Belimo characterized ball valves
   ii. Belimo damper actuators
   iii. DeltaP pressure independent control valves

D. Differential Pressure transmitters
   i. Alta Labs / Veris Industries PW or PX with LCD display

E. Differential Pressure switches
   i. Kele ADPS series

F. Lighting Controls
   i. Blue Ridge Technologies
   ii. Watt Stopper

G. Utility Energy Meters
   i. Shark 200S electric meter with wireless capability
   ii. Onicon Turbine type flowmeter with System 10 BTU Transmitter

H. Variable Frequency Drives
   i. Danfoss
   ii. Toshiba
   iii. ABB

2.1 INPUT DEVICE TYPES

A. Field-mounted Sensors
   i. Air plenum temperature sensors should be averaging type. Duct probes are
      only acceptable when installed in ductwork at least 5 diameters downstream
      of coils and plenum, where sufficient mixing of sampled air is assured.
   ii. Air handlers with economizer cycle shall include a mixed air temperature
       sensor.
   iii. Motor run status proved by analog line current probes is preferred over current-
        operated switches.
   iv. Main building supply/exhaust fans should include air flow measuring stations
       reporting to EMS, with local indication scaled in CFM.
   v. Air filter differential pressure shall be indicated by individual analog transmitters
       for primary and secondary banks.

B. Transmitter outputs should be 0-10VDC only. LCD display type should be provided.

C. Inputs used as reference for control per the SOO must be sensors wired to the input
   terminals of the dedicated EMS controller for that system. Gateway, BACnet or other input
   data may not be used as reference for process loops in EMS controllers. Shared OSA
temperature data for setback strategies is excepted when a single EMS sensor is provided for multiple HVAC systems.

D. EMS field I/O devices shall be selected to provide at least 25% spare capacity of each point type for future expansion. Zone terminal controllers are excepted.

2.2 OUTPUT DEVICE TYPES

A. Actuators
   i. Valve and damper actuators shall be electric, with manual override capability not requiring tools.
   ii. Steam and heating water control valves shall fail to the closed position upon loss of control power.

B. Automatic operating controls for all equipment shall be by means of hardwired output signals (dry contact or 0-10VDC analog) from the dedicated EMS controller output terminals for that system. Gateway, BACnet or other digital commands directly to integrated processors may not be used for control of equipment per the Sequence of Operation.

C. Local H-O-A operation shall be consistently provided, easily accessible, and clearly marked for all equipment operating controls including fan & pump motors, valves, actuators, and VFDs.

D. EMS field I/O devices shall be selected to provide at least 25% spare capacity of each point type for future expansion. Zone terminal controllers are excepted.

2.3 UTILITY METERS

A. Energy demand and consumption shall be transmitted continuously to EMS in the following units:
   i. Chilled Water demand in tons, and consumption in ton-hours.
   ii. Steam demand in pounds per hour, and consumption in pounds.
   iii. Electric demand in kW, and consumption in kWh.
   v. Steam Condensate Return volume in gallons.
   vi. Natural Gas consumption in cubic feet.

B. Local display of rate and consumption shall be provided on the meter face.

C. Chilled water temperature sensors shall be matched pairs with NIST certification wired directly to the BTU meter.

D. Provide remote mount display unit for all steam flow meters.

PART 3 – EXECUTION

3.0 GENERAL

A. Permanent equipment labels should be engraved phenolic labels screwed to machine frame (not removable covers) or other structural member. Do not use P-Touch tape or permanent marker for equipment labels.
B. All devices, controls, and accessories concealed in ceilings or remote locations shall be clearly labelled as per the device’s designation in as-built and O&M records, as well as in the EMS database.

C. Do not install conduit smaller than ¾” for EMS signal and communication wiring.

D. Conditioned air must be provided to pressurize control panels where ambient temperature or humidity conditions exceed the controller manufacturer’s specified limits for electronic components and panels cannot be relocated.

E. All EMS control panels with available 120V power supply should include a service receptacle.

F. Any splices made in new or existing field installations of low-voltage communication cable must be soldered.

G. Provide jacketed EMS communication cable imprinted with “ENERGY MANAGEMENT SYSTEM”. Lavender jacket color is preferred if not in conflict with other cables.

H. Central AHU operation shall be based on programmed zone occupancy schedules. Initial schedules shall be coordinated with Facilities Services Administration prior to Final Commissioning.

3.1 FIELD-MOUNTED DEVICES

A. Air differential (static) pressure sensors
   i. Install transmitters in EMS control panel at equipment, with an unbroken pair of sensing tubes extended out to the duct sensor. Do not install transmitters in remote locations.
   ii. Provide T ports at transmitter and at remote sensor for calibration.
   iii. Record exact sensor location in O&M manual, show location on the operator graphic floor plan and/or air riser display, and mark the ceiling location in the field.
   iv. Provide separate sensor and transmitter for each pre- and final filter bank.

B. Wet differential pressure sensors
   i. Provide calibration T ports.
   ii. Provide individual isolation valves for high and low ports.
   iii. Install with a union or other means of removing transmitter while system is under pressure.

C. Air temperature sensors
   i. Outside air sensor locations must be fully shaded, well-ventilated, and far away from any sources of heat or exhaust air.
   ii. Plenum sensors should be averaging type. Duct probes are only acceptable when installed at least 5 duct diameters downstream of coils or plenums.

D. Safety shutdown switches
   i. Freeze stats, high static switches and other safeties must not be concealed inside fan plenums. Mount devices outside of the AHU enclosure with the sensing element extended into the plenum. Clearly label switches.
   ii. Safety circuit wiring shall not be installed in series between field devices. Each safety device shall be wired to individual terminals on the control panel’s low voltage
termination board.

iii. Equipment safety lockouts shall be by means of dry contact closure. Discrete contacts or pilot relay shall be provided for EMS alarm input from each safety.

E. Actuators

i. Volume damper position and direction of rotation to open shall be indelibly marked at the damper actuator. Position should be marked by scoring a line parallel to the damper across the end of the damper jackshaft.

ii. Control valves must be accessible from a stepladder without reaching overhead. Actuator cover must be visible without use of a mirror.

iii. Outdoor actuators shall be installed with a drip-proof white or reflective UV-resistant weather cover regardless of actuator body rating.

3.2 TERMINAL CONTROLS

A. Controls for terminal equipment mounted in ceiling spaces shall be installed so that all devices are serviceable from a single ladder location, including controller, power supply, flow sensor, damper actuator, control valve, isolation valves, and sensors.

B. Airflow sensor tubes shall have capped test ports.

C. All control panels shall have minimum 24” unobstructed space in front.

D. VAV box manufacturer labels with flow curve must not be obstructed by installation, or labels will be replaced by installing contractor.

E. Each terminal controller shall have a power supply disconnect switch. Power source panel & circuit number or transformer location shall be marked at the control panel.

F. Room thermostat locations and terminal controllers shall each be permanently labelled with both the EMS zone ID and the zone tag number from the mechanical schedule.

G. Volume damper position and direction of rotation to open shall be indelibly marked at the damper actuator. Position should be marked by scoring a line across the end of the damper jackshaft, parallel with the damper blade.

H. Control valves must be accessible from a stepladder without reaching overhead. Actuator cover must be visible without use of a mirror.

I. Triple duty valves may not be used for valve package isolation. Provide separate isolation valves and union to permit removal of valve package under pressure.

J. Individual files with unique names matching the EMS device ID numbers shall be created, downloaded, and backed up for each terminal control device. Generic configuration files downloaded to multiple devices are not acceptable.

K. Zone set point default values:

   i. Occupied cooling 72, heating 68
   ii. Unoccupied cooling 80, heating 60
   iii. Maximum heating set point 72
   iv. Minimum cooling set point 70
   v. Unoccupied minimum airflow: 50 CFM
   vi. After-hours Request period: 4 hours for authorized zones only
3.3 EQUIPMENT CONTROL PANELS

A. Each panel shall be permanently labelled with the controller’s EMS ID, a description of the server system or area, and the source power panel & circuit number.

B. Each panel with 120V supply shall include a service receptacle and circuit breaker or fused disconnect switch with package of spare fuses. The source power panel & circuit number shall be marked.

C. Field wiring shall terminate on a low-voltage terminal board inside the panel. Controller wiring to the terminal board shall be free of any splices, and shall be neatly sized for length and secured without the use of zip ties, to permit wire tracing by pulling on conductors.

D. Each control panel shall be posted with a copy of the as-built process diagram, wiring diagram, and Sequence of Operation for the server system.

3.4 VARIABLE FREQUENCY DRIVES

A. VFDs for critical fan or pump processes serving research or ensuring life safety should be provided with 3-contactor bypass controls to permit uninterrupted motor operation independently of all VFD electronics.

B. VFD enclosures must be pressurized with conditioned air where ambient conditions exceed the manufacturer’s limits for temperature or humidity.

C. Keypad displays must be accessible without defeating the VFD enclosures disconnect switch door interlock.

D. Initial programming parameter list shall be provided at the time of startup, and a copy of the list shall be left in the VFD enclosure.

3.5 UTILITY METERS

A. Steam meters shall be installed with remote mount display unit.

B. Initial programming parameter list and calibration certificate shall be provided with each utility meter.

C. Metered electric service input point descriptors in the EMS database shall name the specific panel & circuit measured, as listed on the Electrical drawings and/or as labeled on the distribution panel.

D. Flowmeter turbines shall be installed with isolation valves to permit hot removal.

3.6 FIRE/LIFE SAFETY

A. All automatically operated fire/smoke isolation dampers shall include open/closed proving switches reporting to EMS.

B. Equipment shutdown for smoke alarm shall be accomplished by dry contact opening in a fire system device and interrupting a magnetic starter or VFD low voltage circuit. Status shall be reported to EMS using auxiliary contacts.
C. Supply/exhaust fan interlocks shall be achieved by means of hardwired control of motor controls with status reported to EMS, where fan failure can result in potential entrapment or loss of air exchange rates in critical zones. Life safety sequences must not rely on controller logic for failure modes.

PART 4 – DOCUMENTATION

4.0 GENERAL

A. EMS Submittals to include:
   i. Network Architecture Diagram
   ii. Physical Point Matrix
   iii. Control Diagrams with Sequences of Operation
   iv. Hardware cut sheets with proposed complete mfg. part numbers indicated
   v. Graphic display samples and proposed list of screens

B. EMS As-Built Records to include:
   i. Network Architecture Diagram with LAN device wiring order listed or depicted
   ii. Control Diagrams
   iii. Wiring Diagrams
   iv. As-programmed Sequence narratives referring to specific Point names, authored by the EMS contractor
   v. Factory technical manuals for all devices, marked with EMS device name(s)
   vi. System operation instructions specific to project, authored by EMS contractor (shutdown, startup, maintenance, graphics, schedules, alarm response)
   vii. A comprehensive Zone Schedule indicating Sequence of Operation by zone type
   viii. A list of programmed zone & equipment schedules referring to Point names
   ix. Air and hydronic riser diagrams showing major motive equipment and general distribution by floor or area

SUBMITTALS

A. A comprehensive air terminal Zone Schedule should be provided in the mechanical plans, with unique ID tag for each terminal. The terminal tags should include designation of air handler system and floor (e.g. VAV01-AH1-FL1). Each terminal listing should refer to the specific Sequence of Operation for that zone.

B. A comprehensive Point Matrix should tabulate all physical EMS points by type (BI, BO, AI, AO) and should describe hardware (ex. averaging sensor, current probe, indicating transmitter, spring return & fail position, gateway data, hardwired safety interlock etc.)

4.2 AS-BUILT RECORDS

A. EMS Control Diagrams should include as-programmed Sequence of Operation in English narrative written by the programmer, not a copy of the EOR’s description of intent. Physical points as listed in the Point Matrix should be specifically referenced.

B. A Control Panel Schedule should list all EMS field panels with a description or summary of installed components and physical location of each panel. Control power transformers shall be listed with power ratings. All panels and transformers shall be assigned unique ID numbers, and shall be field-labelled accordingly.

C. Controller configuration files, server backup and supervisory programming code shall be copied to an archive on removable media. Individual files with unique names matching
the EMS device ID numbers shall be created, downloaded, and backed up for each terminal control device.

D. Generic configuration files downloaded to multiple devices are not acceptable. File names shall match device names in EMS database.

E. TAB report zone names should reference EMS Zones. Editable EMS Zone Descriptors should incorporate room numbers and Mechanical Schedule zone tags.

4.3 GRAPHIC DISPLAYS

A. Floor Zone layouts shall include these features:
   a. Location of each room sensor
   b. Room temperatures with reference to active set points
   c. Supply AHU indicated for each zone by color coding (AHU1 blue, AHU2 red etc.)
   d. All rooms served by each zone indicated by shading (Zone 1 dark blue, Zone 2 light blue etc.)
   e. Every room number shown
   f. Link to each zone’s details
   g. AHU supply air conditions and links to details
   h. Key map of location in building footprint

B. Supply/exhaust tracking VAV pairs shall be shown on a single display page even when served by separate controllers.

C. Air and hydronic riser diagrams shall be provided, showing status of major motive equipment and air/water conditions.

D. Main building display shall contain a hyperlink to O&M Manual PDFs.

4.4 OPERATOR IN-SERVICE TRAINING

E. A copy of the EMS Controls Diagrams and Operation & Maintenance Manual shall be provided to the Operators for review prior to scheduled training.

F. A training syllabus shall be submitted for approval prior to scheduling any training.

G. Training sessions shall not exceed four hours in length on any single day.
SECTION DIVISION 26-ELECTRICAL

1.1 CAMPUS ELECTRICAL OVERVIEW

A. New utilities and extensions shall be coordinated with and be consistent with the University’s Campus master plans. Additions to 12kV system shall be approved after completion of load studies, coordination studies and short circuit studies to determine impact on the existing system configuration.

B. Electrical service requirements for a building must be determined while the project is in the preliminary or early design development phase. This includes establishing dual or single feed requirements, the tie-in points and location of service equipment and the magnitude of new power requirements. Where the design is to utilize an existing building service, establish the net increase in electrical power requirements to evaluate whether the existing service capacity can accommodate existing and new loads. The University will perform demand load surveys on affected portions of the existing system when requested.

C. The location of the main switchgear and the low-voltage distribution system shall take into account voltage drop and material cost. To achieve a high efficiency power delivery design, the power supply point shall be as close as possible to the center of the building electrical load. That will keep feeder lengths short and achieve a minimum voltage drop without resorting to increased copper conductor sizes. The cost for locating the power supply point near the center of building load shall be compared with the cost for any alternate location.

D. Medium Voltage Distribution System:

1. Electrical service is taken from Riverside Public Utility Distribution System at 69kV and transformed to 12kV. With the exception of a few areas served by RPU, most of the campus is served by University’s own 4160 V and 12kV system. The system voltage is a nominal 12,000 volts, three-wire and solidly grounded. No single-phase connections are permitted. Campus distribution is underground via conduit duct banks identified with red concrete, red chalk, or similarly identifiable red colorings, manholes, and tunnel utility systems. New systems will be routed underground. Overhead distribution is prohibited. Duct banks shall be identified with red concrete, red chalk or similarly identifiable red coloring, and shall be routed with burial depths to be coordinated with existing utilities.

2. The University has standardized on 500 thousand circular mils (KCM) as the preferred size for the 12 kV cable. The load carrying capability of 500 KCM is much higher, at 12 kV, than is needed for most of the building loads on campus. The 500 KCM size has been chosen as a standard size to simplify fault calculations and to reduce the amount of stock cable for replacement purposes. The large size allows for future expansion without replacing feeders. Building feeders shall have the following minimum conductor sizes:

<table>
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<tr>
<th>CIRCUIT RATING</th>
<th>MINIMUM CONDUCTOR SIZE AND TYPE</th>
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</thead>
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<tr>
<td>12kV 200A Feeders</td>
<td>No. 4/0 Copper</td>
</tr>
<tr>
<td>12kV 400A Feeders</td>
<td>500 kcmil Copper</td>
</tr>
<tr>
<td>Loop conductors</td>
<td>500 kcmil copper</td>
</tr>
</tbody>
</table>

3. Above grade distribution equipment includes metal-clad switchgear, pad mount transformers, SF6 sectionalizing switches, air-break pad mount switches, and air break load interrupter switches at unit substations. Below grade and tunnel equipment is subject to being submersed and shall be designed accordingly.
4. New building loads shall be supplied from the 12kV system when the load exceeds 150kVA. Generally, two new SF6 sectionalizing switches with a minimum of six switched ways are required for new connections to the 12kV system. Connections to the existing circuits may be provided from existing spare 12kV SF6 sectionalizing switches, each fed from a separate circuit where available. Where G&W type RA oil switches exist at the point of connection, they shall be replaced with new SF6 switches having a minimum of two spare ways available after new switch installation. Dual selective radial feeders shall always be provided under one of the following conditions:

   a. For new major building loads and research or state facilities.
   b. For new 12kV feeder extensions from the “ring” loops.
   c. For continuation of existing dual connections of the existing loop circuits.

5. Connections to the existing loop shall be provided from the existing vaults in the campus ring tunnel where possible. The University’s representative will determine availability of existing switch positions and need for new SF6 sectionalizing switches.

6. Single radial feeders may be provided under one of the following conditions:

   a. Residential buildings.
   b. Temporary facilities.
   c. Special buildings as directed by the University.

E. Where the project design only allows for one 12kV circuit initially installed to a building, provisions shall be made for the future installation of the second sectionalizing switch and second feeder providing a dual selective system. An existing single radial feeder may also be extended to a new building but provisions shall be made for a second feeder and circuit extension. Building 12kV to 480V transformers shall have dual primary switches for dual feed.

F. Minimum conduit size for 12 kV shall be 5" diameter. Provide at least one spare 5" conduit for the service to a building. Conduits extending the campus loop service shall include a minimum of two spare 5" conduits.

G. Where motor loads exceed 250 HP, provide 4160V rated equipment and service. Motor starters shall limit inrush currents and have vacuum-type switching devices. 4160V is appropriate for Central Plant and other installations with similar load conditions. Variable frequency drives (VFD) may be required to limit inrush, voltage dip and control power factor. The use of VFD’s shall be considered and associated project costs identified and presented to the University for approval prior to selection.

H. Service from Riverside Public Utility

   1. Riverside Public Utility (RPU) provides 12 kV underground primary service to some areas of the campus. This service is intended to supply selected individual buildings with individual metered service, independent of the main Campus 12kV system. RPU will provide transformers and meters. This type of service is a special circumstance, and shall be reviewed with the University on an individual basis for the following types of projects:

      a. Faculty residences. Each apartment with individual RPU meter and house meter panel(s) for site lighting and general power requirements.
      b. Temporary structures where connection to the Campus 12kV system is not economically feasible.
      c. Privately funded and operated facilities located on Campus property.
      d. Special buildings as directed by the University.
2. RPU requires five-foot easement on each side of underground service. Any digging near SCE lines requires notification to the power company.

3. The Campus 12kV Distribution System shall be the first choice for electrical service.

I. Low Voltage Systems

1. Power

   a. Electrical system within the buildings shall be three-phase 480Y/277V, solidly grounded and can be provided by 12KV to 480Y/277V transformation. Liquid filled transformers shall be provided at each building with either an outdoor pad mounted or indoor unit substation. Transformation from 480V to 208Y/120V or other voltage will be accomplished in electrical rooms with dry-type transformers. Provide separate transformers for each building’s service.

   b. The University requires separate dedicated feeders for panelboards. A tapped feeder serving more than one panelboard is not acceptable. Provide a dedicated feeder breaker and feeder for each panelboard.

   c. New construction or additions to facilities may be connected to existing secondary distribution systems where the electrical system has adequate spare capacity. Calculate that voltage levels for existing and new loads will be acceptable (not more than 5% drop from nominal) after connection of new load.

   d. Main electric rooms shall be sized large enough to accommodate switchboards, panelboards, transformers, MCC’s and FACP, EMS, or other system cabinets. At least one of the entrances to the main electrical room shall be two 3'-0" doors for an opening size of 6'-0".

   e. Provide one electrical room on each floor of a building and locate electrical rooms in vertical alignment. Feeders to panelboards on the same floor shall not exceed 250 feet. Where feeders exceed 250 feet provide an additional electric room. Provide an outdoor motor control center if needed on roof where mechanical equipment is located on roof.

   f. Conductors shall be selected to provide a quality installation. The choice of conductor size and construction shall be made incorporating factors that affect power delivery, reliability and quality. Conductor ratings shall be based on the highest ambient temperature encountered and derating as required by NEC for the number of conductors in a raceway. Where underground duct banks (red concrete, red chalk or similarly identifiable red coloring) are utilized, duct bank heating and cable-derating requirements shall be determined. Determine the voltage drop is within allowable limits or increase wire size accordingly. Voltage drop shall not exceed 2 percent for feeders and 3 percent for branch circuits. Circuit harmonic content may require oversizing neutral conductors or additional measures, except where standards require installation of 200% neutrals.

2. System Voltages

The preferred voltages for supply of power to motors, lighting, and general loads shall be as follows:

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Voltage</th>
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<tr>
<td>Motors ½ HP and larger</td>
<td>480 volts, 3 phase</td>
</tr>
<tr>
<td>Motors smaller than ½ HP</td>
<td>120 volts, 1 phase</td>
</tr>
<tr>
<td>Lighting, interior fluorescent and HID</td>
<td>277 volts, 1 phase</td>
</tr>
<tr>
<td>Lighting, exterior (attached to building)</td>
<td>480/277 volts, 1 phase</td>
</tr>
<tr>
<td>Lighting parking lot, street and pathways</td>
<td>480 volts, 1 phase</td>
</tr>
<tr>
<td>Convenience receptacles</td>
<td>120 volts, 1 phase</td>
</tr>
</tbody>
</table>
J. Lighting

1. Systems included in lighting category include street lighting, parking area lighting, parking structure lighting, grounds lighting, building lighting, emergency lighting, sports lighting, and the controls associated with each. Lighting levels shall be based on task and location. Lighting controls shall be provided which are capable of interfacing with a building Energy Management System (EMS).

2. Lighting circuits shall be loaded to maximum of 15 amps.

3. Occupancy sensors are to be provided to save energy. That shall include bathrooms, offices, lecture halls, enclosed stairwells and classrooms. Provide automatic daylighting control override of occupancy sensors in rooms that have windows. Occupancy sensors are not to be used in spaces handling chemicals or hazardous materials such as laboratories.

4. Dual switches shall be wired to control inboard/outboard lamps in fixtures and not alternate fixtures unless the fixtures have two lamps or less.

5. Provide automatic dimming with a photocell of lobbies, atrium, and other spaces that have daylighting, but is not otherwise controlled to save energy.

6. In enclosed stairwells with adequate daylighting for emergency egress, provide photocell in the stairwell to control the lighting.

7. Each exterior stairwell shall have the lighting controlled by a respective photocell.

8. Lighting fixtures that are 45 feet above finished floor cannot be relamped by present University equipment. Provide alternate means of relamping fixtures by either lowering fixtures, catwalks, or other approved method.

K. Emergency Power

1. IEEE Standard 446 shall be used as the basis for Emergency System design. Emergency generators shall be provided at buildings identified in this Standard or the Detailed Project Program (DPP) or as directed by the University.

2. Where emergency power is only required for emergency lighting and exit signs, LED exit signs and LED emergency lighting fixtures with battery packs and chargers shall be provided in lieu of a generator.

3. Where emergency power is required for special items not including lighting, an uninterruptible power supply (inverter system) shall be provided. Central inverter back-up systems will be evaluated on a case-by-case basis. Central A.C. inverter battery units shall provide 60 Hz AC power output and automatic battery charging. Units shall have output load and voltmeters, line and load status lights, charge light and disarrangement alarm signal.

L. Power

1. Outlets shall be provided as required to serve both normal and emergency loads.

2. Electrical and data to laboratory modules and benches and equipment or support rooms shall be distributed in an “isoduct” system.
3. The basis for providing outlets and their circuiting requirements for 120 volt branch circuits shall be as follows unless otherwise directed by the University:
   a. Convenience outlets, which per NEC are calculated at 180 W each – maximum eight (8) per circuit, except at lab benches or otherwise noted.
   b. Outlets at lab benches in “Isoduct” shall be 6 per circuit maximum (calculate at 250 W each). If “Isoduct” requires two circuits, stagger circuits per outlets.
   c. Outlets at equipment corridors or dry and wet support rooms in “Isoduct” – maximum of four (4) per circuit (calculated at 400 W each). If “Isoduct” requires two circuits, stagger circuits per outlets.
   d. Single person staff offices - dedicated circuit for convenience outlets. Provide a minimum of five outlets. (Calculate at one outlet for 800 watt printer and others at 180 watts each.)
   e. Printer outlets – maximum one (1) per circuit (calculated at minimum 800 W each). Provide one outlet per 500 square feet of administrative area per floor.
   f. Copy machine outlet – maximum one (1) per circuit (calculated at minimum 1500 W each). Provide one outlet per 2,000 square feet of administrative area per floor.
   g. Electric water coolers if provided– maximum one (1) per circuit (calculated at minimum 900 W each, unless confirmed otherwise by actual equipment).
   h. Biosafety cabinets – one (1) per circuit. Fume Hoods – one (1) per circuit.
   i. Refrigerators/freezers – one (1) per circuit. Film processors – one (1) per circuit.
   j. Outlets in Storage/Utility Areas shall be on dedicated circuits, separate from other circuits.
   k. Other lab or specific equipment – one (1) per circuit.

4. Provide disconnect switch within 10 feet of every motor.

1.2 DESIGN CRITERIA AND ANALYSIS

A. Submit a complete design analysis report for review with every submittal. Analysis shall list design criteria, assumptions, calculations and equipment selections. Provide as back-up data manufacturer’s catalog data showing equipment dimensions, weights, capacities, electrical requirements, and maintenance and operating clearance dimensions.

B. The project program or design analysis shall document any specific exception and compliance to the criteria herein. Generalized exceptions are not acceptable.

C. Design parameters and sizing criteria shall be as follows unless otherwise directed in the project program and Request for Proposal (RFP):

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Sizing</th>
<th>Spares</th>
<th>Spaces</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting panelboard</td>
<td>Demand load plus spares Min. 100</td>
<td>None except if surge shell space provide</td>
<td>Min. 3</td>
<td>1 per floor w/ horizontal wiring</td>
</tr>
<tr>
<td>Lab Power Panelboards</td>
<td>Min: 150 amp panel with 42 poles</td>
<td>Min. 6 - 20 amp CBs</td>
<td>2 - 30 amp spaces</td>
<td>w/ horizontal wiring Conduit sized for 225</td>
</tr>
<tr>
<td>Office Power Panelboards</td>
<td>Demand load plus spares</td>
<td>Min. 3 – 20 amp CBs</td>
<td>Min. 3</td>
<td>w/ horizontal wiring.</td>
</tr>
<tr>
<td>Switchboards</td>
<td>Demand load</td>
<td>None</td>
<td>*</td>
<td>*W/provision for future expansion</td>
</tr>
<tr>
<td>Distribution boards</td>
<td>Demand load plus space</td>
<td>None</td>
<td>20-30% additional</td>
<td></td>
</tr>
<tr>
<td>Motor Control Center</td>
<td>Demand load</td>
<td>*</td>
<td>*</td>
<td>*W/ provision for future expansion</td>
</tr>
<tr>
<td>Unit Substation</td>
<td>Demand Load</td>
<td>None</td>
<td>W/provision for future expansion</td>
<td></td>
</tr>
</tbody>
</table>
### EP Lighting Panelboard

<table>
<thead>
<tr>
<th>EP lighting panelboard</th>
<th>Demand load plus spaces</th>
<th>None</th>
<th>Min. 3</th>
<th>1 per floor</th>
</tr>
</thead>
</table>

### EP Power Panelboard

<table>
<thead>
<tr>
<th>EP Power panelboard</th>
<th>150 amp with 42 poles</th>
<th>Min. 3 – 20 amp CBs</th>
<th>Min. 3</th>
<th>1 per floor</th>
</tr>
</thead>
</table>

### Generator

<table>
<thead>
<tr>
<th>Generator</th>
<th>100% load</th>
<th>Per University</th>
</tr>
</thead>
</table>

### Transformers

<table>
<thead>
<tr>
<th>Transformers</th>
<th>Demand load</th>
<th>Interior only</th>
</tr>
</thead>
</table>

### Exterior 12 kV Transformers

<table>
<thead>
<tr>
<th>Exterior 12 kV Transformers</th>
<th>Per University direction</th>
<th>Size will be 60% of total demand load or smaller.</th>
</tr>
</thead>
</table>

### Main Electric Room

<table>
<thead>
<tr>
<th>Main electric room</th>
<th>Per University direction</th>
<th>20-30% wall space for future</th>
</tr>
</thead>
</table>

### SF6 Switches

<table>
<thead>
<tr>
<th>SF6 switches</th>
<th>Per University direction</th>
<th>Project specific</th>
</tr>
</thead>
</table>

Note: Demand load shall be in accordance with the California Electric Code.

### D. The design analysis shall include:

1. Lighting calculations showing required and designed foot-candles. Include lighting fixture manufacturer’s catalog data.

2. A projection/summation of the panelboard loads to justify the sizing of the network transformers.

3. Site lighting photometric analysis.


### E. Voltage Drop Report

1. Size feeder conductors to limit voltage drop to two percent. Size branch circuit conductors for a voltage drop of not more than three percent. Provide voltage drop calculations of longest circuits for each wire size under maximum load conditions to demonstrate proper circuit sizing.

### F. Phase Balance Report

1. Proper balancing of single-phase loads among the three phases on branch circuits and feeders is necessary to keep the load unbalance and the corresponding phase voltage unbalance within reasonable limits. An unbalance will affect three-phase motors and sensitive electronic equipment and shall not exceed 2 percent. Single-phase loads shall not be connected to three-phase circuits that are supplying equipment that would be sensitive to phase voltage unbalance. Motors and lights shall not be on the same circuit or panelboard.

### G. Power-Factor Correction Report

1. Power-factor correction shall be required at individual inductive loads with PF less than 85 percent. Correction to 90% is required.

2. Power-factor correction shall be required at building service entrance equipment where PF is less than 90 percent under every loading condition.

### H. Power System Report

1. General

   a. Short Circuit, Protective Device Evaluation, and Protective Device
Coordination Studies shall be performed. Submit studies prior to final acceptance of distribution equipment Shop Drawings and prior to release of equipment for manufacture. If formal completion of studies may cause delay in equipment manufacture, acceptance from the University’s Representative may be obtained for preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics will be satisfactory. Provide for both normal and emergency systems.

b. Report shall include portions of electrical distribution system from primary of service transformers down to and including 480V and 208V distribution system. Normal system connections and those that result in maximum fault condition shall be adequately covered in the study.

c. Perform studies in accordance with ANSI C37, ANSI C57, and IEEE Standards 320, 141, 242 and 399.

2. Short Circuit Report

a. Perform study with the aid of a digital computer program, such as OTI’s ETAP or SKM’s DAPPER.

b. Include data on power source’s short circuit contribution, resistance and reactance components of branch impedance, X/R ratios, base quantities selected and other source impedance.

c. Calculate short circuit momentary duty values and interrupting duty values on the basis of three-phase bolted short circuits at each switchgear bus, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, list the total duty on the bus, as well as the individual contribution from each connected branch, with its respective X/R ratio.

d. Perform protective device evaluation study to determine adequacy of circuit breakers, molded case switches, automatic transfer switches and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards.

e. Include recommended settings for system ground fault devices. The settings shall provide coordination so that down stream feeder devices will trip before up stream devices.

3. Coordination Study

a. Perform study with the aid of digital computer program, such as SKM’s Captor or equal.

b. Include system protective devices from utility company devices feeding the building down to distribution panelboard branch breakers.

c. Plot device curves on log-log paper, grouping appropriate devices together.

d. Study shall show selective coordination so that the device closest to the fault will trip before any other device trips. Recommend settings of devices to achieve this coordination.

I. Report Contents

1. Summarize results of system study in a final report. Submit five bound copies of final report.

2. Include the following sections in the report:

a. Description, purpose, basis and scope of study and single line diagram of that portion of power system which is included within scope of study.
b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same.

c. Protective device time versus current coordination curves, tabulations or relay and circuit breaker trip settings, fuse selection and commentary regarding same.

d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

e. Other sections as appropriate.

f. Protective Device Testing, Calibration and Adjustment: Equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate and adjust the protective relays and circuit breaker trip devices as recommended in the power system study.

J. Each luminaire type utilized shall be included on a lighting fixture schedule on the drawings with a brief description, manufacturer’s catalog numbers, mounting type, total wattage, and lamp type and quantity. Provide details for special mounting or installation conditions, pole types and bases, etc.

K. Drawings shall symbolize each lighting fixture location, lighting fixture controls, associated branch circuit conduit, outlet boxes and wires, on the electrical lighting floor plans. Lighting fixtures shall be identified on the electrical lighting plans as to type and total wattage and cross-reference to the light fixture schedule.

L. The electrical power distribution system shall be defined by an electrical single-line drawing showing significant electrical equipment, available fault currents at each equipment location, equipment ratings, identification numbers, circuit protection ratings, feeder conduit and wire sizes, lengths and voltage drops. A load summary shall be provided for each switchboard, panelboard, and MCC.

M. Where a project requires a lighting system controls, the lighting control system shall be defined by a (riser) diagram showing each control component, short description, identification numbers, location (zone), fixtures controlled and the interconnection of major components, conduit and wire sizes.

N. Where the project calls for telecommunications, public address/sound system or a security system, each shall be defined by a (riser) diagram showing major components, short description, identification numbers and the interconnection of major components, conduit and wire sizes.

O. Where it is necessary to prepare or modify a fire detection and notification system, it shall be defined by a (riser) diagram showing each device, including device and circuit identification, flasher candela, and relative location of each device among devices and within the building envelope. The diagram shall establish the building zone locations for each device. Voltage drop calculations shall appear on the plans and noted as an estimated value to establish maximum circuit lengths for devices.

P. Branch circuit panel schedules shall be provided for each panelboard. Schedule shall show each phase, circuit number, breaker size, and connected circuit load in volt-amps, type of load (i.e., lighting, receptacle, etc.), main circuit breaker or main lugs only, surface or recessed mounting, and top feed or bottom feed. Show summary calculations for panel at bottom of each panel schedule. Equipment AIC rating requirements shall be placed in appropriate schedules on the drawings.

1.3 TESTING REQUIREMENTS

A. Documents shall require specific testing of electrical equipment and material. Refer to
Division 1 for additional commissioning test specification standard references. Testing shall be required before and after power is energized to assure proper operation.

B. Acceptance testing shall be performed in accordance with NETA Acceptance Test Specification (ATS), latest revision, and will include applicable sections for electrical equipment installed. Tests are required to be performed by an approved third-party testing laboratory or shall be made by a lab acceptable to the University. NETA membership or A2LA accreditation is minimum selection criteria for laboratory competency.

C. Systems testing requirements shall be included in the project scope of work. The work shall proceed under the direction of the Design Team and require prior notification and witness by the University’s Inspectors and documented in a final report.

1.4 GROUNDING AND BONDING

A. Grounding system requirements shall be defined by a diagram showing system ground method(s), earth connection methods (grounding electrodes), and bonding methods. The diagram shall include requirements for grounding electrodes, grounding electrode conductors, equipment-grounding conductors, and associated equipment and material connections. The grounding diagram shall specifically illustrate duct banks (red concrete, red chalk or similarly identifiable red coloring), manhole (or vault), power transformer, switchgear (or switchboard), distribution panels, unit transformers, ground bus connection requirements and bonding of non-current and current-carrying metal parts as well as specialized requirements for sensitive electronic equipment and loads.

B. Electrical systems are to be solidly grounded unless specifically approved by the University. 12kV and 480V distribution systems shall include a counterpoise grounding electrode, as well as interconnecting ground conductors to tie all grounding systems together. Cable shields shall be utilized for grounding conductors. Ground systems shall be established at buildings with the interconnection of cold water metal pipe, building steel, Ufer, driven rods or plates, ground rings, and coils.

C. In Research, Science, Engineering, Computer and other high tech Buildings, outlets for laboratory equipment, computers, telecommunications and signaling systems, and other sensitive equipment shall have dedicated ground conductors installed from the source transformers to the load. Ground conductors shall be distinctly marked.

D. Campus electrical distribution system grounding shall be in accordance with the requirements of IEEE Standards and Recommendations, Manufactures Requirements, NEC Article 250, and the requirements of this section. The measures taken shall ensure that a good connection to earth is established and extended to all electrical equipment and non-current carrying metal parts associated with the electrical equipment. Sectionalizing switchgear, transformers, vaults, manholes and duct banks (red concrete, red chalk or similarly identifiable red colorings) shall have grounding systems that match their maximum rating and exceed the minimum requirements of the Code and manufactures recommendations.

E. Specific design practices are described for each substation, sectionalizing switch, transformer, vault and manhole. The earth connection at each of those sites shall be interconnected with the duct banks with red concrete, red chalk or similarly identifiable red coloring system grounding conductors.

F. Grounding

1. Grounding ring conductors shall be #4/0 AWG copper and equipment connections shall be #2 AWG copper.
2. Grounding conductors shall be sized so that fault currents likely to be imposed on them will not damage them. Good grounding for the extensive UCR campus distribution system requires that equipment and hardware are properly bonded and the paths of all circuits are accompanied by a low resistance ground path to ensure protective relaying and other devices function properly.

3. Regardless of the ohmic value of the electrode system, it shall include metal underground domestic water pipe (where regular access is available and a 25 length is in contact with earth), ground ring and made electrodes (ground rods.) High temperature and chilled water piping systems shall not be used as grounding electrodes.

4. Each duct banks with red concrete, red chalk or similarly identifiable red coloring run shall contain a bare copper grounding conductor cast in the concrete. The ground conductors shall be located in the top row of the duct banks with red concrete, red chalk or similarly identifiable red coloring. A minimum of 3-inch concrete cover shall be provided.

5. Provide a ground bus at each Service Distribution Panel for the joining of ground connections, and to provide an accessible grounding system test location. The following ground connections shall be required at each ground bus:
   a. Grounding electrode conductor
   b. The metal enclosure of the associated Distribution Panel
   c. The metal tank of the associated Transformer
   d. Other equipment ground conductors

6. Feeder and branch circuits shall include a copper equipment grounding conductor run in the same raceway with the current carrying conductors. Metallic conduit and raceways shall not be used alone as an equipment grounding conductor.

7. The grounded neutral of each separately derived system shall be bonded to ground at the transformer only. Ground shall be established by connection to building system structural steel or other grounding electrode. Where service equipment is provided, the neutral may also be bonded to the grounding electrode conductor as permitted by the NEC.

8. The main switchboard shall have a copper ground bus where grounding electrode conductors are connected. The ground bus shall also serve as connection point for equipment grounding conductors, one for each feeder or branch served by the switchboard.

9. A 3” x 4” x ¼” copper ground bus shall be installed in electrical rooms. All equipment shall be bonded to the ground bus in addition to NEC required grounds.

10. Electrical equipment enclosures shall be bonded to ground by mounting and bonding the enclosure to a grounded steel frame or by proper bonding of a grounding electrode conductor to the enclosure. Metallic piping systems in the building, except natural gas lines, shall be bonded to grounding system.

11. Additional grounding measures shall be provided where specific systems require supplemental grounding to ensure performance.

12. Provide bonding to ground for elevator jack plunger.
1.5 ELECTRICAL IDENTIFICATION

A. Electrical distribution system equipment, conduit and wire shall have identification. Equipment number or plan identification shall be unique to the building; e.g., “LP-11” shall not be used in an addition if the building already has an “LP-11”. Labels shall be based on the University Electrical Equipment Numbering and Identification Scheme included in this Section.

B. Medium Voltage Identification

1. All new high voltage equipment, transformers, switches and vaults are to be assigned numbers. A proposed Hi-voltage connection drawing must be issued to the university electric shop for the numbers to be issued.

2. The numbering scheme provided by the University accomplishes the following:

   a. Establishes a unique identifier for all system components and eliminates possible duplication.

   b. Identifies equipment by type as listed in the following table:

<table>
<thead>
<tr>
<th>MARK OR TAG</th>
<th>DESCRIPTION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>12kV Distribution Circuit</td>
<td>UC-1</td>
</tr>
<tr>
<td>FI</td>
<td>Fault Interrupter</td>
<td>FI-01</td>
</tr>
<tr>
<td>MH</td>
<td>Manhole</td>
<td>MH-102</td>
</tr>
<tr>
<td>OFC</td>
<td>Oil Filled Cutout</td>
<td>OFC-01</td>
</tr>
<tr>
<td>OS</td>
<td>Oil Switch</td>
<td>OS-01</td>
</tr>
<tr>
<td>PMH</td>
<td>Pad-Mounted Housing</td>
<td>PMH-01</td>
</tr>
<tr>
<td>PMS</td>
<td>Pad-Mounted Switch</td>
<td>PMS-02</td>
</tr>
<tr>
<td>SF6</td>
<td>Sulfur Hexaflouride Gas Switch</td>
<td>SF6-01</td>
</tr>
<tr>
<td>T</td>
<td>Transformer</td>
<td>T-001</td>
</tr>
</tbody>
</table>

   c. Use the substation name abbreviation for 12kV circuit breaker identification such as UC, CP1, CP2, ES for University Substation, Central Plant 1, Central Plant 2, East Substation.

   d. Allows for the addition of new devices by type in an ordered manner.

   e. Facilitates the creation of computer database to keep records on equipment.

   f. Reduces confusion when referring to a piece of equipment and enhances communication.

3. The 12kV circuit breakers located at the substation and distribution substations will be unchanged. Existing device numbers shall be reused when replacing equipment. Consult with the University on device number assignment before labeling equipment. The University is continually adding device numbers so tracking and controlled assignment is required.

4. New and future equipment shall be assigned a number during the design phase of a project to minimize the need for new nameplates after construction.
C. Low Voltage Identification

1. The following low voltage equipment numbering scheme shall be followed:

2. **TYPE** | **DESCRIPTION**
---|---
DP | 208/120V Distribution Panelboard
LP | 208/120V Panelboard - Receptacles & Lighting
HDP | 480/277V Distribution Panelboard
HLP | 480/277V Panelboard - Lighting
ATS | Automatic Transfer Switch
CB | Circuit Breaker
DS | Disconnect Switch
EDP | Emergency 208/120V Distribution Panelboard
ELP | Emergency 208/120V Panelboard
EHDP | Emergency 480/277V Distribution Panelboard
EMCC | Emergency Motor Control Center
MSB | Main Switchboard
MCC | Motor Control Center
T | Transformer
US | Unit Substation

Utilize numbering convention as follows:

- First letter or number = floor designation; B = basement, 1, 2, 3, etc. (B)
- Subsequent lower case letter = panel number on each floor; a, b, c, etc. (Ba)

**Example:** Emergency 277/480V Distribution Panelboard installed in basement is “EHDP-B”.

**Example:** second 480/277V panelboard installed on third floor for lighting is “HLP-3b”.

1.6 LOW VOLTAGE CONDUCTORS AND CABLES

A. This section refers to low voltage conductors and cables, 600 volts or less.

B. No aluminum wiring is allowed.

C. Direct burial of power and signal cables is not allowed.

D. Conductors

1. Power circuits shall be 12 AWG minimum. Control circuits shall be 14 AWG minimum. The neutral conductor shall be the same size conductor as the phase conductors throughout the distribution system and rated at 100 percent within the distribution equipment, except where harmonic current levels require use of 200 percent neutral conductor ampacity.

2. Data lines for computer automatic building control system shall be multi-conductor, jacketed cable with four twisted pair, insulated 20 AWG, color-coded.

3. Coaxial cable for television systems shall be broad band shielded type, to allow the addition of future communication channels.

4. Sound, intercom and public address system conductors shall be run in separate raceways from power. Low, medium and high level conductors shall be shielded and run separately to prevent cross talk and interference. Where practical, multi-conductor jacketed cable runs for large groups of conductors of the same signal systems are
preferred over individual conductors.

D. Metal Clad Cable (Type MC): Light-Weight Steel with Copper conductors and insulated ground is allowed in accordance with the campus master specification.

E. Application

1. Conductors used for power and fire alarm shall be in conduit or approved raceway systems.

2. Student and faculty residential buildings may utilize nonmetallic sheath multi-conductor cable in wood frame construction. Multi-conductor cable shall be concealed in above-grade stud walls, ceiling joists and floor joist locations. Multi-conductor cable shall be used only for branch circuit (less than 150 volts to ground) and power conductors 12 through 6 AWG type NMC, color-coded PVC conductor insulation with bare copper ground and PVC jacket. Do not use non-metallic sheath cable for feeders. Feeder conductors shall be installed in conduit.

1.7 MEDIUM VOLTAGE CONDUCTORS AND CABLES

A. This section refers to medium voltage conductors and cables, 12kV.

B. No aluminum wiring is allowed.

C. Direct burial of cables is not allowed.

D. Cable for 12 kV distribution shall be single conductor 15 kV Type with 133% insulation (220 mils min.) over Class B stranded copper conductor.

E. Splices and terminations for 12kV cable shall be made using compression connections and/or in accordance with the requirements of the Facilities Services Electrical Shop. Long barrel terminals shall be used, and compression connectors shall have a minimum of three crimps. At splices three crimps are required on both sides of the joint. The crimps shall be applied by alternating each crimp 90 degrees from the previous crimp. Splicer of 12kV cables shall have a minimum of 15 years experience. Provide the University’s representative and the Facilities Services Electrical shop with sample of the splicer work and documentation of experience.

F. Provide ESNA-type pre-molded separable connectors with insulated bushings for splices below grade and terminations to vault and pad mount style equipment. Manufacturer shall be Elastimold loadbreak or equal. Provide capacitance test point. Connectors shall satisfy requirements of IEEE 386 and shall be designed for use with the specific cable and type of installation required. The manufacturer shall provide all components and at least two copies of complete directions for assembling, and putting the unit into service, one of which shall be submitted for record.

G. Apparatus Connections: 200 amp loadbreak - Used for connection of a feeder cable to a device. Consists of the following components:

1. Apparatus Bushing - Universal Bushing Well, with appropriate shank length.

2. Bushing Insert - 200A or 600A depending on circuit rating.

3. Elbow Connector - Loadbreak Elbow, with grounding adapter and Bailing Assembly.

5. Junction Module – 600 amp, four way. Used for joining a combination of cables.

6. Provide parking stands for elbows and insulating caps for bushing well inserts where cable is not connected.

7. Terminations into existing oil-filled equipment where permitted in writing by the University shall use “stud” type terminators with compound-filled cable compartments covers. Terminators shall not require draining of oil or access into oil filled reservoirs to terminate or remove primary conductors.

8. Indoor terminations shall be heat-shrink or cold-shrink kits suitable for indoor/outdoor use. Outdoor terminations shall have skirts to five additional separations. Kits shall be fully qualified to IEEE-48 requirements. Outdoor switchgear shall be treated as an outdoor installation.

H. Transition splices shall be used for connection of lead sheathed, paper insulated, cable (PILC) to EPR insulated, jacketed cable, Raychem No. HVS1580 High Voltage Transition (stop) Joint or equal. Splice is not to be connected to ground, unless the transition splice, as designed by the manufacturer, includes a ground.

I. Completed high voltage cable installations shall have fireproofing tape applied to exposed cable in vaults, manholes, and pull boxes.

J. Set screw connectors are not acceptable for cable splicing and terminations.

1.8 RACEWAYS AND BOXES

A. Raceway systems shall be designed to properly deal with the constraints of the building environment including corrosion, exposure to physical damage, vibration, movement, temperature variation, moisture, electrical area classification and other conditions which may be unique to an application. Raceway systems shall be designed in accordance with the NEC, appropriate industry standards and recommendations of manufacturers. Where future access to a space will be limited or costly to rework, provide spare raceways to ensure main distribution routes contain the means to transport the ultimate design capacity of service switchboards or other significant equipment.

B. Materials Junction and Pull Boxes: Use outlet boxes with appropriate covers as junction boxes wherever possible. Semi-flush and surface mounted boxes shall not be specified in corridors and public access areas.

C. Outlet boxes: 4 inch square, minimum, for flush mounted devices and lighting fixtures. Cast type with gasket covers for outdoor or wet locations.

D. Conductors shall be installed in raceways. 12kV distribution system conduits shall be 5-inch minimum. Manholes and pull boxes shall be traffic rated and oversized to accommodate installation of future equipment and spares. Spare conduits shall be provided when directed and where future access to add conduits is limited. Spares shall include pull ropes and be routed to an accessible location beyond hardscape and other interferences that would require expensive repairs or service interruptions.

E. Conduit Sizing and Arrangement

1. Raceways shall be sized in accordance with rules and guidelines identified in the NEC. Equipment grounding conductors are required to be run with the power conductors in all types of raceway systems including both metallic and non-metallic. Include the cross section of equipment grounding conductors in fill calculations for power distribution raceways. In addition, the inside conduit diameter shall be of an
appropriate size to prevent cable jamming during installation.

2. Size conduit per NEC for conductor type installed or for Type THW conductors, whichever is larger; minimum size ½-inch conduit.

F. Electrical Classified Areas

1. Areas that include flammable or explosive sources of vapor, liquids, dust or fibers require compliance with NEC Article 500. Specifically identify the sources and the extent of boundaries for the appropriate Class and Division of such substances encountered. Appropriate conduit seals, drains and other fittings shall be provided for conduit systems in such areas.

G. Raceways

1. EMT shall not be used as a ground return path in lieu of a ground conductor.
2. Metal Clad Cable may be used as specified in the campus master specification.
3. Junction, Pull and Outlet Boxes
4. Minimum size for the electrical boxes shall be 4" x 4".
5. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
6. Use flush mounting outlet boxes in finished areas.
7. Metal flex conduit (Steel) may be used as whips for lighting fixtures to a maximum length of 6’. ¾” diameter conduit is the smallest that may be used and aluminum is prohibited.
8. Use UL Manufactured supports, clamps, straps, hangers to support and secure conduit. Tie wire may be used as a support of metal flexible conduit in new work/remodel metal stud walls in accordance with the rules, and guidelines identified in the NEC and CBC of supporting distances within 12” from connectors, and every 4 ½ feet.

H. Cable tray may be used where permitted by NEC.

I. Code-gage steel wire ways may be used for interconnection of multiple enclosure assemblies.

J. Laboratory multi-outlet assembly: The first outlet shall start 3” to 6” from the end of the Isoduct. Electrical outlets shall be 2’-0” on center. Each run of isoduct shall have two data outlets, one emergency power 120 volt outlet with red body and electrical outlets 2’-0” on center. Isoduct raceways over 10 feet shall have additional data outlet for every 4’ added.

K. Installation

1. Low voltage conduit bend radius shall be no less than 15 times the nominal trade diameter. Medium voltage conduit runs shall have a minimum horizontal bend radius of 20 feet using factory bends.
2. Minimum Burial Depth: Underground 12kV power distribution duct banks shall have a minimum burial depth of 36 inches. Low voltage circuits require a minimum burial depth of 24 inches. Refer to NEC for minimum burial depth of raceway for other types and situations.
3. Duct banks: Concrete-encased duct banks with red concrete, red chalk or similarly
identifiable red colorings, shall be provided for 12KV power distribution runs outside buildings between buildings, substations and control centers. Conduit shall also be concrete-encased with red concrete, red chalk or similarly identifiable red colorings, when routed through NEC Article 500 electrical classified areas. 600 volts and less conduit banks adjacent to buildings and under buildings do not require concrete encasement.

4. Route conduit through roof using piping and ductwork openings where possible; otherwise, route through weatherproofed roof jack. Pitch pockets are not acceptable.

5. Maximum Size Conduit in Slabs above Grade: As allowed by Structural Engineer of Record.

1.9 UNDERGROUND ELECTRICAL DISTRIBUTION

A. Provide duct banks with red concrete, red chalk or similarly identifiable red colorings to interconnect 12 kV distribution equipment sites, manholes and vaults. Maximum spacing between essentially straight runs of conduit manholes, vaults or pull boxes shall be 400 feet. Reduce spacing by 50 feet for each 45-degree bend and 100 feet for each 90-degree bend. This shall not release the installer from producing the necessary cable-pulling calculations to make sure the maximum tension or sidewall pressures are not exceeded.

B. Manholes and vaults shall be precast reinforced concrete with traffic or parkway loading rating as appropriate. The size shall provide sufficient space for cable splice bending and training of the cables, but wall length shall not be less than 5'-0". Grade level removable opening shall be large enough to accommodate sectionalizing equipment installation and removal, pulling sheaves and associated hardware. Rectangular removable covers shall be provided with a 3'-0" circular manhole cover for normal access.

C. Electrical power ducts shall be 5-inch minimum.

D. Duct entrances into manholes shall be so located that sharp bends of cable at duct mouth will be unnecessary.

E. Concrete encased 12KV power duct banks shall be completely encased in a minimum of 3 inches of concrete with red concrete, red chalk or similarly identifiable red coloring.

F. The 12KV power electrical system ground conductor shall be a minimum # 4/0 AWG bare stranded copper cast in duct banks, 3 inches below top of "red" concrete, entering each manhole, and bonded to ground to rod.

1.10 WIRING DEVICES

A. A criterion for locating and sizing receptacles and switching is included in Part 1.1, "Campus Electrical Overview."

B. Receptacles

1. Receptacles shall be installed in electrical equipment rooms, mechanical equipment rooms, classrooms, offices, conference rooms, cafeterias, kitchens, dining rooms, etc.

2. Receptacle mounting heights and locations shall be such that they do not interfere with the equipment they serve. Mechanical drawings and furniture layouts shall be checked carefully to prevent receptacles from being isolated behind cabinets, etc.
3. Receptacle capacities or rating shall be adequate to carry the particular loads involved.

4. Receptacles or other outlets in partitions subject to change or relocation should be branched from receptacle or other outlets in permanent walls. Do not use movable partition outlets for wiring necessary to maintain the continuity of a circuit. Drywall partitions not penetrating the finished ceiling shall be considered movable.

5. Receptacle load requirements in underfloor ducts should be based on one-half watt per square foot of office area, except in those locations where special equipment is to be installed.

6. Receptacles installed outdoors, within 6 feet of sinks or in other wet or damp areas including toilets, showers, mop sinks, fume hoods, safety showers and restrooms, shall have automatic 5mA, individual ground fault (GFI) protection. Self-contained GFI protected devices are preferred over GFI circuit breakers located in remote panelboards.

7. In health care facilities, receptacles shall be hospital grade, NEMA 5-20R. Other areas on UCR campus shall be Industrial/Institution grade.

8. Surface mounted multi-outlet raceways are preferred for areas requiring multiple outlets in close proximity. The minimum surface raceway size should be 1-3/4 inch D x 5-1/4 inch H with divider and separate covers, equivalent to wiremold AL 4320, for multiple voltages or signal systems. Surface raceways shall generally be used for the following conditions:
   a. Laboratory benches
   b. Workshop benches
   c. Machine shop areas
   d. Verify exact program requirements for additional areas

9. Hazardous Areas: Wiring devices in hazardous areas shall be rated for the type of hazard per the electrical codes. The classification of hazard shall be clearly indicated on the applicable drawings.

10. Symbols: Drawings shall symbolize each wiring device location and associated branch circuit conduit and wire. Wiring devices shall be identified on the electrical symbol list as to type, mounting height and mounting method (i.e., ceiling, wall, floor, concealed, flush or surface, etc.).

11. Within vivarium’s and other wet areas where epoxy walls are used, and other appropriate areas, waterproof outlets, switches and all electrical devices penetrating the surfaces shall have weather resistant covers with two independent self-closing lid, sealed, and GFCI protected.

12. Voltage drop shall be calculated for every receptacle, and shall not exceed 5% total at the connection point of the load. Steps shall be taken to maintain voltage drop to 5% or less for all normal and emergency system loads.

C. Switches

1. Switches shall be 20 amp, 120 or 277 volt, 60 Hertz, for control of lighting circuits. Switches shall be Industrial/Institutional grade. In Health care facilities, switches shall be Hospital grade.

2. Provide red jewel pilot (ON) light for switches controlling equipment not visible from switch location.
3. Switches controlling lighting system or equipment which should not be accessible by the general public, or switches controlling H.I.D. light sources with extended hot restrike time, shall be key operated.

4. Switches shall be mounted on the striker plate side of doors.

D. Automatic Lighting Control

1. Occupancy sensors shall control lighting and/or HVAC in the controlled area only.

2. Controlled lighting and/or HVAC zones shall not be larger than 2,500 square feet.

3. Wall occupancy sensors, ceiling sensors and power packs shall be warranted for a period of five years.

4. Dual technology occupancy sensors shall be provided, combining passive infrared and ultrasonic technologies.

5. When HVAC system is also to be controlled by occupancy sensor, provide additional isolation relay.

6. When dimming lighting could save energy, internal photocell can be provided integral with occupancy sensor.

7. Restrooms with stalls shall be provided with ultrasonic ceiling mounted occupancy sensors. Infrared sensors can be used with single stall toilets. Provide additional relay for also controlling exhaust fans if applicable.

8. Corridors and hallways shall be provided with ceiling mounted dual technology sensors with appropriate hallway coverage pattern.

9. Interior stairwells shall be provided with bi-level light fixture with built-in motion sensor or an externally mounted dual technology sensors with appropriate stairwell coverage pattern. The motion sensors shall pickup any movement, including a stairwell door opening, and instantaneously switch the lighting from the standby (1 foot candle min.) level to full light output for a minimum 15 minute duration. Each exterior stairwells shall also be provided with bi-level motion sensor controlled lighting, and dedicated day lighting control photocell.

10. Digital time switch shall be provided in storage, utility and service spaces.

11. Diurnal lighting control shall be provided for each room independently within Vivariums. Lighting shall be controlled by lighting relay interface system via BMCS. This can be accomplished by switching one lamp, or all lamps per fixture depending on the diurnal cycle. A digital override time switch shall be provided at each entrance to each room to allow up to 30 minutes of full light output before reverting to BMCS control.

12. Lighting in open laboratory shall be controlled by occupancy sensors. Each bay which consists of three aisles shall be controlled together with the occupancy sensors interconnected. If any one occupancy sensor detects motion, all lights in the bay will turn on. All sensors must detect no motion for entire time-out period (20-30 minutes) before all lights in bay will turn off. Provide override switching for each bay to allow manual control of lighting.

13. For smaller offices, upon entering the room, the photo sensor shall automatically activate between 50-70% of the lights. The occupant shall then be able to manually activate the alternate set of lights, activate 100% of the lights or deactivate all lights.
When the room is unoccupied, all of the lights must automatically turn off. When the room is reoccupied, no more than 70% of the lights can be turned back on automatically or from a single switch action. The use of daylighting control must be added for additional control credit.

14. All offices with exterior windows shall have dual level, photosensor control occupancy sensor located for room coverage.

1.11 GENERATOR ASSEMBLIES

A. Science, Engineering, Computer, Medical and Research Buildings shall include an emergency generator sized for 100% of the calculated emergency load. Generator shall be an outdoor unit; diesel fueled, and has a main breaker. Emergency systems shall be isolated from normal source systems via automatic transfer switches. Emergency distribution systems wiring shall be segregated and include separate wiring, transformers, distribution, and panel boards. Emergency systems shall be connected to building ground system.

B. Emergency power sources shall have spare capacity when directed by the University for electrical loads requiring standby power sources. Planned emergency power measures shall be thoroughly discussed with the University and diagrammed for approval.

C. Health care facilities shall have emergency loads grounded and connected to Life Safety Branch, Critical Branch or Equipment Systems Branches as defined by NFPA.

D. Emergency power source shall be diesel engine driven generator.

E. At least one elevator in a building shall be on emergency power when building has a backup power generator system.

F. Engine-driven generators shall include the following features:

1. Provide manual bypass switch in Health Care, Research and other areas on a case-by-case basis, with automatic engine generator no-load exerciser and time delay shutdown.

2. Generators 250 kW and larger shall be provided with a load bank of 50% capacity, to extend life of generator by testing under load. Load banks shall be mounted on the radiator exterior. The load bank shall be wired through a shunt-trip circuit breaker. The load-dump control circuit in the load bank shall be wired to the transfer switch(es).

G. Engine generators shall be located at grade elevation in a separate dedicated room when indoors, and in a fenced or walled enclosure when outdoors. Outdoor units shall be enclosed in a weatherproof enclosure with lockable doors.

H. In research, science and laboratory buildings, the emergency generator shall be installed to provide emergency power for egress lighting and exit signs, fire alarm, telecommunication, security, fume hood exhaust fans, supply air fans for laboratory, atrium exhaust, fire pump, elevators to sequence the return of a pre-determined level (one elevator at a time), and emergency outlets in the laboratories, electrical and mechanical rooms, warm and cold rooms. Emergency loads shall include owner-furnished refrigerators, 208-volt outlets in equipment hallways or support spaces.

I. The generator shall be located within 100 feet of the main service switchboard and supply an automatic Transfer Switch (ATS). The Automatic Transfer Switch shall be a four-pole unit with a switched neutral. Emergency system and normal system grounding shall be bonded. The ATS shall be capable of transfer to normal power without interruption of load.
J. Emergency systems wiring shall be separated from normal systems in every aspect except for ground. Emergency equipment shall be plainly marked to distinguish it from normal source equipment. Emergency outlets shall be red in color.

K. The location and direction of the engine exhaust shall not adversely affect the air intake for the building. The preferred direction of the exhaust is up, from a sound rating standpoint. A hinged rain cap shall be provided on vertical discharge exhaust pipes.

L. Provide a separate fuel tank when capacity of base-mounted tank raises engine off ground and would require ladder for access to controls, etc. for maintenance, or as an option, provide 3'-0" wide fixed service platform with railings around generator.

M. If generator is indoors, provide room sound attenuation and design for air intake must include combustion air and cooling air. Add additional 10% to this air volume. Provide means to remove indoor generator should it need replacement.

1.12 POWER MONITORING AND CONTROL

A. The University requires each electrical service to have a power revenue meter. The Siemens #9330DC1000NPZZA is the required meter (known equal is manufactured by Power Measurement Inc.) to measure, record and automatically report kilowatt-hours and other electrical parameters to a central computer over the campus Facilities Services Administration fiber optic network. Additional power monitors are not required. Consult with the University’s Representative to establish reporting requirements for the project, which include meter identification, building identification and network connection. The University's Facilities Services Administration will be provided with all information they request in order to program the power meter.

B. Options described in part number are as follows:
   1. D=Meter with integrated display
   2. C=Seabus/module/DNP
   3. 1=Power supply 85/240V
   4. 0=Input voltage 277v
   5. 0=Frequency, 60 Hertz
   6. 0=Network card (none)
   7. N=Network card

C. The University’s existing software shall be used and meter provided shall be compatible with that software. Provide programming, startup and testing of the meter at the building and at the Campus central metering computer. Request the University’s Master Specification for specifying the electric meter with the required accessories.

D. Provide 1” conduit only to meter location from telephone room.

1.13 MEDIUM-VOLTAGE SWITCH (SF6)

A. The SF6 gas-insulated, manually operated, load interrupting 600A SF6 puffer style switch shall be suitable for use on a 12,000 Volt, three phase, three wire, 60 Hertz system.

B. SF6 switch shall be located in the tunnel or above grade or inside a building. Below grade switches or switch in below grade vaults are not acceptable.

C. The switch shall have six (6) three phase entranceways and six switched ways unless otherwise approved by University’s representative.
1.14 UNIT SUBSTATIONS

A. Primary transformation of medium voltage power shall consist of primary incoming line sections, transformer section, and secondary outgoing power section(s). Where space permits, unit substation construction shall be utilized for substations larger than 300kVA, 208/120 volts and larger than 500kVA, 480/277 volts. Indoor dry cast coil type; compact unit power center substation construction may only be used for smaller capacity loads when approved by the University’s representative.

B. Incoming line section shall consist of two primary load break gang operated heavy duty air switches, manual spring charged, 600 amp, 3 pole, with single set of current limiting load side fuses (one per phase). Switches shall be arranged for manual selection of one of two incoming radial primary feeders at a time with Kirk-key interlocks provided. Primary cable terminations shall be at the bottom rear of each switch compartment, with porcelain cable terminators and surge arrestors on each phase. One switch shall be fused to protect the transformer.

C. Medium power transformers shall be liquid-filled pad mount or unit substation style where installed outdoors or unit substation indoors. The transformers shall have a retention area for spill containment. This concrete curb system shall be capable of containing the total fluid capacity. The transformer pad shall be 2” above the maximum containment level. Provisions shall be made, if outside, for the release of rainwater.

D. Transformers shall have dual primary feed selector switches and primary fusing. A pad mount transformer shall incorporate two sets of bushings, an A-B-A&B-Off selector switch, and dry well bay-o-net fusing sized to protect the transformer. Pad mount transformers shall have 200A primary bushings for separable connectors.

E. Transformer and unit substation identification shall comply with the University’s Numbering Scheme.

F. Transformer Section

1. Transformer operating life and efficiency decreases rapidly when transformer loading exceeds the manufacturer’s optimum load range. The transformer shall be sized and loaded within the manufacturer’s optimum load range in order to maximize efficiency. Select a transformer with loss ratios of 1:6 or lower to maximize the transformer’s loading point efficiency range. As an option, determine the transformer’s average loading and review the cost of utilizing an 80°C rise transformer with loss ratios of 1:2 compared to that of 150°C rise transformer with loss ratios of 1:6.

2. Unit substation transformers shall have provisions for forced air, fan cooling, to increase substation capacity. The secondary bussing and main circuit breaker shall have adequate capacity for the fan cool rating of the transformer. Fan cooling provisions shall include:

   a. Power source for the cooling fans.
   b. Mounting provisions for the fans.
   c. Temperature sensor with relay control contracts for control of fans.
   d. Adequate ventilation must be provided for transformer rooms. Transformer vaults shall be fire-rated.

3. Transformer room details shall show plan location of equipment and elevations.

4. Pressurized, gas-filled, medium voltage to low voltage dry-type transformers are not acceptable.
5. Liquid-immersed, polychlorinated biphenyl (PCB) insulated transformers shall not be used under any condition.

6. Liquid filled pad mounted transformers shall be manufactured and installed to meet the following minimum requirements.
   a. Ratings: The required transformer KVA shall be one of the following KVA ratings:

<table>
<thead>
<tr>
<th>KVA</th>
<th>500</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>500</td>
<td>2000</td>
</tr>
<tr>
<td>150</td>
<td>750</td>
<td>2500</td>
</tr>
<tr>
<td>225</td>
<td>1000</td>
<td>3750</td>
</tr>
<tr>
<td>300</td>
<td>1500</td>
<td>5000</td>
</tr>
</tbody>
</table>

   b. Transformers shall be braced for seismic zone D, E, F in accordance with the California Building Code.
   c. Cooling class: OA.
   d. Primary voltage: 12,000 volts.

7. Basic impulse level (BIL):
   a. 95kV (12,000 volts primary delta windings).
   b. 60kV (4160 Y/2400 secondary windings).
   c. 30kV (480 Y/277, 480 delta volts and lower voltage secondary windings and solidly grounded).

8. Taps for 150 – 3750 KVA transformers: Four 2½%, two above and two below nominal 12,000 voltage rating, 12,600 /12,300 /12,000 /11,700 /11,400 volts.

9. Windings: Primary winding connection shall be delta-connected and secondary shall be wye-connected. Primary and secondary winding shall be copper.

10. Impedance voltage:

<table>
<thead>
<tr>
<th>KVA RATING</th>
<th>% IMPEDANCE VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 – 1500</td>
<td>5.00 (minimum)</td>
</tr>
<tr>
<td>2000 – 3750</td>
<td>6.25 (minimum)</td>
</tr>
</tbody>
</table>

11. Transformer insulating fluid:
   a. Liquid-filled transformers shall have Factory Mutual approved less flammable fluid with a fire point greater than 300 degree Celsius such as Enviro-Temp FR3.
   b. Transformers shall be factory-filled and shipped complete to job site.

12. Liquid-filled transformers shall be 55°C rise air-cooled. A 65°C rise rating is also required in addition to the 55°C rating.

G. Pad-Mounted Enclosure

1. The enclosure shall be designed to achieve a high degree of integrity. The pad-mounted transformer shall consist of the transformer tank with high- and low-voltage terminating compartments. Assemble all three of these components as an integral unit, tamper-resistant and weatherproof, suitable for mounting on a pad without additional housing, fencing, or other provisions to make the installation safe. There
shall be no exposed screws, bolts, or other fastening devices that are externally removable. There shall be no opening where objects may be inserted to contact live parts. The completely assembled transformer shall be resistant to unauthorized entry.

2. A bolted tank cover shall be furnished. Welded tank with handhole(s) is not acceptable. The bolted cover assembly shall consist of a reusable nitrile gasket retained in place by a retaining strip welded to the interior of the tank flange. Carriage bolts shall be concealed by a wrap-around “nut guard” accessible from the interior of the cabinet.

3. Before coating, all welds shall be cleaned to remove welding flux and splatter. Surfaces shall be washed and prepared by a chemical-etching phosphate coating process, or be sand blasted, grit blasted or shot blasted.

H. Transformer shall be provided with a four-position, three phase, load break primary switch. The switch shall have positions A, B, A&B, and OFF. The switch shall be hotstick operable with permanently marked positions.

1.15 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Provide lockable safety disconnect switch within 10 feet and in sight of any motor over ½ horsepower. This is in addition to Code required disconnects.

1.16 AUTOMATIC TRANSFER SWITCHES

A. Provide two sets of single pole, double throw contacts that operate 3 seconds before transfer in either direction and reset 3 seconds after transfer. Rated 10 amps, 480 volts, 60 Hz AC. Provide and install three # 12 conductors in ¾-inch conduit from each set of contacts to the building management system to disconnect motor loads before transfer and reconnect them after transfer in either direction.

B. Automatic Sequence of Operation: Close transition switches shall be rated less than 100 milliseconds.

1.17 ENCLOSED CONTROLLERS

A. Manual motor starters

1. Fractional Horsepower Manual Starter: general-purpose Class A manually operated, single pole, full voltage controller for fractional horsepower induction motors, with thermal overload unit and green pilot light, normally open auxiliary contact and toggle operator.

2. Motor Starting Switch: general-purpose Class A manually operated, single pole, full voltage controller for fractional horsepower induction motors, with auxiliary contact, and toggle operator.

3. Enclosure: Type 1 indoors and Type 4 outdoors.

B. Magnetic Motor Starters

1. Enclosure: NEMA ICS 6 Type 1 indoors and Type 4 outdoors.

2. Combination Motor Starters: Combine motor short circuit protector, overload and disconnect in common enclosure.
C. Types of starters shall be selected as follows:

<table>
<thead>
<tr>
<th>Motor H.P.</th>
<th>Voltage</th>
<th>Type Starter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 7 ½</td>
<td>208</td>
<td>Across line magnetic</td>
</tr>
<tr>
<td>7 ½ to 15</td>
<td>208</td>
<td>Across line magnetic, part wind or wye delta</td>
</tr>
<tr>
<td>15 to 30</td>
<td>460</td>
<td>Across line magnetic part wind or wye delta</td>
</tr>
<tr>
<td>Above 15</td>
<td>208</td>
<td>Part wind or wye delta</td>
</tr>
<tr>
<td>Above 30</td>
<td>460</td>
<td>Part wind or wye delta</td>
</tr>
</tbody>
</table>

1.18 SWITCHBOARDS, PANELBOARDS AND CONTROL CENTERS

A. General

1. A 480Y/277 volt low-voltage distribution system shall serve mechanical and end user equipment and lighting loads.

2. A 208Y/120 volt, low voltage distribution system shall be derived from the 480 volt system by utilizing dry-type transformers. The 208Y/120 volt system shall serve general use loads, small equipment loads, and receptacles. Where 208Y/120 volt is proposed as the exclusive secondary utilization voltage, provide a life-cycle cost study analysis to justify.

3. Provide local transformation for equipment requiring other secondary voltages.

4. Service entrance switchboards shall include revenue meter. Metering circuits shall be utility grade metering accuracy class in accordance with campus master specification.

B. Switchboard

1. Main service switchboard shall be solid state trip insulated case type. Provide with electronic sensing, timing and tripping circuits for adjustable current settings, ground fault trip (for main and feeders), short-time trip (for main only), and instantaneous trip (for feeders only).

2. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials used.

3. Main Section Devices: Individually mounted and compartment drawout type. The main breaker shall be a power circuit breaker and shall have LSG trip functions.

4. Distribution Section Devices: Individually mounted and compartmented, fixed type.

5. Bus Material: Copper only.


7. Enclosure shall align at front and rear.

8. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.
9. Provide 4-inch high concrete pad that is a minimum of 4 inches wider and longer than switchboard. Seismic restraint anchor bolts require 10 times the bolt diameter from the bolt to the edge of concrete.

10. In Research, Science, Computer Labs, Engineering, Medical or high tech Buildings, the 480V switchboard shall include a bus connected drawout type Transient Voltage Surge Suppression Device (TVSS). It shall include an isolation disconnect. A bus connected TVSS device shall be provided for each separately derived 208/120V bus. It shall include an isolation disconnect.

11. Secondary switchboards shall be of the dead front, metal enclosed type with circuit breakers of a type and interrupting capacity suitable for the particular installation. Space shall be provided for metering equipment where required.

12. Secondary outgoing power section shall consist of one or more bussed sections, with the following equipment:
   a. Main secondary circuit breaker and attached or remote feeder protective devices.
   b. Provide circuit breakers with the following requirements:
      1) Main and feeder breakers shall be solid state trip insulated case or molded case circuit breakers to achieve satisfactory coordination. If thermal-magnetic is used, oversize breaker and bus to utilize 100% of transformer rating.
      2) Minimum symmetrical interrupting current rating shall exceed calculated fault current at the device location by a minimum of 10% of worst case calculated.
   c. Branch circuits that justify individual measurement of amps and volts, such as a motor over 50 HP shall utilize the solid state multi-function meter.
   d. Current transformers (C.T. - one per phase) 5 amp secondary, primary rating to match bus rating. Relaying circuits may utilize relay accuracy class CT’s.
   e. Control power transformer with protective fuses.
   f. Ground fault protection on main circuit breaker where required by Code. When ground fault is provided on the main circuit breaker, each feeder device shall be equipped with ground fault protection. Ground fault systems shall operate at 120 volts AC. Provide secondary control power transformer for ground fault control power.

C. Panelboards

1. Panelboards shall be of standard manufacture, bussed for 3-Phase, 4-Wire, containing either 1, 2, or 3-poles, bolted to bus connection, and branch circuit breakers. The neutral bus shall be isolated from ground.

2. Every panelboard shall have a dedicated feeder from the main distribution board.

3. Separate panelboards shall be provided for building emergency power circuits. These panelboards shall be connected to the emergency generator if this source is required by the building occupancy.

4. Loads on panels shall be balanced as accurately as possible between phases.

5. Provide flush cabinet front with concealed trim clamps, concealed hinge and flush lock all keyed alike. Surface mounting is acceptable when located in electrical room or other non-public areas.

6. In science, computer, research and laboratory buildings, receptacle and end user
equipment panel boards shall be 120/208V with 200% rated neutrals and ground bus insulator kit with 42-circuit minimum, 3-phase, 4-wire.

7. Leave spare breakers off and directory shall list “spare” for those breakers.

8. Load centers may only be used for residential single family dwelling and apartment units.

D. Distribution Panelboards

1. Panelboards: circuit breaker type.

2. Panelboard Bus: Copper. Provide copper ground bus in each panelboard.

3. Minimum Integrated Short Circuit Rating: 22,000 amperes RMS symmetrical for 208 volt panelboards; 14,000 amperes RMS symmetrical for 480 volt panelboards, or as required by Short Circuit Study.

E. Branch Circuit Panelboards


2. Provide panelboards with copper bus. Provide copper ground bus in all panelboards.

3. Minimum Integrated Short Circuit Rating: 22,000 amperes RMS symmetrical for 208 volt panelboards; 14,000 amperes RMS symmetrical for 480 volt panelboards or as required by Short Circuit Study.

4. Molded Case Circuit Breakers: bolt-on type thermal magnetic trip circuit breakers, with common trip handle for multi-poled breakers. Provide circuit breakers UL listed as Type SWD for lighting circuits. Do not use ground fault interrupter circuit breakers.

F. Motor Control Centers

1. Three-phase induction motors are generally started with across-the-line starters. However, certain requirements including transformer capacity, main breaker size and voltage drop or flicker may limit the size of motor using this type of starting equipment.

2. When reduced voltage starting is required, the specific equipment and application shall determine the best-suited method. Reduced voltage autotransformer, or solid state soft start method for large motor starting, is the preferred reduced voltage starting methods. Closed circuit transition shall be incorporated in the autotransformer style starter.

3. Centralized motor control centers shall be used whenever possible. The minimum motor starter size shall be NEMA 1. Starters shall have Hand-Off-Automatic (HOA) switch, green running pilot light with push-to-test, single phasing protection for motors over 1 HP, manual reset thermal overload protection, motor overcurrent and short circuit protection, elapsed and running time meter (larger than 5 HP), and one set of auxiliary SPDT relay contacts.

4. Where power factor is less than 90%, correction is necessary. Provide power factor correction capacitors at induction motors or motor starters as identified in the power factor correction study. Solid state automatic power factor regulation may be considered.
5. The University requires premium efficiency motors for almost any application. Variable speed drives or multiple speed motors shall be considered for fan and pump loads. The motor short-circuit protective device type and rating shall be selected to allow trip-free motor starting under normal conditions.

6. Electric motor specification is generally not under the control of the electrical engineer. Coordinate installation requirements, including environmental, with mechanical engineer to insure compliance with the project requirements.

7. Control Transformer: Provide control transformer in motor control center to provide 120-volt control source for all motor starters in control center.

8. Provide 4-inch-high concrete pad and a minimum of 4 inches wider and longer than each Motor Control Center. Seismic anchor bolts require 10 times the bolt diameter from the bolt to the edge of the concrete pad.

9. Motor Control Centers: NEMA ICS 2; Class I, Type B.

10. Horizontal Bussing: Copper, with a continuous current rating of 600 amperes minimum. Include copper ground bus entire length of control center.

11. Vertical Bussing: NEMA ICS 2, copper with a continuous current rating of 300 amperes minimum.

12. Integrated equipment short circuit rating adequate for duty available at line terminals plus motor contribution.

13. Configuration: front mounting only, accessible from the front only.

14. Enclosure: ANSI/NEMA ICS 6, Type I indoors and Type 3R outdoors.

1.19 ENCLOSED BUS ASSEMBLIES

A. Indoor Plug-In Busway: NEMA BU 1; 4 wire, low impedance plug-in busway rated 120/208 or 277/480 volts, 60 Hz. Provide non-ventilated housing with plug-in openings on 24-inch centers each side, with hinged doors to protect opening where plug-in unit is not installed.

B. Conductors: Copper bars, fully insulated, except at joints. Provide full neutral. Provide 50% internal ground bus of same material as phase conductors.

C. Joints: Provide single bolt type, with silver-plated contact surface for bus and splice plate.

1.20 FUSES

A. Fuses: Dual element, current limiting, time delay, one-time fuse, 600 volt, Class RK1.

B. Interrupting Rating: 200,000 RMS amperes.

1.21 LOW VOLTAGE TRANSFORMERS

A. General

1. Low-voltage dry-type distribution transformers shall be energy-saving type and selected with 115 degree C temperature rise above a 40 degree C maximum ambient
B. Dry Type Transformers

1. Dry Type Transformers: copper wound, factory-assembled, air cooled dry type transformers. K-4 Factor transformers are required for harmonics from non-linear loads.

2. Mounting: Transformers 25 KVA and less may be wall, floor, or trapeze mounted. Transformers larger than 25 KVA shall be floor mounted.

C. In research, laboratory, computer, office or electronic buildings, dry-type transformers shall be 480/208V/120V transformers, dry-type copper wound, 115 degree C rise with double size neutral terminal and K-4 rating. The core and coil shall be mounted on rubber isolation pads if not installed on slab-on-grade and if any vibration or hum could affect occupied spaces.

1.22 BUILDING INTERIOR LIGHTING

A. The aesthetics and type of light fixtures shall be compatible with the task and area in which it is located. Placement, candlepower, distribution and luminance ratios shall be chosen to reduce veiling reflections and promote visual performance. Selection shall insure that visual comfort probability (VCP) conforms to IES recommendations and luminaire efficiency is maximized. Interior lighting shall be 277V fluorescent.

B. Lamp diffusers shall be hinged so as not to require removal of diffuser or louver for changing lamps, and allow removal for cleaning or replacement of diffuser or louver. The bottom of lighting fixtures shall be aluminum, at least 7 feet above finish floor line and 8 feet minimum is preferred.

C. Special custom design light fixtures shall generally not be used unless approved or requested by the University.

D. Ceilings heights less than 8 feet 6 inches high shall have recessed light fixtures except as approved or directed by the University.

E. Ballast shall be removable through light fixture opening in non-accessible ceilings.

F. Do not use incandescent lamps.

G. Ceiling mounted fluorescent lamps shall be 4 feet nominal, 32 watt, super T8, and for direct-indirect and cove application to be T-5 or T-5HO, 265 mA, rapid start, 2950 initial lumens with a Color Rendering Index (CRI) of 84, color temperature of 4100 degree Kelvin and 20,000 hours average life. Lamps shall pass the EPA TCLP test for low mercury content.

H. Under counter task light fixtures shall be stainless steel housing 1” height, one-piece co-extruded clear DR acrylic prismatic bottom lens with opaque front, power factor corrected ballast(s), 120 volts. Florescent lamps shall be 13 watt, T-5, natural white 4000 degree K. Fixture length shall be 42” nominal (coordinate with casework). Provide with integral On/Off rocker switch. Provide hardwire concealed connection.

I. Compact fluorescent lamps shall be 4,100 K color temperature with a CRI of 82 and rated average life of 10,000 hours. The wattage shall vary according to the application.

J. Eight-foot long, “U” shaped or circular shaped fluorescent lamps are difficult to maintain and
shall not be used.

K. Fixtures

1. The most common lighting fixture on campus will be a 2’ x 4’ or 1’ x 4’ recessed fluorescent luminaire. Luminaire shall meet the following criteria:
   a. Coefficient of Utilization (CU): 0.89 minimum for 2’ x 4’ fixture and 0.79 minimum for 1’ x 4’ fixture at room cavity ratio of 1.0 and ceiling/wall/floor reflectance of 80%/50%/20%.
   b. Lens: Parabolic-type reflector fixtures shall be used in public spaces except for areas with computer screens to provide less reflective glare. Lenses in service areas shall be one hundred percent virgin acrylic or Lexan. Within Vivariums provide prismatic tempered glass lenses.

L. Ballasts shall be electronic and reduced harmonic type.

M. Dimming Ballasts:

1. Fluorescent electronic dimming ballasts shall be utilized in lecture halls, selected dark rooms, electron microscope rooms, selected laboratories, X-Ray viewing areas, eye exam and testing rooms, theaters, and rooms with projection equipment and similar areas as identified in the project program. The ballasts shall meet the following criteria and provide a flicker-free dimming range from 100 percent down to 10 percent. In areas where projection equipment is utilized, the dimming range shall be from 100 percent down to 1 percent.

N. Electronic Suppression

1. Provide proper protection for radiated and line transmitted electromagnetic noise to prevent magnetic and radio frequency interference. Suppression techniques shall be included in areas sensitive to electromagnetic interference including the following:
   a. X-ray facilities
   b. Electron microscopes
   c. Electron laboratories repair and research areas
   d. Sound reproduction and relocating areas
   e. Other areas designated by the University.

O. Special Lighting Fixtures

1. Certain task areas will require highly specialized lighting fixtures. The special requirements shall be individually reviewed with the University’s representative or were identified in the detail project program (DPP). These areas are as follows:
   a. Surgeries
   b. Medical treatment rooms
   c. Medical exam room d. Autopsy room
   e. Photographic dark rooms
   f. Dental treatment rooms
   g. Eye examination and testing
   h. X-ray rooms
   i. Vivariums
   j. Other areas designated by the University

P. HID Interior Lighting

1. High Intensity Discharge (HID) lamps may be used in large indoor areas where frequent switching is not required. Consider HID dimmer systems with automatic
light level controls in these applications. They are generally not to be used for indoor lighting where fixture height is less than 18 feet above the floor.

2. HID lamp ballasts shall provide maximum lamp output energy efficient designed for specific lamp. In noise-sensitive areas, ballast shall be fully encapsulated or remote mounted in an adjacent area where noise will not be objectionable.

3. Utilize Pulse Start lamps and Ballast for all Metal halide applications.

Q. Interior Illumination Levels

1. Design to the recommended illumination levels for the type of areas indicated. Illumination levels are not necessarily average levels over an entire space. Task oriented lighting is encouraged where its use will not affect general appearance of space adversely. For areas not listed, refer to the most current issue of the IES Lighting Handbook for illumination levels. Levels indicated are maintained illumination levels unless otherwise noted. This table shall be used by the Designer in developing a lighting system for the project based on current IES recommended practices, code, life safety and good engineering practices. Day lighting contribution can be considered in calculation of illuminance. Foot-candle levels do not include task lighting contribution to the room.

<table>
<thead>
<tr>
<th>MAINTAINED FOOT-CANDLE REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE OF OCCUPANCY</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>Classroom space</strong></td>
</tr>
<tr>
<td>Regular classroom work</td>
</tr>
<tr>
<td>Computer</td>
</tr>
<tr>
<td>Lecture rooms – audience</td>
</tr>
<tr>
<td>Lecture rooms – sending wall/marker boards</td>
</tr>
<tr>
<td>Colloquium and team rooms</td>
</tr>
<tr>
<td><strong>Corridors</strong></td>
</tr>
<tr>
<td>At corridor intersections</td>
</tr>
<tr>
<td>Corridors and hallway</td>
</tr>
<tr>
<td>Lobbies – main entrances (dimmable &amp; photo sensor controlled)</td>
</tr>
<tr>
<td>Vestibules</td>
</tr>
<tr>
<td>Student housing</td>
</tr>
<tr>
<td>Emergency lighting</td>
</tr>
<tr>
<td><strong>Dormitory rooms</strong></td>
</tr>
<tr>
<td>Bedroom</td>
</tr>
<tr>
<td>Study</td>
</tr>
<tr>
<td>Lounge/lobbies</td>
</tr>
<tr>
<td>Kitchen (with task light) and laundry</td>
</tr>
<tr>
<td>Kitchen (without task light)</td>
</tr>
<tr>
<td>Bathrooms</td>
</tr>
<tr>
<td>Lobbies and community room</td>
</tr>
<tr>
<td><strong>Laboratories</strong></td>
</tr>
<tr>
<td>General</td>
</tr>
<tr>
<td>Computer</td>
</tr>
<tr>
<td>Close work (with task lighting)</td>
</tr>
<tr>
<td>Close work (without task lighting)</td>
</tr>
<tr>
<td><strong>Libraries</strong></td>
</tr>
<tr>
<td>Reading rooms, carrels</td>
</tr>
<tr>
<td>Category</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Stacks (active)</td>
</tr>
<tr>
<td>Check in and out, catalogs</td>
</tr>
<tr>
<td><strong>Lounges</strong></td>
</tr>
<tr>
<td>Study (with task light)</td>
</tr>
<tr>
<td>Study (without task light)</td>
</tr>
<tr>
<td>Non-study</td>
</tr>
<tr>
<td><strong>Offices</strong></td>
</tr>
<tr>
<td>Accounting, bookkeeping</td>
</tr>
<tr>
<td>General, reading, filing, mail, copy</td>
</tr>
<tr>
<td>Offices: private &amp; open (w/task lighting)</td>
</tr>
<tr>
<td>Computer rooms</td>
</tr>
<tr>
<td>Conference/work rooms/ reception/administration</td>
</tr>
<tr>
<td>Stock rooms</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
</tr>
<tr>
<td>Restrooms</td>
</tr>
<tr>
<td>Service areas (mechanical, electrical rooms)</td>
</tr>
<tr>
<td>Elevator equipment rooms</td>
</tr>
<tr>
<td>Storage rooms</td>
</tr>
<tr>
<td>Main telecom equipment room</td>
</tr>
<tr>
<td>Stairwells (interior)</td>
</tr>
<tr>
<td>Stairwells (exterior)</td>
</tr>
<tr>
<td>Stairwells emergency lighting</td>
</tr>
</tbody>
</table>

* Work plane height of zero inches.
** Vertical FC at a work plane height of 30” unless otherwise noted.
*** Conference rooms and lecture halls shall have dimmable lighting.
1.23 EXTERIOR LUMINARIES

A. The University has standardized on high-pressure sodium (HPS) as the energy efficient light source for exterior lighting. Exterior lighting shall be 480 volts and for the security of students shall remain on all night. See Section 31, “Site Work” for additional Plaza and site lighting issues.

B. Installations shall comply with Illuminating Engineering Society (IES) lighting handbook standards.

C. Calculations:
   1. A computer point-by-point printout of exterior and parking structure lighting shall be submitted for approval. The printout shall depict location of luminaires at their respective mounting height, to verify horizontal and vertical illumination requirements on grade.
   2. Include any existing fixtures in the computer analysis that may exist around the perimeter of the new site lighting.
   3. A sample luminaire cut sheet(s) with candlepower curves and isolux charts shall be submitted.

D. Exterior lighting circuits shall be multi-staggered circuits to minimize a total outage.

E. Lighting Contactor Control circuits shall be a separate dedicated circuit from lighting branch circuits to minimize disruption.

F. Lighting circuits shall be activated and deactivated by a single photocell per building or parking lot. Do not use lamps or fixtures with individual photocells.

G. Plaza lighting fixtures shall be pole mounted type fixtures, either the campus standard light fixture or the campus “theme” birdcage light fixture. Fixtures set into building exteriors or retaining walls shall be avoided due to difficulty in re-lamping or replacing, and rusting of the fixture housing. Light bollards shall be not be used if possible; if used they shall be located in planting areas where exposure to pedestrian and bicycle traffic is minimal. Fixtures that are difficult to change lamps are unacceptable. Outdoor signage shall be placed near light fixtures to improve visibility at night.

H. Pedestrian walkway light fixtures layout shall be designed to prevent bright spots or heavily shadowed areas coordinate with landscape and growth of bushes and tress.

I. The University shall approve the use of Handrail lighting. If used shall be C.W. Cole, Cat #1586-5 with PL-13 Lamps.

J. Fixtures recessed into building exteriors should be avoided due to difficulty in changing lamps and rusting, surface mounted fixtures. Any fixtures that are difficult to change lamps or painted are unacceptable.

K. To minimize stocking numerous lamp sizes the University has standardized on 100, 150 and 250-watt high-pressure sodium lamps. Other wattage shall not be used.

L. Design lighting standards and base anchor for 100-mph wind.

M. Fixtures that are difficult to change lamps are unacceptable to the University.

N. Comply with the USGBC LEED credit SS 8 for light pollution reduction. Only light areas as required for safety and comfort. Do not exceed 80% of the lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments. Design exterior lighting so that all site
and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site. Uplights at trees and buildings shall not be provided.

O. Pole Height

1. General Pole Height by Area should be:

<table>
<thead>
<tr>
<th>AREA</th>
<th>POLE HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mall (theme light)</td>
<td>10 ft.</td>
</tr>
<tr>
<td>Pedestrian Paths</td>
<td>12 ft.</td>
</tr>
<tr>
<td>Pedestrian Paths / Fire lane</td>
<td>18 ft.</td>
</tr>
<tr>
<td>Fire Lane</td>
<td>18 ft.</td>
</tr>
<tr>
<td>Bike Paths</td>
<td>18 ft.</td>
</tr>
<tr>
<td>Main Campus</td>
<td>18 ft.</td>
</tr>
<tr>
<td>Open Areas</td>
<td>24 ft.</td>
</tr>
<tr>
<td>Parking Lots</td>
<td>28 ft.</td>
</tr>
<tr>
<td>Street Lighting</td>
<td>30 ft.</td>
</tr>
</tbody>
</table>

a. Note 1: Where cars can contact pole light, provide a 3 foot-4 inch high concrete base but total pole height shall remain as shown.

b. Note 2: Variation in height due to landscape and trees should be considered and variations indicated to the University.

P. Street Lighting

1. High-pressure sodium 250-watt luminaries with self-contained 480-volt ballast shall be utilized along streets, roadways and pedestrian crossings. General Electric model # M-250A-2 POWR/DOOR luminaire or equal.

2. Street lighting shall be concrete standards with eight-foot aluminum davit arm. Ameron Contemporary Series, 1C1 octagonal pole anchor base with anti-graffiti sealer.

3. Minimum set back is 30 inches back from face of curb.

4. Check with the University when adding fixtures of this type to the campus existing power circuits.

5. Each fixture shall be fused with time delay fuse in a weatherproof holder in the head.

Q. Parking Structure Lighting

1. Provide ultra-long life lamps (minimum 60,000 hours) with electrode less construction, such as Philips Lighting QL series or other state-of-the-art lamps.

2. Fixtures shall be specifically designed for use in parking structures. Fixtures on the top level shall be pole mounted campus standard parking lot fixtures but not HPS lamps.

3. Fixtures on the perimeter of above grade open parking structure shall be photocell controlled. Provide a minimum of two photocells to zone by exposure.

R. Parking Area Lighting
1. Luminaries shall be 250 watt, 480 volt self contained, high pressure sodium, manufactured by Gardco, model Hardtop 22 inch CA series, bronze anodized finish or equal by Kim Lighting (no other known equal).

2. Poles should be 5-inch diameter, straight round aluminum, with dark bronze anodized finish, as manufactured by Thomas Lighting.

S. Grounds Lighting

1. Landscape lighting of trees and plants shall be limited. Ground lighting must account for the very corrosive nature of the University’s soil. Do not recess metal fixture housings in the soil. Provide a concrete pedestal or non-metallic materials.

T. Ring Mall Lighting

1. Ring mall lighting fixtures are manufactured specifically for the University and known under the general name “Theme Light” or “bird cage”. The University shall provide direction on when to add these type fixtures to the Campus system at locations other than ring mall. Details of this fixture are included with campus standard details.

2. Lighting circuits for exterior lighting in the central ring area are to be connected to panelboards in the tunnel vaults. Existing time switches in the Central plant control the panelboard contactors. Confirm panelboard location and determine that available capacity and circuits are adequate for project requirements.

3. Lighting in areas away from the ring mall area shall be controlled from nearest large building and as directed by the University Building Management system director.

U. Pathway Lighting

1. Pathway luminaries shall be Gardco model # CA 1713-100HPS-480-BRA-HF or equal by Kim Lighting (no other known equal). Use 150 watts lamps in well lit when directed by the University.

2. Lighting standards shall be Gardco model # RA4-12-AF-D1-BRA, 4-inch diameter, aluminum bronze anodized, straight round pole with a round pole base cover.

3. Pathway lighting with bollards should be minimized. If bollards are used locate in planting areas where exposure to pedestrian and bicycle traffic is minimal. Bollard shall be Ameron, model # B20x1.5BP 113 LUC DB 100 watts HPS, 480V, concrete aggregate type.

4. Pathway lighting for major spokes from the ring mall shall use the campus theme light fixture. The University shall determine when a pathway is a major spoke.

V. Exterior Building Lighting

1. Exterior surface building mounted lighting in public areas that has been used on campus is Kim Lighting model WF20, WF21 or WF22. Lamps shall high-pressure sodium or compact fluorescent.

2. Service area fixtures shall be Holophane Wallpack II with 150-watt high pressure sodium lamp, model WL2K 15AHP MT BZ.

W. Foot-Candle Levels
The following levels shall be provided:

<table>
<thead>
<tr>
<th>TYPE OF OCCUPANCY</th>
<th>FOOT-CANDLE ILLUMINATION LEVEL</th>
<th>UNIFORMITY RATIO (AVERAGE: MINIMUM)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXTERIOR LIGHTING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIKEWAYS</td>
<td>0.5*</td>
<td>5:1</td>
</tr>
<tr>
<td>PARKING LOTS</td>
<td>1.0***</td>
<td>4:1</td>
</tr>
<tr>
<td>PATHWAY**</td>
<td>1.0*</td>
<td>4:1</td>
</tr>
<tr>
<td>PLAZA</td>
<td>1.0*</td>
<td>5:1</td>
</tr>
<tr>
<td>RING MALL LIGHTING</td>
<td>2.2#</td>
<td>5:1</td>
</tr>
<tr>
<td>SERVICE YARD (SECURITY)</td>
<td>0.2*</td>
<td>Na</td>
</tr>
<tr>
<td>WELL LIT PATHWAY</td>
<td>2.2#</td>
<td></td>
</tr>
<tr>
<td><strong>ROADWAYS (AVERAGE)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRIMARY AND SECONDARY</td>
<td>0.9</td>
<td>4:1</td>
</tr>
<tr>
<td>RESIDENTIAL</td>
<td>0.6</td>
<td>4:1</td>
</tr>
<tr>
<td>SERVICE ROADS AND ALLEYS</td>
<td>0.4</td>
<td>4:1</td>
</tr>
<tr>
<td><strong>PARKING STRUCTURES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARKING &amp; PEDESTRIAN</td>
<td>5.0 &amp; 5.0##</td>
<td>4:1</td>
</tr>
<tr>
<td>RAMPS AND CORNERS</td>
<td>10.0 &amp; 5.0##</td>
<td>4:1</td>
</tr>
<tr>
<td>ENTRANCE AREA</td>
<td>50.0 &amp; 5.0##</td>
<td>4:1</td>
</tr>
</tbody>
</table>

* Average maintained horizontal level on grade or pavement.
** Crosswalks traversing roadways in the middle of long blocks and at street intersections shall be provided with additional illumination.
*** Minimum maintained on the parking lot surface.
# Average maintained vertical level at six feet above walkway.
## Day and night foot-candles. Day foot-candle level is sum of electric lighting and day-light.

1.24 **EMERGENCY LIGHTING**

A. General

1. One corridor light on each floor level located near each stairwell, elevator and/or exit shall be serviced from and switched at the Building Emergency Panelboard.

2. Egress stairwell lights shall be served from the Building Emergency Panelboard.

3. Home runs for both normal and emergency power shall be in separate conduits.

4. At least one light fixture in a public toilet shall be an emergency lighting fixture. Rooms over 30 feet deep from exit door shall have two emergency light fixtures.

5. Emergency lighting may also serve as night lighting fixture.

6. Provide pathway and l or exterior building lighting on emergency power circuits from exit doors to the adjacent public way, normally 50 feet from the building. University representative shall consult with DCFM for area requiring exterior emergency lighting.

7. Provide emergency lighting in mechanical and electrical rooms. They shall not be used
as night lights.

8. LED emergency lighting fixtures with battery packs may be used in lieu of connecting light fixtures to the building emergency system.

9. All emergency lighting shall meet the requirements of CBC for secondary power and CEC article 700.

B. Without Emergency Power Present

1. Where an emergency panelboard is not available, supply fixtures from a remote battery and battery charger served from a normal source circuit.

2. Provide integral or remote battery packs for emergency lighting circuits. An inverter system shall only be used when directed by the University.

3. Provide power for emergency lighting for a minimum of 90 minutes during a power failure.

4. Exit signs may be with integral or remote battery pack.

5. A separate fixture for emergency lighting from normal lighting shall not be used except as follows:
   a. Temporary construction.
   c. Where required to comply with emergency transfer response code criteria.

C. Exit Signs

1. LED exit signs shall operate at or below 30mA current at nominal AC input voltages (277 volts).

2. LED emergency exit signs with battery packs may be used in lieu of connecting exit signs to the building emergency system.

3. Exit signs shall be “RED” lettered, LED type. Green exit signs and nuclear powered exit signs shall not be furnished

4. Provide low level exit signs as required by NFPA 101, CBC and CEC.

D. Health Care Facilities

1. Battery units shall not be used in Health Care facilities as the only source of emergency power.

END OF SECTION 26
DIVISION 27 0543
UNDERGROUND DUCTS AND RACEWAY FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Publications and Standards
B. Related Sections
C. Telecommunications Submittals
D. Quality Assurance

1.2 PUBLICATIONS AND STANDARDS
A. National Electrical Code (NEC) (ANSI/NFPA 70):
   1. Chapter 8: “Communications Systems”
   2. Article 250: “Grounding”
B. Electronics Industry Alliance/Telecommunications Industry Association (EIA/TIA): EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
C. Federal Communications Commission (FCC) Part 15 and Part 68
D. Rural Utilities Services (RUS), formally REA
E. Lightning Protection Code - ANSI/NFPA 780
F. American Society for Testing Materials (ASTM) Publications
G. National Electrical Manufacturer’s Association (NEMA) Publications
J. Underwriter’s Laboratories Inc. (U.L.) Publications
   1. 6-1981 (R86) Rigid Metallic Conduit
   2. 514B-1982 Fittings for Conduit and outlet Boxes
   3. 651-1981 Schedule 40 and 80 Rigid PVC Conduit
   4. UL 467 “Grounding and Bonding Equipment”
   5. UL 497, 497A, and 497B “Communications Circuit Protectors”
1.3 RELATED SECTIONS

A. Contract Terms and Conditions

B. Section 27 1500 – Telecommunications

1.4 SUBMITTALS

A. Submittals shall be made for the following products:

1. Underground Conduits and Supporting Components
2. Pull Boxes and related hardware
3. Warning Tape
4. Pull Rope
5. Grounding and Bonding Hardware
6. Conduit tags

1.5 QUALITY ASSURANCE

A. For products or workmanship specified by association, trade, Federal, or State Standards, the Contractor shall comply with the requirements of the standard. When more rigid requirements are specified, the Contractor shall comply with the most stringent code.

B. The Contractor shall conform to reference standard by date of issue current on final design documents.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS UTILITY VAULTS

A. All utility vaults to be installed shall be specifically designed for telecommunications applications, with no exceptions.

B. Materials

1. The Contractor shall provide pre-cast utility vaults meeting ASTM C 478 with 28 day 5500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading per AASHTO HB 14. See conduit construction drawings for vault sizes. The Contractor shall install vaults to meet all manufacture requirements. The contractor shall furnish and place sand bedding to allow proper weight distribution and leveling of all vaults.

2. Utility vaults shall have tongue-and-grove double sealed joints on mating edges of pre-cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer’s installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer’s printed instructions.

3. Conduit Entrances
   a. For conduit installed on this project, knockout panels or pre-cast individual conduit openings may be used.
   b. For existing utility vaults, new ducts shall enter the utility vault with factory-
formed bell end of the conduit, and a seal around the conduit shall be applied after installation. Existing utility vaults that shall be re-used to install new copper and fiber cables shall be retrofitted with the required racking and grounding and bonding per the TIA/EIA Bonding and Grounding Standards.

4. Covers

a. The Contractor shall provide solid covers (traffic rated), with a 76.2 cm (30 in.) diameter clear opening.

b. Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.

c. The covers shall be of indented type with solid top design.

d. The upper side of each cover shall have the letters “Communications” cast or burned by welder, in integral letters no less than 2 inches high. The ring of the casting shall be field stamped with utility vault or pull box numbers as indicated on the conduit drawings.

e. Double lids are required for vaults over 12 feet in length as per OSHA.

C. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal

2.2 COMMUNICATIONS PULL BOXES

A. Pre-cast pull boxes shall meet the standards defined in Subsection 2.1.B. (1).

B. Joints and seals shall be provided and installed as defined in Subsection 2.1.B. (2).

C. Conduit entrances shall be provided as defined in Subsection 2.1.B. (3).

D. Pull boxes shall be equipped with cable racking hardware suitable to support large copper cables.

E. All pull boxes shall be equipped with traffic-rated spring loaded hinged lids with a locking mechanism. All lids shall have the identification marking of “Communications” permanently affixed to the cover. The upper side of each cover shall have the letters “Communications” cast or burned by welder, in integral letters no less than 2 inches high. The cover shall also be field stamped with two inch high pull box identification numbers as indicated on the conduit drawings.

F. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal

2.3 COMMUNICATIONS UTILITY VAULT/PULL BOX HARDWARE

A. Materials

1. Pulling irons shall be provided, as required for the size of utility vault/pull box (minimum of 4 per utility vault; 2 Installed on each end wall, top and bottom). Pulling irons shall be installed opposite the terminators. All pulling irons shall be constructed of 2.2 cm (7/8 inch) hot-dip galvanized steel.

2. A sump of 30 cm (12 in.) in diameter shall be provided in each utility vault, per the manufacturer’s specifications.

3. Heavyweight cable racks with adjustable arms shall be provided for all cables in each utility vault. The racks shall be attached with adjustable inserts set in the concrete walls.
(bolts or studs embedded in concrete will not be used). Racks and inserts shall be centered on the side walls that are utilized for the racking of splice cases in the utility vault, arranged so that all spare conduit ends are clear for future cable installation. The racks shall have a sufficient number of arms to accommodate cables for each conduit entering or leaving the utility vault.

4. Corner standoff brackets 15cm to 20cm (6 in. to 8 in. from wall) shall be provided if the utility vault is equipped with center exit conduits. The bracket shall extend from 15cm (6 in.) off floor to 15cm (6 in.) below roof.

5. All utility vault and pull box hardware shall be steel that is hot dip galvanized after fabrication.

6. Each utility vault shall have a detachable galvanized steel ladder per opening that can be removed to facilitate future work in the utility vault. The ladder shall be secured to a top support arm in the utility vault opening or chimney.

**B. Manufacturers**

1. Hardware: Jensen Precast, Alhambra Foundry (model No. A-3382 ladder with A-3383 support bar), Inwesco Products, or equal.

2. Utility vault: Jensen Precast, Brooks, Utility Vault, or Associated Concrete Products, or equal.

### 2.4 COMMUNICATIONS DUCT-BANKS

**A. Materials**

1. Conduit

   a. Schedule 40 PVC - Size and quantity as shown on Drawings.

2. Conduit shall have a factory formed bell on one end for interconnecting segments.

3. All conduits shall be installed in an encased steel pipe where a boring method is utilized. Grout shall be provided between conduits inside pipe and around steel pipe to fill voids per manufacturer’s specifications.

4. Spacers: High impact spacers shall be used in all multi-duct systems, for both solely-owned or joint telecommunications/power constructions. They shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512 dimensions.

5. All fittings shall be designed specifically for use with the type of conduit installed.

6. All conduits shall be equipped with expansion rubber type sealing plugs in all utility vaults/pull boxes to include conduits within all buildings.

**B. Manufacturer:** CARLON or equal for conduit.

TYCO / JACKMOON for conduit Duct Sealing Plugs

### 2.5 COMMUNICATIONS ENTRANCE CONDUIT

**A.** Conduit entering a building shall be galvanized steel pipe (rigid steel). Conduit shall transition from PVC to GRC at a distance of 24 inches beyond the exterior of the foundation to two inches AFF in the entry room. The conduits shall slope downward away from the building to reduce the potential of water entering the building. All metal conduits shall be equipped with a plastic grommet to prevent cable damage during installation.

### 2.6 DUCT-BANK LOCATING CABLE (DETECTABLE WARNING TAPE)
A. Warning tape shall be a minimum of 6” wide, orange in color, and shall have a nondegradable imprint as follows:
   1. “Caution Fiber Optic Cable Buried Below”
B. The tape shall be detectable.
C. Manufacturer: As follows:
   1. Carlon
      a. MAT3061 “Caution Fiber Optic Cable Buried Below”.
   2. Equivalent manufacturer’s type and style is acceptable.

2.7 PULL ROPE
A. Pull rope shall be new 3/4” polyester mule tape with a minimum 2500 lb. tensile strength.
B. Manufacturers: NEPTCO or equal.

2.8 BONDING/GROUNDING
A. The reinforcing steel in the walls of the utility vault shall be bonded together and brazed to the bronze inserts of each section of the utility vault per the manufacturer’s utility vault specifications. The ground inserts shall be attached to the steel rebar to provide a point of attachment for the ground wires or bonding ribbon. The inserts shall be bronze, flush mounted, and brazed to the rebar cage of all the sections of the utility vault (bottom, intermediate, and roof sections).

B. Materials
   1. Bonding Ribbon: Shall be made of annealed solid copper 3/8 inch wide x 1/16 inch thick, tin plated. Manufacturer: INWESCO Cat.12A55 or equal.
   2. Bonding Ribbon Clamp: Shall be made of soft lead 1/2 inch wide by 1/16 inch thick and shall accept 1/4 inch diameter bolt. Manufacturer: INWESCO Cat. 12A56 or equal.
   3. Fargo Clamp: Shall be cast from copper, silver plated, furnished with copper bolt. Manufacturer: INWESCO Cat.12A57 or equal.
   4. Ground Inserts: Shall be made of Cast Bronze W/1/4 Copper Rod. Manufacturer: INWESCO Cat.12H69 or equal.

2.9 CONDUIT AND RACEWAY TAGS
A. All conduits and other raceways shall be labeled with permanent type tags. Tags shall include destination engraved onto the tag. Adhesive or taped-on type markers shall not be permitted.

PART 3 - EXECUTION
3.1 COMMUNICATIONS UTILITY VAULTS AND PULL BOXES

A. General

1. The Contractor shall obtain all required permits and notifications before commencing any work operations.
2. All state and local ordinances shall be complied with at all times.
3. All federal, state, and local safety rules, including OSHA, will be enforced at all times during the duration of the project. It is the responsibility of the Contractor to inspect the job site to ensure compliance.

B. Final location of all communications utility vaults and pull boxes shall be determined by the Contractor and Engineer of Record. All manholes to have a minimum cover of 2 ft. measured from final grade to top of manhole.

C. All conduits entering a utility vault or pull box shall be installed at right angles to the short walls and shall be sealed to prevent seepage unless otherwise specified on the construction documents.

D. Excavation dimensions shall be verified with the utility vault supplier in advance so as to prevent delays in setting schedule.

E. Shoring shall be in accordance to prevailing underground construction codes, i.e., OSHA, G. O. 128, NESC, and all applicable local, state, and federal statutes.

F. All utility vaults shall be equipped with pulling irons.

G. Finish grade shall be established prior to placing structures.

H. The Contractor and the Inspector of Record shall inspect all utility vaults prior to backfilling.

I. Backfill materials shall have been sifted to provide a sand equivalent of not less than 20, and a sieve size of No.4. Backfill material shall be mechanically compacted to a minimum relative compaction of 90 percent to a level six (6) inches above final grade. The excess material shall be excavated to the final grade upon acceptance of compaction.

J. Existing and/or new communications utility vaults/pull boxes may be installed near the existing power and signal vault system. The Contractor shall either install new or enlarge existing utility vaults/pull boxes and conduits in such a manner as to not disturb existing utilities while maintaining specified clearances from all obstructions. This may require clearing much of the area around the vaults by hand. The final installment and depth shall be determined by the Contractor and Engineer/Inspector of Record.

K. The Contractor shall locate all existing utilities within 20 feet of the new and/or enlarged utility vault/pull box system. The Contractor and Engineer/Inspector of Record shall review and approve any revised coordination schematics. Caution shall be used when working in this area.

L. The Contractor shall excavate around existing vaults using caution to identify and preserve all utilities in the area.

3.2 DUCT BANKS AND CONDUITS

A. All communications conduit ducts shall be encased in 2-sack concrete mix slurry with at least 3 inches of concrete at the top and bottom and 3 inches on each side. A horizontal and vertical
separation of 2 inches between the ducts shall be maintained by installing high impact spacers with horizontal and vertical locking intervals of ten feet. The top surface of the concrete encasement shall include an orange color dye for future identification.

B. All communications conduit shall be installed in a uniform manner between vaults. Conduit in position #1 at one utility vault shall maintain its position within the duct run and terminate in the #1 position at the next utility vault. The position of all conduits between utility vaults shall be maintained.

C. Long radius bends (over 30 feet) shall be used whenever possible to make changes in direction. If it is found to be necessary to install a 90 degree bend in the conduit run, a factory-made sweep of no less than 12 feet 6 inches radius shall be used. No conduit run shall exceed a total of 180 degrees of bend between any two points (such as utility vaults or buildings) considering both vertical and horizontal sweeps. Cold-formed trench bends shall have a radius of not less than 40 feet and shall pass mandrel integrity. Bend radius criteria are 2” or less 6 times the diameter of the conduit and, for any conduit larger than 2”, 10 times the diameter of the conduit.

D. The length and destination of all conduits shall be identified in each utility vault, pull box, and building. Embossed metal or heavy plastic tags strapped to each conduit shall be used.

E. After installation of communications conduit and after the concrete encasement has cured, the Contractor shall prove all conduits by pulling a mandrel with a diameter ¼ inch smaller than the conduit and 12 inches long through each conduit end-to-end. The Inspector of Record shall be notified 24 hours before this procedure. Each conduit shall be cleaned with a bristle brush to remove any debris.

F. All utility vault and pull box entrances shall be shear-blocked with standard concrete extending no less than 15 inches from the entry wall. All entering ducts shall be completely encased.

G. Utility marking tape shall be buried 12 inches below the surface directly above the conduit.

H. All conduit structures shall be built with the telecommunications conduits installed above the power conduits with a minimum of 12 inches of separation unless otherwise called out on the construction drawings. If this type of construction is required, it shall receive prior approval of the Engineer of Record.

I. All entrance conduits shall be securely fastened to the building. The end of the conduit located inside the building shall be sealed to prevent rodents, water, or gases from entering the building.

3.3 ENTRANCE CONDUIT

A. Install entrance conduits of Rigid Steel 4” conduits from within 24” of new building foundation and all the way to the telecom room (BDF) of the new building.
3.4 LOCATING DUCT BANK CABLE

A. Underground detectable warning tape shall be installed in all trenches at one foot below the final grade after the conduit and encasement is complete. The tape shall indicate the type of cable that will utilize the substructure system, e.g., fiber optic or copper cables. The detectable warning tape shall be installed according to manufacturer’s specifications to ensure access to the tape for locating purposes.

3.5 MULE TAPE

A. Mule tape shall be new material that is free of knots, kinks, and abrasions.

B. Mule tape shall be installed as a single continuous length in every new conduit, no splicing will be allowed.

C. Mule tape shall be installed in all conduits to include an additional 10-feet of slack remaining on each end secured to loop-eye end of expanding rubber type duct plug.

3.6 BONDING/GROUNDING

A. Bonding conductors shall be routed with a minimum number of bends. The bends placed in the conductor should be sweeping.

B. All bonding connections shall utilize listed bolts, crimp pressure connectors, clamps, or lugs. Exothermic welding may be used.

END OF SECTION 27 0543
NOTE: THIS SPECIFICATION (27 1300) IS BEING PROVIDED FOR REFERENCE ONLY. OUTSIDE PLANT BACKBONE CABLE DESIGN FOR EACH NEW AND/OR REMODELED BUILDING IS DEALT WITH ON A CASE-BY-CASE BASIS. THIS DOCUMENT ALONG WITH THE NECESSARY DRAWINGS AND ESTIMATED COST BUDGET WILL BE PROVIDED BY THE UNIVERSITY “INFORMATION TECHNOLOGY SOLUTIONS” (ITS) DEPARTMENT TO THE DESIGN CONSULTANT(S).

GENERAL
1.1 DESCRIPTION OF WORK
A. The work shall consist of the provision, splicing, termination and testing of a complete and fully-functional Air-Blown Fiber (ABF) data system and if required an extension of the existing Copper Plant. There will be a 24 Strand ABF Singlemode Optical link between Telecom Building Room 123 or SOM-EB Data Center Room 1600 and (New Building Name, BDF-xxx Telecom Room xxxx). This work will also include a xx Pair 24 AWG Copper Cable extension from MH-xx thru MH-xx to Building Name BDF-xxx Telecom Room xxxx. This work shall include but not limited to the provision of the following:
1. Telephone and data system hardware.
2. Telephone system underground copper backbone OSP cable with Protection.
3. Data system Air-Blown Fiber (ABF) bundles and tubing in the underground.
C. The work shall not include provision of the following:
1. Telephone handsets and active switching equipment.
2. Integrated Services Digital Network equipment.
3. Telephone services. Active computer and networking equipment.
5. Horizontal Category 6 Cabling.
D. Provide incidental items that belong to the Work described and which are required for a complete end to end system.

1.2 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to this Section.

1.3 QUALIFICATIONS
A. A specialist installer company that has completed work of a similar nature shall carry out the telephone and data system installation work detailed in this section.
B. The installer shall have a proven track record in the field of telephone, data, and fiber cabling and system installation, with at least five previous installations of comparable size and complexity undertaken within the last three years.
C. The installer shall be qualified in the installation and termination of optical fiber cabling as described in this specification.
D. Installer shall be an authorized Sumitomo Electric Lightwave Corporation Licensed FutureFLEX Installer (LFI) and shall provide the Sumitomo Electric 25 year extended product warranty and application assurance on this installation.

1.4 SUMMARY
A. This Section includes the following items for wiring systems used as signal pathways for voice and high-speed data transmission:
   1. Mounting elements.
   2. Underground copper and protection.
   4. Identification products.

1.5 DEFINITIONS
A. ABF: Air-Blown Fiber
B. Backbone: A facility (e.g., pathway, cable, or conductors) between telecommunications rooms or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings.
C. BDF: Building Distribution Frame.
E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
F. EMI: Electromagnetic interference.
G. FTU: Fiber Termination Unit.
I. LAN: Local area network.
J. LFI: Licensed FutureFlex Installer.
K. MDF: Main Distribution Frame.
L. RCDD: Registered Communications Distribution Designer.
M. PFE: Polyethylene Extruded Foam (jacketed).
N. SEL: Sumitomo Electric Lightwave.
O. TC: Tube Cable.
P. TDU: Tube Distribution Unit.
Q. TGB: Telecommunications Grounding Busbar (IDF locations).
R. TMGB: Telecommunications Main Grounding Busbar (BDF location).

1.6 SUBMITTALS
A. Qualification Data: See 1.3.
B. Provide sample copy of copper riser and fiber test reports.
C. Cable Test Results: (Mandatory for FutureFLEX Extended Warranty)
   1. Tube Cable Tests.
      a. Pressure Tests shall be submitted to the Owner’s Representative on appropriate forms showing; (Refer to Sumitomo Recommended Procedure SP F-04-003 – Tube Pressure Testing Procedure)
      b. Test date
      c. Installer’s name
      d. Tube Cable ID
e. Tube # (in)
f. Tube # (out)
g. Test Pressure (P.S.I.)
h. Time held
i. Obstruction Tests shall be submitted to the Owner’s Representative on appropriate forms showing; (Refer to Sumitomo Recommended Procedure SP F-04-004 – Tube Obstruction testing Procedure)

j. Test date
k. Installer’s name
l. Tube Cable ID
m. Tube # (in)
n. Tube # (out)
o. Span Length
p. Travel time
q. P.S.I. test rate
r. PEF jacketed, Bundled Fiber Optics Testing shall be submitted to the Owner’s Representative.
s. Submit manufacturer’s test reports for each reel of fiber bundle provided prior to installation.
t. Submit Contractors on-reel test results at 850 and 1300 nm for multimode and 1310 and 1550nm for single-mode.
u. Submit Contractor’s OTDR test results after bundled fiber terminations are installed. (Required for FutureFLEX Extended Warranties)
v. Submit soft copy PEF jacketed, bundled fiber optic cable OTDR test results on compact disc (CD). Format CD test results in comma separated variable (CSV) format wherever possible. Provide proprietary software on the CD to enable viewing of the soft-copy test results. (Required for FutureFLEX Extended Warranties)

1.7 AS BUILT DOCUMENTATION
A. The as-built documentation shall consist of the construction drawings to include wall to wall and wall to building footages (Telecom room) inserted next to the symbol for each MH and MDF/BDF location.
B. Show FTU Panel numbering.
C. Show PEF jacketed, bundled optical fiber cable numbering and labeling.
D. The as-built documentation shall also contain the cabling routes taken between the cable tray, conduit and/or J-Hooks if applicable.

1.8 COORDINATION
A. Coordinate layout and installation of communication cabling with UCR telecommunications representative prior to start of work.
B. Meet jointly with UCR telecommunications representative to exchange information and agree on details of equipment arrangements and installation interfaces.
   1. Record agreements reached in meetings and distribute to other participants.
1.9 WARRANTY

A. Submit at project closeout, a signed and registered FutureFLEX® Warranty consisting of extended product warranty and applications assurance in accordance with the FutureFLEX® Extended Warranty Program.

1. 25-Year Extended Warranty (SEL warrants the FutureFLEX products to be free of defects in material and workmanship for a period of twenty-five (25) years from the date of shipment.)

B. The following is a list of required items that must be submitted for application for this warranty:

a. Complete the Warranty registration Form on the FutureFLEX website and submit to SEL.
b. Testing data for the Obstruction and Pressure Test for each tube and tube cable in the system.
c. Sample Test Data Sheets are available on the website.
d. Original handwritten test results from the field are required; typed results are not acceptable.
e. Electronic copies of OTDR Readings with viewing software and fiber spans identified per As-Built Drawing.
f. Bi-Directional measurements are required at the highest wavelength
g. All software required to run or view the test data must accompany the application.
h. Copies of as built drawings must be submitted to SEL via electronic or hard copy to SEL. (Drawings must be in AutoCAD or Visio)
i. Submit copies of purchase invoices for the FutureFLEX products used in the installation. (Hard copies only)

C. At notice to proceed, submit the most current copy of the FutureFLEX® certificate of registration and the warranty terms and conditions that apply to the FutureFLEX® solution, unless submitted with pre-qualification documentation.

D. Submit a statement, at notice to proceed, of any Contractor warranties in addition to the manufacturer’s stated and supplied warranties. Submit at closeout signed copies of the Contractor provided warranties that are in addition to manufacturer’s stated and supplied warranties.

1.10 MATERIALS STANDARDS

A. Products, services, and materials provided by the Contractor shall meet the requirements of the following:

1. National Electrical Manufacturer’s Association (NEMA).
3. Institute of Electrical and Electronic Engineers (IEEE).
4. Underwriter’s Laboratories, Inc., (UL) or equivalent.
11. EIA/TIA Standard EIA/TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
B. Products, services, and materials provided by the Contractor shall be new and of high quality and free of faults and defects.

1.11 SYSTEM TESTING
A. Following telephone, data, and fiber optic cable installation and termination at both ends, undertake and record tests to ensure that the cabling system will perform satisfactorily in service. In addition to the tests detailed in this specification, the Contractor shall carry out any additional tests that he deems necessary to ensure the satisfactory operation of the telephone, data, and fiber optic cable systems. The costs of these additional tests shall be borne by the Contractor.

B. Provide the University Representative with the opportunity to witness all testing. On request, the installer shall demonstrate that the test procedure competently identifies the fault conditions being tested for.

C. Complete the tests identified in all of the telephone and data system specifications in accordance with TIA/EIA-568-B.1, B.2 & B.3

D. Notify the University Representative in writing seven working days before the date of commencement of the cable tests. Provide details, on that advance date, of proposed tests, the test schedule, equipment to be used, its certification and calibration, and the names and qualifications of test personnel.

E. Personnel shall be competent in and qualified by experience or training for detailed design, installation, and testing of telephone, data, and fiber optic cable systems.

F. Include the cost of obtaining, calibrating, and maintaining test equipment, and the cost of carrying out and recording the tests, including labor costs, in the bid sum.

G. Ensure that all Test Equipment is in calibration before delivery to site and throughout the testing period. The installer shall be responsible for ensuring that any necessary tests and rework to maintain equipment's calibration status are carried out.

H. To support the test procedure, create a printed table of every cable in the building or outside plant (OSP) with appropriate columns for each test result and comments.

I. Sign and date each successful series of test results as the tests proceed. As a minimum, each completed page of test results shall be signed and dated once all the tests on that page have been successfully completed and their results recorded.

J. The test documentation shall be available for inspection by the University Representative during the installation period and the original documents (not copies or retyped versions) shall be passed to the University Representative within five working days of completion of tests on cables in each area. The installer shall retain a copy to aid preparation of as-built information.

K. Failures detected during the testing shall be duly noted on the test results schedule and rectified. On the fault being rectified, this shall also be noted. These notes shall not be deleted or obliterated.

L. Rectification of all damaged cables shall include replacing damaged cables with new cables in complete runs or remaking poor terminations. In-line cable joints, splices, or distribution points are not acceptable. All damaged cables shall be removed from site and replaced at no cost to the University.

1.12 JOB CONDITIONS
A. Prior to starting any Work, notify the University Representative in writing of dimensional discrepancies and other conditions detrimental to proper performance of the Work.

B. There shall be no additional cost incurred by the Owner for complying with the specifications and requirements of the Contract Documents.
C. As catalog numbers change frequently, the Contractor must verify all part numbers prior to ordering materials. Written clarifications shall be issued in response to written Request for Information (RFI).

1.13 LIFETIME OF SYSTEM
A. The physical and operational lifetime of the installation is intended to be in excess of ten (10) years.

1.14 WARRANTY
A. Provide a 25 year Premium Product & Installation Warranty by Sumitomo Electric and the Licensed FutureFlex Installer.

1.15 LABELING AND NUMBERING SCHEME
A. Label each component of the telephone and data systems with its unique identification number. The labeling and numbering scheme shall be compatible with the labeling and numbering scheme currently used by the University of California-Riverside. The labeling and numbering scheme used by the contractor/installer shall be approved by the University Representative.

PRODUCTS AND SYSTEM REQUIREMENTS
1.16 MANUFACTURERS
A. Manufacturers:
   2. Essex PE-89 for twisted pair Copper (backbone) cable.
   3. Preformed Line Products for Stainless Steel Splice Cases.
   4. Panduit, Hellerman-Tyton, Allen-Tel or CPI for horizontal and vertical wire management products.

1.17 TUBE CABLES AND HARDWARE
A. The Contractor shall provide all Tube Cables, Tube Couplings, Tube Distribution Units (TDUs), Fiber Bundles, Fiber Termination Units (FTUs), Connectors and hardware/equipment as indicated on the drawings.
B. Contractor to couple assigned tubes in tube cables as shown on drawings with clear tube couplers in TDU’s; (List out TDU’s) X.X.X, X.X.X, X.X.X, X.X.X, and X.X.X.
C. Contractor to verify cut lengths required prior to ordering.
D. In MH-17, TDU 6.7.5, change-out existing end plate to accommodate new 7-tube cable as required, field verify splice case size, records show (DE12SPC) 12.5 inch Stainless Steel Splice Case.
E. Provide TDU 6.9.2 (DE06MDU) on north wall in Telecom Room 0137 BDF-LLA.

1.18 TELEPHONE SYSTEM BUILDING ENTRANCE TERMINAL
A. Provide XXX Pair Building Entrance Terminals (Porta Systems 24XXX-110-M110C) or equal equipped with (xxx) 4C1S CommScope Protection Modules, Protector Code 4C1S and Material ID # 104386545. The cable sheath and the Building Entrance Terminal shall be bonded and grounded to the TMGB bus bar with green, stranded #6 ground wire. Terminate and connect
one end with two-hole compression lugs at TMGB and use set screw on protector side. Label Building Entrance Terminal with Cable Number and Pair Count.

1.19 DATA SYSTEM FIBER OPTIC PATCH PANELS
   A. At Telecom Building; Terminate 24 Strand SM in Room 123 in exiting equipment Rack D, FTU #4A, panel(s) “F & G”. Coordinate location with UCR Telecommunications Representative, see drawings.
   B. At MRB1 Building; Terminate 24 Strand SM in Room 0137 in new existing FTU 6.9.3, panel(s) “A & B”, see drawings.
   C. At Telecom and MRB1 Building, Provide SC Duplex Connector Panels in the existing FTU(s), See Drawing T1.3 & T1.4 for Panel Details.

1.20 DATA SYSTEM EQUIPMENT HARDWARE
   A. Provide Data System Hardware as shown on drawings.
      1. Supply all miscellaneous parts and pieces to make a complete system.
      2. Provide Fanout kits for 24 strand ABF on each end.

1.21 TELEPHONE AND DATA SYSTEM CABLE TAGS AND LABELS
   A. Provide labels and/or Cable Tags for telephone and data distribution and feeder cables.
   B. The lettering on each label shall be as large as is practicable. All labels shall be machine produced. Handwritten labels will not be acceptable.
   C. A standard relative orientation shall be adopted for all labels unless otherwise specified.
   D. Labels shall be robust, durable, shall resist abrasion, and shall be UV inhibiting, permanent and indelible. Labels shall be proof to 140°F Fahrenheit.
   E. Labels shall be readily visible and shall be fixed so that they remain in a visible position wherever practical.
   F. Labels shall carry the full complement of characters to designate the unique identification for the item that they identify.
   G. Cable Tags (OSP Copper and ABF Tube Cable): Canoga Perkins, Panduit or approved equal.
   H. Cable Labels: Provide Self-Laminating Wrap Around Cable Labels Brady Corporation or equal. Cable Labels shall have a white printing area with black print. Cables Labels shall be preprinted or computer printed type. Hand written Labels are not acceptable. Cable Labels shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

1.22 DATA SYSTEM VERTICAL/HORIZONTAL PATCH MANAGEMENT
   A. Provide vertical/horizontal patch management for Building Entrance Terminals. Provide Allen-Tel GB13x “D”-Rings or approved pathway.

1.23 TELEPHONE DATA SYSTEM NON-CONTINUOUS CABLE SUPPORTS
   A. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed. Non-continuous cable supports shall have flared edges to prevent damage while installing cables. Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
B. Non-continuous cable supports shall be ERICO CableCat™ J-hook series or approved equal.

1.24 OPTICAL FIBER BACKBONE CABLE
A. Optical Fiber Backbone Cable: Provide one (1) Air-Blown Fiber (ABF) Bundled cable consisting of one (1) twenty-four (24) strand single-mode fibers. ABF bundle shall be FB24SX. Fiber bundle shall be Polyethylene Extruded Foam (PEF), Color Yellow, marked every two feet with: strand count and fiber mode. Factory-fabricated, industry standard low water peak, glass-type optic single-mode fiber bundle with the following operational and construction features.

Single-mode Optical Fiber Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Diameter</td>
<td>8.3 µm nominal</td>
</tr>
<tr>
<td>Cladding Diameter</td>
<td>125.0 (± 0.5) µm</td>
</tr>
<tr>
<td>Core/Clad Offset</td>
<td>≤ 0.5 µm</td>
</tr>
<tr>
<td>Cladding Non-Circularity</td>
<td>≤ 0.5%</td>
</tr>
<tr>
<td>Coated Fiber Diameter</td>
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<tr>
<td>Cladding/Coating Offset</td>
<td>≤ 12 µm</td>
</tr>
<tr>
<td>Colored Fiber Diameter</td>
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<tr>
<td>Attenuation</td>
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<tr>
<td></td>
<td>0.30 dB/km @ 1550 nm</td>
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<tr>
<td>Maximum Dispersion</td>
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</tr>
<tr>
<td>Zero-Dispersion Slope</td>
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<tr>
<td>Polarization Mode Dispersion LDV</td>
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</tbody>
</table>

B. Contractor to verify cut lengths required prior to ordering.

1.25 SINGLE MODE OPTICAL FIBER CONNECTORS
A. Optical Fiber Connectors. Provide Corning UniCam 95-200-42 SC style single-mode fiber connections or approved equal, conforming to the following specification.

B. SC compatible with ceramic ferrule.
C. Maximum insertion 0.2 dB average, 0.5 dB max, 0.1 dB standard deviation.
D. Optimally keyed.
E. Fitted with strain relief boots to ensure durable and robust connections.
F. Durability better than 500 rematings, FOTP-21 with maximum increase in insertion loss of not more than ≤0.2 dB change.
G. Color-coded caps and boots to distinguish between transmit and receive elements in a duplex pair.

1.26 TELEPHONE SYSTEM BACKBONE OSP CABLE
A. Provide PE-89 copper 24 AWG twisted pair cable, see drawings for pair size and cable route.
B. Contractor to verify cut lengths required prior to ordering.
C. Materials shall be Superior Essex (PE-89) or approved equal.
D. Provide 3M 710 splicing system OSP Connectors for underground splices.
E. Provide 3M710-SC1-25 for the CO side of all splices.
F. Provide 3M710-BC1-25 for the Field side of all splices.
G. All OSP Manhole/Cabinet splices to be completed in a facilities type fold back design.
1.27 GROUNDING AND BONDING
   A. Materials: Comply with NFPA 70, TIA/EIA-607, and UL 467.

1.28 TELEPHONE SYSTEM BACKBONE OSP CABLE SPLICE CASES & PROCEEDURES
   A. Provide Preformed Line Products Stainless Steel splice cases for all Manhole (underground) splice locations.
   B. Provide all required racking and/or steps necessary for proper support of cable.
   C. Provide step locks to secure all steps in place and secure cables to steps.
   D. In MH-17 (copper splice), change-out existing end plate as required, field verify splice case size, records show 6.5-inch Stainless Steel Splice Case, see Construction drawings for splice case size and locations.
   E. Bond & Ground all cables and splice closures.
   F. Flash Test underground splice cases with a minimum of 10Lbs PSI to assure complete resistance to water penetration. Provide the University Representative (48 hours’ notice) with the opportunity to witness all testing.

1.29 IDENTIFICATION PRODUCTS
   A. Manufacturers:
      1. Brady Corporation, Inc.
      2. Panduit Corp.
      3. Hellerman-Tyton
      4. Kroy LLC.
   B. Comply with TIA/EIA-606-A.
   C. Cable Tags (OSP Backbone Copper and ABF Tube Cable): Canoga Perkins, Panduit or equal.
   D. Cable Labels: Self-Laminating Vinyl Cable Labels, machine printed with alphanumeric cable designations.

1.30 SOURCE QUALITY CONTROL
   A. Fiber-Optic Cable: Each cable spool tested at factory before shipping at 1310 and 1550 nm for Single-mode.

EXECUTION
1.31 INSTALLATION STANDARDS
   A. Comply with BICSI TCI, TIA/EIA-568-B.1, TIA/EIA-568-B.2, TIA/EIA-568-B.3, and TIA/EIA-569-A.
   B. Installation and certification of all unshielded twisted pair (UTP) cabling in accordance with the latest available TIA/EIA requirements for cabling installations is required.
   C. Cabling Systems and Pathways shall be installed in a “neat and workmanlike manner” as specified by ANSI/NECA/BICSI 568-2001 and National Electrical Code (NEC) Sections 110-12 and 800-6.
D. The contractor shall adhere to and comply with the latest versions and/or revisions of each applicable standard. Among the various standards, guidelines and practices applicable to this project are the following:

1. Building Industry Consulting Services International (BICSI)
2. BICSI Telecommunications Distribution Methods Manual (TDMM 11th edition)
3. California Building Standards Commission
5. Federal Communications Commission (FCC)
6. FCC Part 68.5 Establishment of Telephone Premises Wiring Attestation List
7. Insulated Cable Engineers Association (ICEA)
8. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
12. Telecommunications Industry Association / Electronic Industries Alliance (EIA)
22. UNDERWRITERS LABORATORIES INC. (UL)
29. UL 1286 (1993) Office Furnishings
E. Federal, state, local codes, rules, regulations, and ordinances governing the work, as well as the Owner Technology Infrastructure standards, guidelines and practices may apply and shall be incorporated as part of these Technical Specifications.

F. In reviewing the various Contract Documents, the Systems Contractor shall be responsible for noting conflicts between proposed design/concepts and the applicable standards, guidelines and practices. A written Request for Information (RFI) shall be developed by the Contractor and submitted to the Owner representative prior to commencing any work impacted by such conflicts. Such RFIs shall describe the conflict/violation and, if appropriate, recommend alternative solutions with associated costs. The Owner representative warrants that they will diligently strive to address such RFIs in order to minimize negative impact on the schedule.

G. Where the requirements of the Contract Documents are more stringent than applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the Contract Documents shall apply. In all other instances, the most current standards, guidelines and practices shall apply.

1.32 EXAMINATION

A. Examine pathway elements intended for cables.
   1. Verify proposed routes of pathways. Check raceways, conduits, tube cables, cable trays, J-Hooks, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements. Contractor to verify lengths required prior to ordering.
   2. Identify plan to support cables in suspended and/or open ceilings from the cable tray, conduits sizes and/or J-Hooks to the workstation locations. Verify that load capacity of cable support structures is adequate for each pathway.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

1.33 APPLICATION OF MEDIA

A. Backbone Fiber Optic Cable (ABF) for Data Service: Use Single-mode for runs between Telecom Building and Multidisciplinary Research Building 1 (MRB1) BDF. See construction drawings for details.

B. Backbone Copper Cable for Voice Service: Use OSP PE-89 category 3 cable for runs between MH-17 and MRB1 BDF. See construction drawings for details.

1.34 DATA AND COPPER SYSTEM INSTALLATION DETAILS

A. Data System Cabling:
   1. Install one (1) twenty-four (24 strand SM FB24SX) data system Air-Blown Fiber (ABF) optical fiber cabling as indicated on drawings running between the Fiber Termination Unit (FTU 4A) connector panel(s) F & G in the Telecom Room 123 and the FTU (6.9.3) connector panel A & B in Multidisciplinary Research Building 1 (MRB1) Telecom Room 0137.
2. Couple assigned tubes in tube cables as shown on drawings with clear tube couplers in TDU's; 6.7.11, 6.4.2, 6.7.1, 6.7.4, 6.7.5 and 6.9.2.
3. In MH-17, Change-out existing TDU 6.7.5 endplate on DE12SPC 12.5-inch Stainless Steel Splice Case. In MH-17, cut in new 7 Tube Cable (TC07TOX) 6.9.1 into TDU 6.7.5.
4. In MH-17, Change-out (as required) existing 6.5-inch endplate on (copper splice) Stainless Steel Splice Case.
5. Install one (1) seven (7) tube ABF tube cable (TC07TOX) from TDU (6.7.5) in MH-17 to the wall mounted TDU 6.9.2 in MRB1 Telecom Room 0137 BDF as indicated on the drawings.
6. Install one (1) one tube (TC01TGX) from TDU (6.9.2) to FTU (6.9.3) in MRB1 Telecom Room 0137 BDF-LLA Data Rack (RR-02) as indicated on the drawings. Coordinate exact location with University Communications Services representative.

1.35 INSTALLATION PRACTICE

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceway and using conduit, J-Hooks and/or cable tray. Cable Installation:
   1. Install cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
   2. Make terminations only at indicated cross-connect and/or patch panels.
   3. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable at no cost to the University.
   4. Secure and support cables at intervals 12" to 18" and not more than 6" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

C. Wiring within Wiring Closets and Enclosures:

D. Separation from EMI Sources: Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
   1. Separation between unshielded power lines or electrical equipment in proximity to open cables or cables in nonmetallic raceways is as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: 12 inches.
   2. Separation between unshielded power lines or electrical equipment in proximity to cables in grounded metallic raceways is as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: 6 inches.
   3. Separation between power lines and electrical equipment located in grounded metallic conduits or enclosures in proximity to cables in grounded metallic raceways is as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: 3 inches.
4. Electrical Motors and Transformers, 5 kVA or HP and Larger: 48 inches.
5. Fluorescent Fixtures: 5 inches.

E. Take due account of the minimum bend radius of all cables installed. No cables shall be installed in a fashion that contravenes the minimum bend radius of the cable.

F. Provide all cables in straight parallel runs when on cable trays and/or J-hooks. Hold cables running in the vertical direction in place with broad cable ties at not more than 15" centers. Hold cables running in the horizontal direction in place with broad cable ties at no more than 18" centers.

G. Telephone and data system cables shall run in dedicated cable tray, J-hooks and/or conduit provided for data and telephone system use only. Do not tie communication system cables to power or other foreign services. Notify the University Representative in writing of all instances of foreign cabling or other systems installed in telephone, or data system tray or conduit. All cabling shall run parallel or at right angles to building wall structures.

H. Reinstate all pull-wires in conduits after use to facilitate future addition of cables.

I. Contractor shall be responsible to ensure that all new and existing conduit(s) are clean and free of debris. This will require the Contractor to Swab and Mandrel each conduit to be used prior to installing any cable(s) e.g. innerduct, ABF Tubing, Fiber, etc.

J. The Contractor shall individually and properly ground all voice termination frames with #6AWG green stranded wire to the MTGB or TGB.

1.36 GROUNDING
A. Comply with TIA/EIA 607.
B. Grounding Points:
   1. Locate TMGB grounding terminal in the MDF/IDF room.
   2. Provide a ground connection from all voice termination frames, copper riser sheaths to the grounding terminals in the MDF/BDF and IDFs.

1.37 LABELING CONVENTIONS
A. General. Outlets, cables, and terminations shall be labeled with a standard identification tag. Tags shall be typewritten or stamped with indelible waterproof ink and mechanically secured in a permanent fashion. Handwritten labels are NOT acceptable. Labels shall be mounted in a manner, which permits easy access and viewing. Receptacles, cables, and terminations shall be identified using the following conventions.
B. Riser and OSP Cables:
   1. Telephone cable(s) will have cable ID and pair counts, from and to locations clearly marked on each cable and building equipment room punch down blocks.
   2. Optical ABF cable will have cable ID and strand count, from and to locations clearly marked on each building equipment room fiber optic patch panel.
   3. Label each cable with wrap around label so that the label is visible for inspection.
C. Telephone System Termination 110 Block:
   1. Termination 110 Block Labels. Provide a full complement of pre-printed cardboard patch frame labels, allowing each pair of each telephone system distribution, feeder, and external cable to be clearly identified.
1.38 IDENTIFICATION
A. Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by University.

1.39 TESTING AND DOCUMENTATION
A. General:
1. Acceptance testing by the University Representative shall not occur until all work in the communication closet is completed, including but not limited to mounting and installation of fiber riser cables, backboards, terminating boxes, and grounding blocks, and termination of fiber riser cables, copper riser cables, station wires, or any other work necessary for the completion of the installation. Acceptance testing shall be in compliance with TIA/EIA-568-B.1, B.2 & B.3.
2. The University Representative shall have the right to schedule acceptance testing at its convenience.
3. A University Representative, at the option of the University Representative, shall be present during testing.
4. Such acceptance testing shall in no way reduce the Contractors’ obligations regarding restoration, clean up, or warranty.
5. Contractor shall perform tests necessary prior to acceptance testing to ensure that the installed cables will pass acceptance testing performed in conjunction with University Representative.
6. Contractor shall be responsible for performing, tracking, and recording the results of tests.
7. Contractor shall be responsible for providing equipment and materials necessary for as long a period of time as necessary to complete testing to the satisfaction of the University Representative.
8. Test record forms shall be agreed to by the University Representative prior to the commencement of acceptance testing.
9. When testing is completed on cables, the Contractor shall deliver typewritten records of the test results to the appropriate University Representative within 48 hours of completion of such tests.

B. Telephone and Data OSP and/or Riser Cables:
1. A visual inspection shall be made to insure that the cables have been terminated on the punch down block in proper color code order. An end-to-end continuity test is to be made for each pair to insure wire continuity and correct tip and ring polarity. Riser/OSP cables will be tested from the building entrance frame punch down blocks to the floor equipment room punch down blocks that the cable serves.
2. Vertical and/or horizontal riser and/or OSP cables will be tested to insure that they meet the current requirements of EIA/TIA cabling standard for premises horizontal wiring for the category of cable being installed, i.e., Category 3 cable shall meet Category 3 parameters within a 25-pair binder group. Documentation will include cable ID, pair ID, from and to points, pair ID marked on the punch down blocks, results of testing, and as-built information.
3. Bad pairs in copper cables shall be limited to a maximum of 0% of the total number of pairs.
4. Measures taken to correct unacceptable test results will be recorded, along with loss measurements taken before and after corrective measures.
5. Acceptance testing shall be completed not more than 30 days after written notification by the Contractor of completion of its contractual obligations.

6. Documentation will include cable ID, from and to points, strand ID, bi-directional attenuation figures in dB, OTDR wave forms, and as-built information.

7. Use of an OTDR may require that a "launch reel" be used to overcome the OTDR's dead zone. Include this information in the documentation.

8. Fiber jumpers used with the OTDR, light source, and power meter must be of the same size and type as the fiber being tested.

9. Fiber jumpers used with the light source and attaching the jumper from the light source via a coupler to the jumper from the power meter shall zero power meters out. This reading noted will become the reference level to obtain a true attenuation reading (some power meters can be zeroed to allow reading the attenuation level directly).

C. Test Equipment:

1. It will be the Contractor's responsibility to provide the test equipment necessary and document to the University Representative the test equipment available for testing and the last date of certification.

2. Testing Equipment:
   a. Continuity tester.
   b. Power meter/source.
   c. OTDR (Optical Time Domain Reflectometer).
   d. Appropriate types of fiber jumpers.
   e. Equipment for two testers to communicate.

3. Other equipment as approved by designated University Representative and as required completing the testing to the satisfaction of the University.

D. Documentation:

1. The contractor shall submit three (3) copies (drawings hard copy 24" x 36" and Compact Disc) of the following as-built record drawings and documentation in a 3-ring binder following completion of testing (and re-certification, as necessary):
   a. Construction Drawings: The as-built documentation shall be in AutoCAD min 2004 dwg or dxf equal and shall consist of the construction drawings with Equipment Rack and Wall elevations to include Copper and Fiber riser diagrams shall be provided.
   b. Fiber Optic riser Test reports (OTDR and Power Meter).
   c. Copper riser Test reports (Cable No. and pair counts: opens, shorts, grounds, etc).

E. The documentation format (Test reports) will be agreed upon between the University Representative and the Contractor. The Contractor may be required to furnish licensed system software if the University is unable to view any of the Test reports submitted.

END OF SECTION
PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work shall consist of the provision, termination, and testing of complete and fully-functional Structured Cabling System (SCS) for telephone and data system network. This work shall include provision of but not limited to the following:

1. Telephone and data system equipment racks, cable runway in BDF/IDFs, patch panels and associated hardware.
2. Telephone and data system horizontal station cables.
3. Telephone and data system connectors and faceplates.
4. Telephone and data system optical/copper patch cords.
5. Telephone and data system optical fiber/copper riser cables.
6. Telephone and data system pathways; wire basket cable tray, j-hooks, conduits, boxes, raceways and sleeves.

B. The work shall not include provision of the following:

1. Telephone handsets and active switching equipment.
2. Integrated Services Digital Network equipment.
3. Telephone services or active computer and networking equipment.
5. Copper and Fiber entrance cables, air blown fiber (ABF) bundles and tube cables.

C. Provide all incidental items that belong to the Work described and which are required for a complete system.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Wire Basket cable tray system, raceways, conduits and boxes, external duct bank tie and other components that make up the infrastructure pathways that will carry the telephone and data cabling shall be furnished and installed by the electrical contractor.

C. Section 01 91 13 - General Commissioning Requirements.

1.3 QUALIFICATIONS

A. Manufacture:

1. The SCS specified products for the horizontal cabling (e.g. Cat-6 cable, patch panels, information outlets, faceplates, jacks, patch cords, etc.) shall be supplied by a single manufacturer.

2. Manufacturer shall have a minimum of ten (10) years of experience in the manufacture of the specified cabling products and shall be ISO 9001/14000 Certified.

B. Installer:
1. Installer shall be certified by the manufacture company in all aspects of design, installation and testing of the SCS horizontal cabling specified products.

2. The installer shall utilize the authorized SCS manufacturer horizontal cabling components and distribution channels in provisioning this Project.

3. Installer shall own and maintain tools and equipment approved by the cabling system manufacturer for installation and testing of the SCS Category 6 horizontal cabling balanced twisted pair distribution systems.

4. SCS Installer shall carry out the telephone and data network system installation work detailed in this specification.

5. SCS Installer shall have a proven track record in the field of telephone, data, and fiber cabling and system installation, with at least five previous installations of comparable size and complexity undertaken within the last five years.

6. Installer shall be qualified in the installation and termination of optical fiber cabling as described in this specification.

7. Contractor shall have a minimum of one (1) Registered Communications Distribution Designer (BICSI RCDD) and a minimum of two (2) BICSI TECHNICIAN level technicians on staff as full-time employees of the Contractor.

8. A specialist installer company that has completed work of a similar nature shall carry out the telephone and data system installation work detailed in this specification.

9. The Contractor shall hold a valid State of California C-7 Low-Voltage license at the time of bidding.

10. Installer shall be an authorized Belden Partner Alliance Member in good standing and shall provide the Belden 25-year Product Warranty and Lifetime Application Assurance.

1.4 SUMMARY

A. This Section includes the following items for wiring systems used as signal pathways for voice and high-speed data transmission:

1. Mounting elements.
2. Un-shielded twisted-pair cabling.
3. Fiber-optic cabling (Single-mode and/or Multi-mode).
4. Workstation outlets.
5. Backboards.
6. Identification products.

1.5 DEFINITIONS

A. ABF: Air-Blown Fiber
B. Backbone: A facility (e.g., pathway, cable, or conductors) between telecommunications rooms or floor distribution terminals, the entrance facilities, and the equipment rooms within or between buildings.
C. BDF: Building Distribution Frame.
E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
F. EMI: Electromagnetic interference.
G. Horizontal Cabling: Cabling between and including the telecommunications outlet/connector and the horizontal cross-connect. Also the cabling between and including the building automation system outlet or the first mechanical terminations on the horizontal connection point and the horizontal cross-connect.
H. IDC: Insulation displacement connector.
J. LAN: Local area network.
K. MDF: Main Distribution Frame.
L. RCDD: Registered Communications Distribution Designer.
M. SCS: Structured Cabling System: SCS is defined in this document as all required horizontal category 6 cabling including associated hardware, patch panels, BDF/IDF patch cords, information outlets, faceplates, work area patch cords, installed and configured to provide telephone and/or computer data network connectivity.
N. TGB: Telecommunications Grounding Busbar (IDF locations).
O. TMGB: Telecommunications Main Grounding Busbar (BDF location).
P. UTP: Un-shielded twisted pair cable.

1.6 SUBMITTALS
A. Provide three (3) full-size installation samples of the telephone and data system outlet. The sample shall include, as a minimum, one four-port faceplate with two data system connectors (each terminated with a 12" length of distribution cabling) and two blanking plates. Provide sample with faceplate labeling and wrap-around cable labels.
B. Shop Drawings:
   1. Include dimensioned plan and elevation views of telecommunications equipment rooms, labeling each individual component. Show equipment rack elevations, method of field assembly, workspace requirements, and access for cable connections.
   2. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by University.
   3. Cabling Administration Drawings.
   4. Wiring diagrams to show typical wiring schematics including the following:
      a. Workstation outlets, jacks, and jack assemblies.
      b. Patch cords (Category 6 and Fiber Optic).
      c. Copper patch panels and blocks.
      d. Fiber-optic enclosures.
      e. Data equipment racks.
C. Qualification Data: See 1.3.
D. Provide sample copy of copper (horizontal station and riser) and fiber test reports.
E. Submit manufacturers' product data sheet(s) for each component of the telephone and data systems. Certify that the data sheets depict the components to be provided by the Contractor to make up the complete system as described in this specification. Indicate each component(s) to be used on each product data sheet(s). Submit details of the warranty (including manufacturer twenty-year warranties) to be provided for the cabling systems, clearly indicating that all components are covered.
F. Submit samples of the labels to be used for labeling cables, patch panels, termination frames, and faceplates for the telephone and data systems.
G. Submit a testing schedule indicating how each telephone and data cabling system component is to be tested. The scheduled shall, as a minimum, indicate the testing process from factory testing through to final acceptance testing. The schedule shall list (by part number) testing equipment that will be used and detail each step of each test to be performed. The schedule shall list the criteria that will be applied to each test of each component of the telephone and data cabling systems. The schedule shall include the test results form that will be filled in by the tester as each component is tested.
H. Submit Current Belden Partner Alliance Certificates for the relevant staff involved in this project.
I. Submit references for a minimum of three similar projects successfully undertaken and completed within the last three years. As a minimum, provide project name and address, client
contact name and telephone number, and construction manager name and telephone number. Provide a brief description of each project indicating types of systems installed, quantities and configurations of outlets, and projected time scales.

1.7 AS BUILT DOCUMENTATION

A. As-built documentation shall consist of all the construction drawings to include each floor plan with the telephone and/or data outlet station location numbers (faceplate identification numbers, e.g. 1A-V12, 1A-C15, etc.) inserted next to the telephone and/or data symbols for each location.

B. The as-built documentation shall also contain the cabling routes taken between the cable tray, conduit and/or J-Hooks and the workstation outlets.

C. An additional requirement shall be a wire run list created in Microsoft Excel that contains the specific details of each location and all of the cables that are terminated there. Create separate tabs in the spreadsheet for each IDF/BDF.

1.8 COORDINATION

A. Coordinate layout and installation of voice and data communication cabling and all equipment hardware with UCR telecommunications representative prior to start of work.

B. Meet jointly with UCR telecommunications representative to exchange information and agree on details of equipment arrangements and installation interfaces.

1. Record agreements reached in meetings and distribute to other participants.

1.9 MATERIALS STANDARDS

A. Products, services, and materials provided by the Contractor shall meet the requirements of the following (latest edition):

1. National Electrical Manufacturer's Association (NEMA).
3. Institute of Electrical and Electronic Engineers (IEEE).
4. Underwriter's Laboratories, Inc., (UL) or equivalent.
12. TIA Standard TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

B. Products, services, and materials provided by the Contractor shall be new and of high quality and free of faults and defects.

1.10 SYSTEM TESTING

A. Following telephone, data, and fiber optic cable installation and termination at both ends, undertake and record tests to ensure that the cabling system will perform satisfactorily in service. In addition to the tests detailed in this specification, the Design-builder shall carry out any
additional tests deemed necessary to ensure the satisfactory operation of the telephone, data, and fiber optic cable systems. The costs of these additional tests shall be borne by the Contractor.

B. Provide the University Representative with the opportunity to witness all testing. Notify the University Representative in writing seven working days before the date of commencement of the cable tests. On request, the installer shall demonstrate that the test procedure competently identifies the fault conditions being tested for.

C. Complete the tests identified in all of the telephone and data system specifications in accordance with TIA-568-B.1, B.2 & B.3.

D. Notify the University Representative in writing seven working days before the date of commencement of the cable tests. Provide details, on that advance date, of proposed tests, the test schedule, equipment to be used, its certification and calibration, and the names and qualifications of test personnel.

E. Personnel shall be competent in and qualified by experience or training for detailed design, installation, and testing of telephone, data, and fiber optic cables systems.

F. Include the cost of obtaining, calibrating, and maintaining test equipment, and the cost of carrying out and recording the tests, including labor costs.

G. Ensure that all Test Equipment is in calibration before delivery to site and throughout the testing period. The installer shall be responsible for ensuring that any necessary tests and rework to maintain equipment's calibration status are carried out.

H. The installer shall be responsible for ensuring that any necessary tests and rework to maintain equipment's calibration status are carried out.

I. To support the test procedure, create a printed table of every cable in the building with appropriate columns for each test result and comments.

J. Sign and date each successful series of test results as the tests proceed. As a minimum, each completed page of test results shall be signed and dated once all the tests on that page have been successfully completed and their results recorded.

K. The test documentation shall be available for inspection by the University Representative during the installation period. The original documents (not copies or retyped versions) shall be retain and included as part of the as-built information.

L. Failures detected during the testing shall be duly noted on the test results schedule and rectified. On the fault being rectified, this shall also be noted. These notes shall not be deleted or obliterated.

M. Rectification of all damaged cables shall include replacing damaged cables with new cables in complete runs or remaking poor terminations. In-line cable joints, splices, or distribution points are not acceptable. All damaged cables shall be removed from site.

N. The Contractor shall use Fluke Networks Versiv DSX-8000 CableAnalyzer with LinkWare Management Software for all cable testing.

1.11 JOB CONDITIONS

A. Prior to starting any Work notify the University Representative in writing of dimensional discrepancies and other conditions detrimental to proper performance of the Work.

B. There shall be no additional cost incurred by the University for complying with the specifications and requirements of the Contract Documents.

C. As catalog numbers change frequently, the Contractor must verify all part numbers prior to ordering materials. Written clarifications shall be issued in response to written Request for Information (RFI).

1.12 LIFETIME OF SYSTEM

A. The physical and operational lifetime of the installation is intended to be in excess of ten (10) years.
1.13 WARRANTY
   A. Provide a Belden IBDN System 3600 25 Year Product Warranty and Lifetime Application Assurance Certification for this installation.

PART 2 PRODUCTS AND SYSTEM REQUIREMENTS

2.1 MANUFACTURERS
   A. Manufacturers (Campus Standard):
      1. Belden IBDN System 3600, or equal, for Category 6 (voice and data) horizontal structured cabling system.
      2. Belden FiberExpress System, or equal, for all Fiber Optic cables, connectors and associated hardware.
      3. Chatsworth Products Inc. (CPI), or equal, (see note), for in Telecom Room(s); seven-foot by 19-inch data equipment racks, cable runway and support products to include vertical cabling (between racks) management.
         Note; use one manufacturer for all racks, cable runway, vertical cable managers and associated hardware.
      4. CPI, or equal, for horizontal wire management products.
      5. Arlington 2.5” minimum #38085 (preferred), Erico® Caddy®, MonoSystems, or equal, for J-Hook Cable Support Systems and other non-continuous cable supports. Hooks shall be attached to structural support devices as manufactured by Erico Caddy, or equal.
      6. Superior Essex® ARMM, or equal, for twisted pair Copper riser distribution cable.
      7. Carlon®, or equal, for Innerducts and associated fittings.
      8. Belden, or equal, for Voice Grade Patch Panels riser distribution in data equipment racks.
      9. Belden, or equal, for Copper riser distribution 110 wall mounted wiring blocks.
     10. Copper B-Line Flex Tray, MonoSystems™ Mono-Mesh or equal, for Wire Basket Cable Tray support system.

2.2 TELEPHONE AND DATA SYSTEM HORIZONTAL STATION CABLING
   A. Provide Belden 3600 Cable #3613 plenum rated cable, or #3612 riser rated cable, or equal.
      Cable shall be Blue in color. Each cable shall have eight unshielded twisted-pair 24 AWG solid copper conductors (i.e., four pairs), color blue (voice/data) and meet or exceed the specifications for Category 6 cables detailed in the TIA cabling standard for premises horizontal wiring to include:
      1. Category 6 cable and all Category 6 channel components shall be manufactured by a single manufacture.
      2. Category 6 UTP balanced twisted pair cable and apparatus channel performance shall be guaranteed up to the maximum 100 meters (328 feet) length, and shall meet the following Guaranteed Channel Performance Specifications
         At a minimum, the balanced twisted-pair cabling system shall exceed the key performance parameters for Cat 6 found in ANSI/TIA-568-C.2 Category 6 standard over the specified frequency ranges by the values listed below. The balanced twisted-pair cabling system shall also meet all the requirements of ISO/IEC 11801 Edition 2.0 2002-09.
### Margin

<table>
<thead>
<tr>
<th>Parameter</th>
<th>100 MHz</th>
<th>200 MHz</th>
<th>250 MHz</th>
<th>300 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion loss</td>
<td>1.4 dB</td>
<td>2.2 dB</td>
<td>2.6 dB</td>
<td>3.0 dB</td>
</tr>
<tr>
<td>Return loss (a)</td>
<td>4.0 dB</td>
<td>4.0 dB</td>
<td>4.0 dB</td>
<td>4.0 dB</td>
</tr>
<tr>
<td>PSNEXT</td>
<td>8.0 dB</td>
<td>8.0 dB</td>
<td>7.0 dB</td>
<td>6.0 dB</td>
</tr>
<tr>
<td>PSACR-N</td>
<td>9.4 dB</td>
<td>10.2 dB</td>
<td>9.6 dB</td>
<td>9.0 dB</td>
</tr>
<tr>
<td>PSACR-F (formerly PSELFEXT)</td>
<td>8.0 dB</td>
<td>8.0 dB</td>
<td>8.0 dB</td>
<td>8.0 dB</td>
</tr>
</tbody>
</table>

Values represent System 3600 channel margin against TIA-568-C.2 Category 6 standard. The margin is the additional headroom (in dB) compared to the minimum specified value for Category 6 at each frequency point over the specified frequency range.

The worst case margin is determined at the frequency where the measured data point is closest to the limit line. The Category 6 limit line equations are used to determine the worst case margin over the frequency range from 250 MHz to 300 MHz. This margin applies for a worst-case, 4-connector, 100-meter channel configuration.

PSNEXT = Power-sum near-end crosstalk
PSACR-F = Power-sum attenuation-to-crosstalk ratio far-end
PSACRN = Power-sum attenuation-to-crosstalk ratio near-end
(a) = applies to bonded-pair cables and cords, for non-Bonded pairs 2.0 dB
(b) = extrapolated values using Category 6 limit line equations

### 3. Cable Specifications for Belden 3600:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Outer Jacket OD</td>
<td>0.230 in</td>
</tr>
<tr>
<td>Nominal Outer Jacket Thickness</td>
<td>0.018 in</td>
</tr>
<tr>
<td>Maximum Pulling Tension</td>
<td>40 lbs.</td>
</tr>
<tr>
<td>Nominal Cable Weight</td>
<td>31 lbs./1,000 ft.</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-20°C to 75°C</td>
</tr>
<tr>
<td>Installation Temperature</td>
<td>0°C to 50°C</td>
</tr>
<tr>
<td>Conductor Diameter</td>
<td>23 AWG</td>
</tr>
<tr>
<td>Jacket Material</td>
<td>Low Smoke PVC</td>
</tr>
<tr>
<td>ETL Listed Type</td>
<td>CMP, CMR</td>
</tr>
<tr>
<td>Nominal Velocity of Propagation</td>
<td>72%</td>
</tr>
<tr>
<td>Maximum DC Resistance</td>
<td>77 Ohms/Km</td>
</tr>
<tr>
<td>Maximum DC Resistance Unbalanced</td>
<td>3%</td>
</tr>
<tr>
<td>Maximum Mutual Capacitance at 1 KHz</td>
<td>90 pf/100 m</td>
</tr>
<tr>
<td>Min Bend Radius During Installation</td>
<td>2.5&quot;</td>
</tr>
<tr>
<td>Voltage Safety Rating</td>
<td>300 Volts per NEC 800.179</td>
</tr>
</tbody>
</table>

B. For cabling routed in underground duct, provide Belden #OSP6U Category 6 / UTP Cable (campus standard), or equal, suitable for outside plant use with PE Jacket. Each cable shall have
eight unshielded twisted-pair 24 AWG solid copper conductors (i.e., four pairs), color black and meet or exceed the specifications for Category 6 cables detailed in the TIA cabling standard for premises horizontal wiring for Category 6.

<table>
<thead>
<tr>
<th>Nominal Outer Jacket OD:</th>
<th>0.251 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separator Material</td>
<td>X-Spline</td>
</tr>
<tr>
<td>Maximum Pulling Tension:</td>
<td>25 lbs.</td>
</tr>
<tr>
<td>Nominal Cable Weight:</td>
<td>25 lbs./1,000 ft.</td>
</tr>
<tr>
<td>Operating Temperature:</td>
<td>-40°C to 75°C</td>
</tr>
<tr>
<td>Installation Temperature:</td>
<td>-40°C to 60°C</td>
</tr>
<tr>
<td>Conductor Diameter:</td>
<td>24 AWG</td>
</tr>
<tr>
<td>Jacket Material:</td>
<td>LLDPE - Linear Low Density Polyethylene</td>
</tr>
<tr>
<td>ETL Listed Type:</td>
<td>OSP</td>
</tr>
<tr>
<td>Nominal Velocity of Propagation:</td>
<td>65%</td>
</tr>
<tr>
<td>Maximum DC Resistance</td>
<td>93.8 Ohms/Km</td>
</tr>
<tr>
<td>Maximum DC Resistance Unbalanced:</td>
<td>3%</td>
</tr>
<tr>
<td>Maximum Mutual Capacitance at 1 KHz:</td>
<td>15.7 pf/100 m</td>
</tr>
<tr>
<td>Min Bend Radius During Installation:</td>
<td>2.5&quot;</td>
</tr>
<tr>
<td>Voltage Safety Rating:</td>
<td>300 Volts per NEC 800.179</td>
</tr>
</tbody>
</table>

### 2.3 TELEPHONE AND DATA SYSTEM INFORMATION OUTLETS

Provide a Category 6 four-position information outlet for each telephone and/or data system outlet. The outlets shall be capable of supporting telephone (analog and digital) and/or data services. The outlets shall allow the cable to terminate directly onto the connector with no pair separation. The connector termination method must also offer the possibility to change the connector interface without having to re-terminate the cable (ex.: Change jack color or replace a jack by a plug interface) The outlets shall be offered in 19 colors. The information outlets shall be Belden REVConnect RV6MJKUGY, (Grey for analog voice, elevators and emergency phones only), RV6MJKUBK, (Black for data), or equal. Category 6 outlets shall meet the following Guaranteed Margin Performance and Physical Specifications:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Max. Insertion Loss TIA*</th>
<th>Max. Insertion Loss Belden** (dB)</th>
<th>Min. NEXT TIA* (dB)</th>
<th>Min. NEXT Belden** (dB)</th>
<th>Min. FEXT TIA* (dB)</th>
<th>Min. FEXT Belden** (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>0.100</td>
<td>0.100</td>
<td>75.000</td>
<td>77.000</td>
<td>75.000</td>
<td>77.000</td>
</tr>
<tr>
<td>4.000</td>
<td>0.100</td>
<td>0.100</td>
<td>75.000</td>
<td>77.000</td>
<td>71.100</td>
<td>75.100</td>
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<tr>
<td>8.000</td>
<td>0.100</td>
<td>0.100</td>
<td>75.000</td>
<td>77.000</td>
<td>65.000</td>
<td>69.000</td>
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<tr>
<td>10.000</td>
<td>0.100</td>
<td>0.100</td>
<td>74.000</td>
<td>77.000</td>
<td>63.100</td>
<td>67.100</td>
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<tr>
<td>16.000</td>
<td>0.100</td>
<td>0.100</td>
<td>69.900</td>
<td>72.900</td>
<td>59.000</td>
<td>63.000</td>
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<tr>
<td>20.000</td>
<td>0.100</td>
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<td>68.000</td>
<td>71.000</td>
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<td>55.100</td>
<td>59.100</td>
</tr>
<tr>
<td>31.250</td>
<td>0.110</td>
<td>0.100</td>
<td>64.100</td>
<td>67.100</td>
<td>53.200</td>
<td>57.200</td>
</tr>
<tr>
<td>62.500</td>
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<td>0.120</td>
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<td>0.160</td>
<td>54.000</td>
<td>57.000</td>
<td>43.100</td>
<td>47.100</td>
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<td>200.000</td>
<td>0.280</td>
<td>0.240</td>
<td>48.000</td>
<td>51.000</td>
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<td>41.100</td>
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<td>0.280</td>
<td>46.000</td>
<td>49.000</td>
<td>35.100</td>
<td>39.100</td>
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<tr>
<td>300.000</td>
<td>0.310</td>
<td></td>
<td>44.500</td>
<td></td>
<td>37.600</td>
<td></td>
</tr>
</tbody>
</table>

**Mated Connection Table - Footnote:**

* TIA-568-C.2 Category 6 Standard.
** Worst-case performance for a CAT6+ mated connection using CAT6+ modular plugs.
Mated Connection Table 2:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Min. Return Loss TIA* (dB)</th>
<th>Min. Return Loss Belden** (dB)</th>
<th>Min. Balanced TCL TIA* (dB)</th>
<th>Min. Balanced TCL Belden** (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>30.000</td>
<td>32.000</td>
<td>40.000</td>
<td>42.000</td>
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<tr>
<td>4.000</td>
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<td>8.000</td>
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<td>40.000</td>
<td>42.000</td>
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<tr>
<td>10.000</td>
<td>30.000</td>
<td>32.000</td>
<td>40.000</td>
<td>42.000</td>
</tr>
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<td>31.250</td>
<td>30.000</td>
<td>32.000</td>
<td>38.100</td>
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<tr>
<td>62.500</td>
<td>28.100</td>
<td>32.000</td>
<td>32.100</td>
<td>36.100</td>
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<tr>
<td>100.000</td>
<td>24.000</td>
<td>28.000</td>
<td>22.000</td>
<td>26.000</td>
</tr>
<tr>
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<td>250.000</td>
<td>16.000</td>
<td>22.000</td>
<td>20.000</td>
<td>24.000</td>
</tr>
<tr>
<td>300.000</td>
<td>18.500</td>
<td>22.000</td>
<td>22.500</td>
<td>26.000</td>
</tr>
</tbody>
</table>

Materials:

<table>
<thead>
<tr>
<th>Description</th>
<th>Type</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Connection</td>
<td>RJ45</td>
<td>Copper Clad Flexible PCB, 50uin Gold plated contacts over Nickel</td>
</tr>
<tr>
<td>Rear Connection</td>
<td>REVConnect</td>
<td>Copper alloy, Gold plated contacts over Nickel</td>
</tr>
<tr>
<td>Connector Body</td>
<td>N/A</td>
<td>PBT glass reinforced UL94V-0</td>
</tr>
</tbody>
</table>

Termination Interface:

<table>
<thead>
<tr>
<th>Termination</th>
<th>Connection</th>
<th>Durabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>Mated Connection</td>
<td>750 cycles</td>
</tr>
<tr>
<td>Rear</td>
<td>Mated Connection</td>
<td>20 cycles</td>
</tr>
</tbody>
</table>

Dielectric Strength: 1,000 V RMS @ 60 Hz for 1 minute (Signals to Ground)

Current Rating: 1.300 A

Insulation Resistance: 500 M-Ohm Minimum

Max. Contact Resistance: 20 m-Ohm

Termination Resistance: 2.5 m-Ohm

2.4 TELEPHONE SYSTEM RISER CABLE

A. Provide one (1) Superior Essex® ARMM 50-Pair Riser Cables #02-100-03, or equal between BDF 110 wall mount wiring blocks and each IDF 48-port Voice Patch Panel in Data Equipment Rack to include BDF 48-port Voice Patch Panel in Data Equipment Rack. Each cable shall be shielded twisted-pair 24 AWG solid copper conductors, be riser rated and meet or exceed the specifications for Category 3 cables detailed in the TIA cabling standard for premises horizontal wiring, see copper riser drawing for locations.

B. Ground each end of 50-Pair Riser Cable Shield to TMGB (BDF) or TGB (IDF) with approved Cable Shield Bond Connector (Mfg. 3M, part number 4460-D) using Two-Hole compression lugs (Mfg. T&B, or equal) with #6AWG green insulated, stranded THHN conductor wire.

2.5 TELEPHONE SYSTEM RISER CABLE 110 WIRING BLOCKS

A. Provide Belden 300 Pair Field Termination Kit with back panel and 110C5s, Part Number AX100696-S, or equal, in BDF. The wiring blocks shall be fully equipped with five pair 110C-5 connecting blocks, jumper troughs, label designations and rivets.
2.6 TELEPHONE SYSTEM VOICE GRADE PATCH PANELS (FOR RISER CABLES)

A. Provide one (1) 110-Style Voice Grade Cat5e 48-Port Patch Panels in BDF and each IDF location in Data Equipment Rack. Terminate 50-Pair Copper Riser distributions cables on Patch Panels. Patch Panels shall be Belden part number AX103259, or equal. Patch Panel shall meet ANSI/TIA-568-B and FCC Part 68 requirements. Patch Panels shall be provided with forty-eight (48) 8 Pin RJ-45 jacks.

Note: On one end of 50-Pair Riser Cable, at BDF and each IDF in Data Equipment Rack, terminate Cables Pairs 1 through 48 (pair-for-port, pair 1 to port 1, pair 2 to port 2, up to pair 48 to port 48) on 48-Port Voice Grade Patch Panels, store (coil) pairs 49 and 50 at rear of patch panel. On other end of 50-Pair Riser Cable terminate all pairs on wall mount 110 wiring blocks in BDF.

2.7 TELEPHONE AND DATA SYSTEM FACEPLATES

A. Provide a flush-mounted modular faceplate to house data and telephone system connectors, capable of housing a maximum of four (4) information connectors. The faceplate shall fit over a standard NEMA electrical outlet box (4S) with a single-gang plaster ring and shall allow information outlets to be snapped into the faceplate with the nose flush to the plate surface. The faceplate shall be Belden KeyConnect Style 4 port single gang wall plate (AX102249) or equal, (match color of electrical plates), or equal.

B. Provide modular faceplates suitable for Modular Furniture to support data and telephone system connectors, capable of housing a minimum of three (3) information outlets. The faceplate shall be compatible to fit modular furniture raceway. Provide bezel(s) and all associated hardware as required. The faceplate shall be Belden Keyconnect series triplex outlets (AX104457; AX107029; AX103925; AX102291; AX102292), match color of electrical plates, or equal.

C. Blanking Plates. Provide blanking plates to be installed in faceplate outlet positions that are not populated with telephone and/or data system information outlets. Provide blanking plates in sufficient quantities to cover all unused openings in every faceplate. The blanking plate shall be Belden KeyConnect blank module or equal (AX104456; AX107026; AX102261; AX102262; AX102263), (match color of telephone / data plate).

D. At Wall (+42” AFF) Phone Outlet locations. Provide Stainless Steel Faceplate suitable for wall mount phone. Belden AX104126

2.8 TELEPHONE AND DATA SYSTEM MODULAR PATCH PANELS

A. Telephone and Data System Modular Patch Panels:

1. Provided Belden REVConnect RV6PPF2U48BK CAT-6 48 port patch panels for telephone and data cables, or equal, Capable of accepting REVConnect cores.

   Features:Universal T568A and T568B wiring labels.
   • Labeling areas adjacent to conductors.
   • Replaceable connectors – supporting 100% port availability.
   • 24 or 48 ports.
   • Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
   • Patch Panel must be available in colors Black and White

2. The first 12-ports of the first patch panel of each IDF will be dedicated for Station Outlet analog voice lines. These ports will be populated with the Belden REVConnect Grey Category 6 Jack Inserts # RV6MJKUGY

3. Patch Panel shall have strain relief (rear wire management bars) for each cable terminated on the connector.

4. Patch Panel shall be UL listed, UL-C certified and ACA approved.

5. Patch Panel 19-inch rack mountable and be able to store cable reserve with no bends sharper than 2" bend radius.
6. Provide sufficient finger space to allow connectors to be mounted and demounted easily.
7. Provide Space for labeling of each individual copper connector.
8. Shall allow any individual cable to be terminated or otherwise handled without disturbing other cables.

Materials:

<table>
<thead>
<tr>
<th>Description</th>
<th>Material</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel</td>
<td>Steel</td>
<td>Black/White</td>
</tr>
<tr>
<td>Frame</td>
<td>PC/ABS</td>
<td>Black/White</td>
</tr>
<tr>
<td>Management Bar</td>
<td>Steel</td>
<td>Black</td>
</tr>
<tr>
<td>Clear Window</td>
<td>Polycarbonate</td>
<td>Transparent</td>
</tr>
</tbody>
</table>

Mated Connection Table 1:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Max. Insertion Loss TIA* (dB)</th>
<th>Max. Insertion Loss Belden** (dB)</th>
<th>Min. NEXT TIA* (dB)</th>
<th>Min. NEXT Belden** (dB)</th>
<th>Min. FEXT TIA* (dB)</th>
<th>Min. FEXT Belden** (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>0.100</td>
<td>0.100</td>
<td>75.000</td>
<td>77.000</td>
<td>75.000</td>
<td>77.000</td>
</tr>
<tr>
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<td>75.000</td>
<td>77.000</td>
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<td>57.200</td>
</tr>
<tr>
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<td>47.100</td>
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<td>49.500</td>
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</table>

Mated Connection Table 2

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Min. Return Loss TIA* (dB)</th>
<th>Min. Return Loss Belden** (dB)</th>
<th>Min. Balanced TCL TIA* (dB)</th>
<th>Min. Balanced TCL Belden** (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>30.000</td>
<td>34.100</td>
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<td>42.000</td>
</tr>
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<td>40.000</td>
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<td>40.000</td>
<td>42.000</td>
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<tr>
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<tr>
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<td>18.500</td>
<td>20.500</td>
<td>22.500</td>
<td>26.500</td>
</tr>
</tbody>
</table>

Dielectric Strength: 1,000 V RMS @ 60 Hz for 1 minute (Signals to Ground)
Current Rating: 1.300 A
Insulation Resistance: 500 M-Ohm Minimum
Max. Contact Resistance: 20 m-Ohm
Termination Resistance: 2.5 m-Ohm
2.9 DATA SYSTEM FIBER OPTIC CLOSET CONNECTOR HOUSINGS (CCH) AND CONNECTOR PANELS

A. Provide Belden 19-inch rack-mountable (4U) FiberExpress (ECX-04U) that support inter-connect or cross-connect capabilities between outside plant, riser and/or building distribution cables and opto-electronics as shown on drawings to include the following capabilities:
   1. Shall hold 12 Frames, cassettes and/or modules that support a variety of field-termination options; e.g. ST, LC, SC connectors and/or splicing/pigtail assemblies.
   2. Removable clear top cover for visibility and ease of access for installation, testing and troubleshooting.
   3. Multiple patch cord management and strain-relief options.
   4. TIA hole spacing (1.75-in)
   5. Removable front and rear housings; field installable lock kit availability for front and rear doors Belden ECX-LOCKKIT.
   7. Provide one (1) Belden ECX-02U, or equal, Rack Mountable FiberExpress Patch Panel in each IDF Telecom Room, Equipment Rack (RR-XX).

B. Provide FiberExpress Frames that support factory-installed or field-installable fiber optic connectors as shown on drawings.
   1. Provided FiberExpress FFSX06LA, 12-fiber single-mode LC Duplex FiberExpress Frames in BDF and each IDF Telecom Rooms for each 12 fiber single-mode cable.

2.10 OPTICAL FIBER RISER CABLE

A. Provide Optical Fiber Tight-Buffered (OS2) Armored Interlocked Plenum-Rated Cable OFNP consisting of twelve (12) Single-mode fibers that shall have enhanced low-loss and bend-improved fiber technologies, Belden FiberExpress FISD012A9, or equal, from BDF to each IDF. Riser cable shall be plenum rated OFNP and meet application requirements of the NEC® Article 770 and the ICEA S-83-596 test criteria to include UL-1666 flame resistance. Riser cable shall be suitable for riser type environments for intra-building back-bone installations. Fabricate system using manufacturer's standard materials, and in sizes, types, and performance characteristics as indicated. Factory- fabricated, 900 µm tight-buffered, all-dielectric, low-loss, with bend-improved technologies with the following operational and construction features.

<table>
<thead>
<tr>
<th>Single Multimode Optical Fiber</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Specifications Outer Jacket Color:</td>
<td>Yellow</td>
</tr>
<tr>
<td>Flame Rating:</td>
<td>OFCP</td>
</tr>
<tr>
<td>Core Diameter:</td>
<td>8.3 µm nominal</td>
</tr>
<tr>
<td>Cladding Diameter:</td>
<td>125.0 (± 0.7) µm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optical Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode Field Diameter:</td>
<td>9.0</td>
</tr>
<tr>
<td>Fiber Core Diameter:</td>
<td>8.3/125µm</td>
</tr>
<tr>
<td>Max Attenuation at 1310 nm:</td>
<td>0.5 dB/km</td>
</tr>
<tr>
<td>Max Attenuation at 1550 nm:</td>
<td>0.5 dB/km</td>
</tr>
<tr>
<td>Wavelength:</td>
<td>1310 nm / 1550 nm</td>
</tr>
<tr>
<td>10 Gigabit Ethernet Performance:</td>
<td>10,000 m / 40,000 m</td>
</tr>
<tr>
<td>1 Gigabit Ethernet Performance:</td>
<td>5,000 m / -</td>
</tr>
</tbody>
</table>
2.11 SINGLE-MODE OPTICAL FIBER CONNECTORS

A. Provide Belden FX Field-Termination Pigtail, OS2, LC Simplex, Tight Buffer 900 um, Color-Coded FTSCLC900PR12, or equal, on each end of all fiber optic cable strand(s). Fiber Optic Field-Termination Pigtail to be spliced into the Belden AX103912 FiberExpress Ultra 8 inches Splice Tray with splice sleeves (use heat shrink protection sleeves #FXFUHS900AB25). LC Connectors shall meet the following specifications:

### Mechanical Specifications

<table>
<thead>
<tr>
<th>Test</th>
<th>GR-326-CORE/1081-CORE (SM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermateability Requirement</td>
<td>Compliant with TIA-604-3 (FOCIS 3)</td>
</tr>
<tr>
<td>Operating Temp Range</td>
<td>-40°C to +75°C</td>
</tr>
<tr>
<td>Storage Temp Range</td>
<td>-40°C to +60°C</td>
</tr>
<tr>
<td>Durability</td>
<td>500 cycles, less than 0.2 dB change, FOTP-21</td>
</tr>
</tbody>
</table>

### Mechanical Characteristics

- **Maximum Insertion Loss:** 0.50 dB
- **Typical Insertion Loss:** 0.20 dB
- **Minimum Reflectance @ 1550nm:** -30 dB
- **Termination Style:** Mechanical
- **Interconnection Compatibility:** Compliant with TIA-604-3 (FOCIS 3)
- **Durabilities@Termination:** 500 cycles, less than 0.2 dB change, FOTP-21

### Standards

- **Telecommunications Standards:** TIA 568-C.3
- **EU Directive 2011/65/EU (ROHS II):** Yes
- **EU RoHS Compliance Date (yyyy-mm-dd):** 2006-07-01
- **MII Order #39 (China RoHS):** EUP 50
- **Safety Listing:** ACA

2.12 OPTICAL FIBER PATCH CORDS

A. Provide six (6), 2 Meter duplex single-mode (LC to LC) fiber optic jumpers (patch cords) for
use with Optical System Patch Panels. Each fiber optic jumper shall be a duplex Zipcord Cable. Both ends shall be terminated with a Duplex LC Ceramic single-mode connector. Fiber Optic Jumper shall be Belden FiberExpress **FPSLALA002M** or equal, and meet the following specifications:

<table>
<thead>
<tr>
<th>Description</th>
<th>FX OM1</th>
<th>FX OM3</th>
<th>FX OM4</th>
<th>FX SM</th>
<th>FX SM/APC</th>
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<tbody>
<tr>
<td><strong>Cable Performance - LC/SC/ST</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>IL Max. 850 nm/1300 nm (dB/Km)</td>
<td>3.5/1.2</td>
<td>3.0/1.2</td>
<td>3.0/1.0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>IL Max. 1310 nm/1550 nm (dB/Km)</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td>0.5/0.5</td>
</tr>
<tr>
<td>Fire Rating</td>
<td>LC/SC/ST: Riser</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Style</td>
<td>LC: Interconnect Simplex Zip 2 mm LC Uniboot: Interconnect Mini-Round 2 mm SC/ST/Hybrid: Interconnect Duplex Zip 3 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jacket Color</td>
<td>Orange</td>
<td>Aqua</td>
<td>Erika Violet</td>
<td>Yellow</td>
<td>Yellow</td>
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</table>
2.13 TELEPHONE AND DATA SYSTEM PATCH CORDS

A. Provide (1) four-pair Belden CAT6 Modular Patch Cord Small Diameter CAT 6 Patch Cord, or equal, for each telephone and data system information outlet installed in the project. Each patch cord shall have eight unshielded twisted-pair 28 AWG Stranded copper conductors (i.e., four pairs), meeting the specifications for Data System Distribution Cabling and as detailed in this specification. Each patch cord shall be terminated with a Category 6 RJ45 data system copper connector on each end and meet the following:

1. Category 6 Patch Cord Requirement:
   a. All patch cords shall exceed TIA and ISO/IEC Category 6/Class E specifications.
   b. The patch cords shall incorporate an anti-snag feature that provides maximum protection from snagging during moves and re-arrangements.
   c. Patch cords shall be UL listed, UL-C certified.
   d. Patch cords shall support network line speeds in excess of 1 gigabit per second

Transmission Characteristics (Connectivity)

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Max. Insertion Loss TIA* (dB)</th>
<th>Max. Insertion Loss Belden (dB)</th>
<th>Min. PSNEXT TIA* (dB)</th>
<th>Min. PSNEXT Belden (dB)</th>
<th>Min. PSACRF TIA* (dB)</th>
<th>Min. PSACRF Belden (dB)</th>
</tr>
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<tr>
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<td>2.400</td>
<td>2.000</td>
<td>72.300</td>
<td>73.300</td>
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### Performance Table 2:

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<tr>
<th>Frequency (MHz)</th>
<th>Min. Return Loss TIA* (dB)</th>
<th>Min. Return Loss Belden (dB)</th>
<th>Min. Balanced TCL TIA* (dB)</th>
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<td>300.000</td>
<td>17.500</td>
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</tbody>
</table>

1. Provide the following:
   a. 50 percent of Patch Cords shall be 1ft. Belden #C6D1106001 CAT 6 Patch Cord, or equal, (No Known Equal).
   b. 25 percent of Patch Cords shall be 3ft. Belden #C6D1106003 CAT 6 Patch Cord, or equal, (No Known Equal).
   c. 25 percent of Patch Cords shall be 6ft. Belden #C6D1106006 CAT 6 Patch Cord, or equal, (No Known Equal).

2. Deliver all data system Patch Cords to the University Representative.
   d. The Contractor is not required to install patch cords.

### 2.14 TELECOM ROOM DATA SYSTEM EQUIPMENT RACKS, HARDWARE AND GROUNDING

A. Provide Data System Equipment Rack(s) and associated hardware as shown on drawings.
   1. Provide standard 3” deep channel 19” wide and 84” high Data System Equipment Rack(s) as shown on drawings. Equipment Rack(s) shall be Chatsworth Products Inc. 55053-703 UL Listed, or equal.
   2. Each rack shall have a load-carrying capacity of 1000 lbs.
   3. Provide one (1) Chatsworth Products 11729-703, or equal, Double-Sided Wide Vertical Cabling Section on each side of each Data System Equipment Rack.
   4. Provide Chatsworth Products 12100-718, or equal, Cable Runway Radius Drop, two (2) per Data System Equipment Rack.
   5. Provide Chatsworth Products 31472-718 Alternate Space Cable Runway, or equal, over Data System Equipment Racks. Provide all associated hardware as required for an complete installation.
   6. Provide Chatsworth Products 10250-718 Universal Cable Runway, or equal, over Data System Equipment Racks. Provide all associated hardware as required for a complete installation.
   7. Provide two (2) CPI 13239-757 Horizontal Rack-Mount Power Strip with Ten (10) Outlets and NEMA 5-20P Straight Plug with Amp Meter, Surge Protection and Circuit Breaker, or equal, in each Data System Equipment Rack.
   8. Provide one (1) CPI 13622-012 Grounding Busbar (TMGB or TGB), BICSI & ANSI/TIA, or equal, in the BDF and in each IDF Telecom Rooms. Connect each TMGB and TGB to electrical panel serving BDF or IDF Telecom Room with #6AWG green insulated, stranded THHN conductor wire, or equal, using two-hole compression lugs on each end.
9. Provide #6AWG green insulated, stranded THHN conductor wire, or equal, from each Data Equipment Rack(s), Cable Runway(s) and Cable Sheath(s) to the Main Telecommunications Ground Bus (BDF) or Telecommunications Ground Bus (IDF). Terminate each end of #6 conductor wire with two-hole compression lug; connect lugs to TMGB or TGB.

10. Data Equipment Rack(s) shall be securely attached to the concrete floor using Chatsworth Products 40604-003 Rack and Frame Installation Kit, or equal. For additional strength solidly attach racks to overhead Cable Runway. When mounted in a row, maintain a minimum of 72 inches from the wall behind and 42 inches in front of the row of racks (measured from Rack Base Plate). Where racks are shown side by side securely connect together to provide a stable system.

11. Provide all mounting components and accessories to securely fix racks to floor, overhead cable runway and supporting walls.

12. Provide all necessary Chatsworth Products, or equal, hardware to make a complete system as required but not limited to:
   a. 11421-712 Wall Angle Support Kit, Cable Runway
   b. 11302-701 Junction-Splice Kit
   c. 40164-001 Cable Runway Ground Strap Kit
   d. 11301-701 Butt-Splice Kit
   e. 11310-003 Threaded Ceiling Kit, Cable Runway
   f. 11312-718 Triangular Support Bracket, Aluminum
   g. 10642-001 Protective End Caps
   h. 11700-718 End Closing Kit

2.15 DATA SYSTEM HORIZONTAL PATCH MANAGEMENT

A. Provide horizontal patch management panel(s) for each Data System Equipment Rack(s). Provide one (1) CPI #30130-719 (front pathway only) 2U-high horizontal cable manager(s), or equal, above and below each 48-port patch panel and each 10 Outlet power strip (front pathway).

B. Provide horizontal patch management panel(s) for each Data System Equipment Rack(s). Provide CPI #30139-719 (front pathway only) 1U-high horizontal cable manager(s), or equal, where shown on drawings.

2.16 TELEPHONE AND DATA SYSTEM LABELS

A. Provide labels for telephone and data distribution and feeder cables to include; patch panels, frames, telephone and data outlets.

B. The lettering on each label shall be as large as is practicable. All labels shall be machine produced. Handwritten labels will not be acceptable.

C. A standard relative orientation shall be adopted for all labels unless otherwise specified.

D. Labels shall be robust, durable, shall resist abrasion, and shall be UV inhibiting, permanent and indelible. Labels shall be proof to 140° Fahrenheit.

E. Labels shall be readily visible and shall be fixed so that they remain in a visible position wherever practical.

F. Labels shall carry the full complement of characters to designate the unique identification for the item that they identify.

G. Horizontal Telephone and Data Cable Labels: Provide Self-Laminating Vinyl (wrap-around type) Cables Labels Brady Corporation, or equal. Cable Labels shall have a white printing area with black print. Cables Labels shall be preprinted or computer printed type. Cable Labels shall meet the legibility, defacement, exposure and adhesion requirements of UL 969. Handwritten Labels are not acceptable.

H. Termination Frame (110 Blocks and Patch Panels) Labels. Provide pre-printed labels on card for
110 blocks. Label each frame on the front, enabling terminations to be clearly identified.

Cable terminations on frames shall be uniquely labeled in strict numerical order with the lowest numbered cable to the top left of the allocated portions of the frame.

2.17 TELEPHONE SYSTEM BACKBOARDS – TELECOM ROOM(S)

Provide telephone system plywood backboards (4-foot by 8-foot by ¾-inch) on all walls starting at 6-inch AFF to 8-foot 6-inches AFF. Each plywood backboard shall be fire-retardant plywood, painted with two coats of white fire-retardant intumescent paint with one (1) fire rating stamp per sheet of plywood masked prior to painting and visible after installation. Exposed edges shall be chamfered, with no exposed screws, bolts, nuts, washers, or other protruding fastenings.

2.18 TELEPHONE DATA SYSTEM NON-CONTINUOUS J-HOOK CABLE SUPPORTS

Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed. Non-continuous cable supports shall have flared edges to prevent damage while installing cables. Non-continuous cable supports sized 1-5/16-inch and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces. Note: no more than two-inch (2.5”) maximum Cable bundle diameter will be allowed for any one (1) non-continuous cable support.

2.19 TELEPHONE DATA SYSTEM WIRE BASKET CABLE TRAY SUPPORT PATHWAYS

Except as otherwise indicated, provide wire basket cable tray support system, Cooper B-Line Flex Tray, or equal, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

A. Pre-galvanized Zinc Finish: Straight sections, fitting side rails, rungs, and covers shall be made from carbon steel wire meeting the minimum mechanical properties in accordance with ASTM A641 SS for Zink-Coated (Galvanized) Carbon Steel Wire.

B. Provide wire basket cable tray of types and sizes necessary with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces in compliance with applicable standards.

C. Wire basket cable tray systems are defined to include but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, dropouts, supports and accessories.

D. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all traysizes.

E. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

F. All fittings shall be field formed from straight sections in accordance with manufacturer’s instructions.

G. Wire basket cable tray supports shall be trapeze type hangers or wall brackets supplied by manufactured. No center type support hanger will be allowed.

H. Wire basket cable tray system installation shall be per manufacture directions and shall meet all seismic requirements. Use the proper installation tools; e.g. Cleanshear™ or Angular Bolt Cutters for cutting tools.

I. Provide all special accessories (e.g. radius shields, cable dropouts, cable rollers, etc.) and fittings as required to protect, support and install a wire basket cable tray system.

J. Wire basket sizes shall have 4 inch minimum usable load depth.

K. All fittings must have a minimum radius of 12 inches.
2.20 GROUNDING AND BONDING

Materials: Comply with NFPA 70, TIA-607, and UL 467.

2.21 IDENTIFICATION PRODUCTS

A. Manufacturers:
   1. Brady Corporation, Inc.
   2. Panduit Corp.
   3. Hellerman-Tyton
   4. Kroy LLC.
B. Comply with TIA-606-A Class 3 and University Standards for Telecom Identification.
C. Cable Labels: Self-Laminating Vinyl Cables Labels, machine printed with alphanumeric cable designations.

2.22 SOURCE QUALITY CONTROL

Each Singlemode Fiber-Optic Cable (all strands) shall be tested at factory before shipping at 1310 and 1550 nm.

PART 3 EXECUTION

3.1 INSTALLATION STANDARDS

B. Installation and certification of all unshielded twisted pair (UTP) cabling in accordance with the latest available ANSI/TIA requirements for cabling installations is required.
C. Cabling Systems and Pathways shall be installed in a “neat and workmanlike manner” as specified by ANSI/NECA/BICSI 568-2001 and National Electrical Code (NEC) Sections 110-12 and 800-6.
D. The Contractor shall adhere to and comply with the latest versions and/or revisions of each applicable standard. Among the various standards, guide-lines and practices applicable to this project are the following:
   1. Building Industry Consulting Services International (BICSI)
   2. BICSI Telecommunications Distribution Methods Manual (TDMM 13th edition)
   3. California Building Standards Commission
   5. Federal Communications Commission (FCC)
   6. FCC Part 68.5 Establishment of Telephone Premises Wiring Attestation List
   7. Insulated Cable Engineers Association (ICEA)
   8. National Electrical Manufacturers Association (NEMA)
   9. NEMA WC 66 (2014) Premise Wiring
   10. National Fire Protection Association (NFPA)
   12. American National Standards Institute (ANSI) / Telecommunications Industry Association (TIA)
21. UNDERWRITERS LABORATORIES INC. (UL)
22. UL 444 (R. 2017) Communications Cables
23. UL 467 (R. 2013) Grounding and Bonding Equipment
26. For Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air Please Refer to NFPA 262 (2019) Standard Method of Test for Fire and Smoke Characteristics of Wires and Cables
27. UL 969 (R. 2017) Marking and Labeling Systems
28. UL 1286 (R. 2008) Office Furnishings
29. UL 1581 (R. 2001) Electrical Wires, Cables, and Flexible Cords
30. UL 1666 (R. 2012) Flame Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts

E. In reviewing the various Contract Documents, the Contractor shall be responsible for noting conflicts between proposed design/concepts and the applicable standards, guidelines and practices provided by the University. A written Request for Information (RFI) shall be developed by the Contractor and submitted to the University representative prior to commencing any work impacted by such conflicts. Such RFIs shall describe the conflict/violation and, if appropriate, recommend alternative solutions with associated costs.

F. Where the requirements of the Contract Documents are more stringent than applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the Contract Documents shall apply. In all other instances, the most current standards, guidelines and practices shall apply.

G. Federal, state, local codes, rules, regulations, and ordinances governing the work shall be incorporated as part of these Technical Specifications.

3.2 EXAMINATION
A. Examine pathway elements intended for cables.

1. Verify proposed routes of pathways. Check raceways, cable trays, J-Hooks, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements.

2. Identify plan to support cables in suspended and/or open ceilings from the cable tray, conduits sizes and/or J-Hooks to the workstation locations. Verify that load capacity of cable support structures is adequate for each pathway.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATION OF MEDIA
A. Backbone Fiber Optic Riser Distribution Cable for Data Service: Use 8.3/125 single-mode fiber-
optic cable for runs between the BDF and each IDF(s).

B. Backbone Copper Riser Cable for Voice Service: Use Listed (as required for installation) category 3 cable for runs between the BDF and each IDF(s).

C. Horizontal Copper Cable for Data Service: Use UTP Category 6 cable (color blue) for wiring runs between BDF and/or IDF(s) to workstations, cameras, lighting control, card access, energy management system or any other outlet identified as Data.

D. Horizontal Copper Cable for Voice Service: Use UTP Category 6 cable (color blue) for wiring runs between BDF and/or IDF(s) to workstation outlets.

3.4 TELEPHONE SYSTEM INSTALLATION DETAILS

A. Telephone System Plywood Backboards, 110 wiring blocks and Patch Panels:
   1. Provide telephone system plywood backboards in the BDF Room and in each of the IDF Rooms located on each floor of the building. Securely fix backboards to the walls in the locations as shown on the drawings.
   2. Provide Telephone system 110 wiring blocks with patch management in the BDF Room. Securely fix each panel to the telephone system backboard.
   3. Provide a sufficient number of Telephone Patch Panels in Data System Equipment Rack to house all Telephone system information outlet connectors.

B. Telephone System Distribution Cables and Connectors:
   1. Provide telephone distribution cable(s) running from each telephone outlet to the BDF and/or IDF Patch Panel on that floor. Provide telephone system distribution cable(s) at each combined telephone/data and/or telephone only outlet location.
   2. Terminate each telephone system distribution cable(s) with an information outlet connector REVConnect RV6MJGKY at the outlet end and on patch panel in the BDF or IDF end of the cable. Use the TIA-T568B wiring configuration, as defined in the ANSI/TIA-568-A-1995 Commercial Building Telecommunications Cabling Standard as detailed below:

<table>
<thead>
<tr>
<th>Patch Panel</th>
<th>Conductor Color</th>
<th>Connector Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>White/Blue</td>
<td>Pin 5</td>
</tr>
<tr>
<td></td>
<td>Blue/White</td>
<td>Pin 4</td>
</tr>
<tr>
<td>Pair 2</td>
<td>White/Orange</td>
<td>Pin 1</td>
</tr>
<tr>
<td></td>
<td>Orange/White</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Pair 3</td>
<td>White/Green</td>
<td>Pin 3</td>
</tr>
<tr>
<td></td>
<td>Green/White</td>
<td>Pin 6</td>
</tr>
<tr>
<td>Pair 4</td>
<td>White/Brown</td>
<td>Pin 8</td>
</tr>
<tr>
<td></td>
<td>Brown/White</td>
<td>Pin 7</td>
</tr>
</tbody>
</table>

C. Telephone System Riser Cables:
   1. Provide telephone system riser cables between the telephone system 110 wall mount blocks located in the BDF Telecom Room and each voice grade patch panel located in data equipment rack of the IDF or BDF Room on each floor. Terminate all pairs of feeder cable in sequential order on the 110 block with 110C-5’s on BDF side and pairs 1 thru 48 on IDF or BDF voice grade patch panel side in data equipment rack.

D. Telephone System Cross-Connects:
   1. All Telephone System Cross-Connects will be installed by the University. Coordinate installation needs with University Representative in a timely manner as to not create a scheduling problem.

E. Telephone and/or Data System Faceplates:
   1. Provide one (1) 4 Port Faceplate at each combination telephone/data and/or telephone only outlet.
and/or data only outlet location. Fix each faceplate to the electrical back box with its full complement of screws.

2. Provide all Faceplates as shown on drawings.

3. Fix data and telephone connectors in the openings of the faceplate. Locate a blanking plate(s) in all unused openings in each faceplate.

4. Provide one (1) single Port Stainless Steel Faceplate (Wall +42” AFF) at each telephone only outlet.

3.5 DATA SYSTEM INSTALLATION DETAILS

A. Data System Equipment Racks:

1. Provide Data System Equipment Racks in each BDF and/or IDF Telecom Room in the locations shown on the floor plans. Securely fix each rack to the floor and overhead cable runway.

B. Data System Patch Panels:

1. Provide Data System Patch Panels in the equipment racks located in the BDF and/or IDF Telecom Room.

2. Provide a sufficient number of Data Patch Panels to house all Data system information outlet connectors.

3. Provide one 2U horizontal cable manager above and below each patch panel and power strip to allow for the horizontal routing of cables. Provide 1U horizontal cable mangers where shown on drawings.

C. Data System Distribution Cables and Connectors:

1. Provide horizontal data system distribution cable(s) running from each data outlet to the BDF and/or IDF Telecom Room data system patch panel on that floor. Provide data system distribution cable(s) at each combined telephone/data and/or data only outlet location shown on drawings.

2. Terminate each data system distribution cable with an information outlet connector (REVConnect RV6MJKUBK) at outlet end of the cable. Use the TIA-T568B wiring configuration, as defined in the ANSI/TIA cabling standard for premises horizontal wiring, shown below:

<table>
<thead>
<tr>
<th>Patch Panel</th>
<th>Conductor Color</th>
<th>Connector Pin</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td></td>
<td>Blue/White</td>
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</tr>
<tr>
<td>Pair 2</td>
<td>White/Orange</td>
<td>Pin 1</td>
</tr>
<tr>
<td></td>
<td>Orange/White</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Pair 3</td>
<td>White/Green</td>
<td>Pin 3</td>
</tr>
<tr>
<td></td>
<td>Green/White</td>
<td>Pin 6</td>
</tr>
<tr>
<td>Pair 4</td>
<td>White/Brown</td>
<td>Pin 8</td>
</tr>
<tr>
<td></td>
<td>Brown/White</td>
<td>Pin 7</td>
</tr>
</tbody>
</table>

3. Install station cables using the most direct route possible between outlet and patch panel while using the conduit, J-hooks and/or cable tray. Avoid distribution cables that are in excess of 250 feet in length.

D. Telephone and/or Data System Faceplates:

1. Provide one (1) 4 Port Faceplate at each combination telephone/data and/or telephone only and/or data only outlet location. Fix each faceplate to the electrical back box with its full complement of screws.

2. Provide all Faceplates as shown on drawings.

3. Fix data and telephone connectors in the openings of the faceplate. Locate a blanking...
plate(s) in all unused openings in each faceplate.

3.6 OPTICAL FIBER RISER CABLE
A. Optical Fiber Riser Cabling:
   1. Provide optical fiber riser cabling as shown on drawings running between the BDF Telecom Room fiber termination unit (FTU) connector panel(s) and each IDF Telecom Room FTU connector panel(s).

3.7 INSTALLATION PRACTICE
A. Comply with NECA 1.
B. Wiring Method: Install cables in raceway and/or using conduit, J-Hooks and/or cable tray except within consoles, cabinets, desks, and counters and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
C. Telephone/Data Cable Installation:
   1. Install cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
   2. Make terminations only at indicated outlets, terminals, and cross-connect and/or patch panels.
   3. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   4. Secure and support cables at intervals 48" to 60" and not more than 6" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Keep Cable bundles to no more than two-inch (2") maximum diameter to include being installed in any one (1) non-continuous (J-hook) cable support.
   6. Where Cables enter conduit stub-ups above outlet boxes or surface mounted raceways, provide minimum ten-inch (10") diameter service loop with two (2) wraps.
   7. Install UTP cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
D. Wiring within Wiring Closets and Enclosures:
   1. Use cable strain relief brackets behind all patch panels to prevent straining connections to prevent bending cables to smaller radii than minimums recommended by manufacturer.
E. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
   1. Separation between unshielded power lines or electrical equipment in proximity to open cables or cables in nonmetallic raceways is as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: 12 inches.
   2. Separation between unshielded power lines or electrical equipment in proximity to cables in grounded metallic raceways is as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: 6 inches.
3. Separation between power lines and electrical equipment located in grounded metallic conduits or enclosures in proximity to cables in grounded metallic raceways is as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: 3 inches.

4. Electrical Motors and Transformers, 5 kVA or HP and Larger: 48 inches.

5. Fluorescent Fixtures: 5 inches.

F. Do not untwist more than 1/4 inch of Category 6 cables at connector terminations

G. Provide grommets and strain-relief for cables terminating on wall-mounted user outlets to ensure durable and robust connections. Leave a 4-inch (4") slack loop in each cable neatly coiled (no more than twelve-inches 12") in the outlet back-box at each termination location.

H. Take due account of the minimum bend radius of all cables installed. No cables shall be installed in a fashion that contravenes the minimum bend radius of the cable.

I. Provide all cables in straight parallel runs when on cable trays and/or J-hooks. Hold cables running in the vertical direction in place with broad cable ties at not more than 15” centers. Hold cables running in the horizontal direction in place with broad cable ties at no more than 48" centers.

J. Telephone and data system cables shall run in dedicated cable tray, J-hooks and/or conduit pathways provided for data and telephone system use only. Do not tie communication system cables to power or other foreign services. All cabling shall run parallel or at right angles to building wall structures.

K. Reinstate and/or provide mule-tape (pull-wire) in all conduits after use to facilitate future addition of cables.

L. Provide and install fire-stopping in accordance with all local and NFPA regulations to sustain ratings when passing through (floors, wall or ceilings) with; conduits, sleeves, raceway, cable tray, wire basket cable tray through fire-rated elements.

M. Install all cables in complete runs from outlet or patch panel to patch panel. In-line joints, splices, distribution points, or other intermediate connections are not permitted.

N. The Contractor shall individually and properly ground all voice (110) termination frames, data system equipment racks, building entrance terminals, copper riser sheaths and cable runway with #6AWG green stranded wire to the TMGB or TGB using two-hole compression lugs on each end. Note: individual copper riser cable(s) sheaths at BDF backboard location maybe bonded together (at 4460-D cable shield bond connectors) side-by-side with bonding braid with eyelets (3M #25T-BBE3) or approved equal, then with a single #6AWG ground wire to TMGB when more than one riser cable exist. Not every cable sheath has to be bonded with #6AWG to TMGB.

3.8 WIRE BASKET CABLE TRAY INSTALLATION

A. Install wire basket cable tray in accordance with NEMA VE 2 to ensure that the cable tray equipment complies with the requirements of the NEC, applicable portions of NFPA 70B, and the National Electrical Contractors Association’s (NECA) ‘Guide to Quality Electrical Installations’ pertaining to general electrical installations practices.

B. Install wire basket cable tray system to meet all current code required Seismic requirements.

C. Coordinate wire basket cable tray with other electrical work as necessary to properly interface installation of wire basket cable tray with other work.

D. Install expansion connectors where recommended by manufacturer.

E. Support wire basket cable tray and fasten to building structure. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of eight-foot zero-inch (8'-0") maximum.

F. Support wire basket cable tray with three-eighths of an inch (3/8") diameter minimum size all-threaded rod, trapeze style (dual rod attachment) allowed only, no center hung style (single rod attachment) will be allowed, when wire basket cable tray is suspended from ceiling above.

G. Provide sufficient space around wire basket cable tray to permit access for installing and maintaining cables.
H. Install firestopping in accordance with NFPA and Building Code requirements when passing through all fire-rated elements; e.g. walls, floors, ceilings, roofs.
I. Ground and Bond metal cable tray in accordance with NFPA 70, NEC, Article 392.
   1. Provide continuity between wire basket cable tray components.
   2. Make connections to tray using mechanical, compression or exothermic connectors.
J. Comply with the appropriate Division 26 Section for "Grounding and Bonding" and with TIA 607.

3.9 GROUNDING
A. Comply with the appropriate Division 26 Section for "Grounding and Bonding" and with TIA 607.
B. Grounding Points:
   1. Locate grounding busbars (MTGB) in BDF and (TGB) in each IDF Telecom Rooms.
   2. Provide a ground connection from all voice termination frames, data system equipment racks, copper riser sheaths and cable runways to the grounding terminals in the MDF/BDF and IDFs.

3.10 LABELING AND NUMBERING CONVENTIONS
A. General.
   1. Outlets, cables, and terminations shall be labeled with a standard identification tag. Tags shall be typewritten or stamped with indelible waterproof ink and mechanically secured in a permanent fashion. Handwritten labels are NOT acceptable. Labels shall be mounted in a manner, which permits easy access and viewing. Receptacles, cables, and terminations shall be identified using the following conventions.
      a. Outside Plant and Riser Cables:
         1) Telephone cable(s) will have cable ID and pair counts, from and to locations clearly marked on each cable and building equipment room punch down blocks.
         2) Optical fiber cable will have cable ID and strand count, from and to locations clearly marked on each building equipment room fiber optic patch panel.
   2. Label each cable so that the label is visible for inspection.
B. Station Cable:
   1. Label each component of the telephone and data systems with its unique identification number using TIA 606-A Class 3 standards. The labeling and numbering scheme shall be compatible with the labeling and numbering scheme currently used by the University of California, Riverside. The labeling and numbering scheme used by the Contractor shall be approved by the University Representative.
   2. All labeling will follow the TIA 606-A Class 3 standard. Each telecommunications room; e.g. BDF or IDF will have a letter (A, B, C, etc.) assigned on each floor.
   3. The Station label will follow the format listed in this section. However, the top label includes both top ports i.e. "1A-A04 1A-A05". "1" identifies the 1st Floor, "A" identifies IDF/Closet #. "A04 and A05" represents the Panel number ("A") and the port numbers ("04 and 05"). The first patch panel port number will always be the left face plate port and the second patch panel port number will always be the right face plate port. The bottom label will follow the same guidelines when used. When unused the label will be left blank. The font size will be the largest size that fits the required information but no smaller than 10-point font. Voice jacks shall start at the top left position on the wall plate left to right top to bottom. Data jacks shall start at the next open lower row after all voice jack locations are populated. The voice jacks shall be gray for analog, elevators and emergency outlets and the data jacks shall be black. Data and voice cables are blue.
C. Typical 4-Port faceplate (2-Data)

The cable serving each receptacle must be labeled at the receptacle and patch panel or 110 wiring blocks with wrap-around label. Label each cable (voice or data) so that the label is within 2” of the end of the cable at the 48 port data system patch panel end or 110 wiring block and at each outlet end.

C. Connectors:

Label each connector at each outlet (faceplate) location. The label shall be clearly visible for inspection.

D. Telephone System Termination 110 Block:

Telephone System Termination 110 Block Labels. Provide a full complement of pre-printed cardboard patch frame labels, allowing each pair of each telephone system distribution, feeder, and external cable to be clearly identified. Telephone feeder cable pairs at terminal frames shall identify telephone outlet that they are connected to via the telephone station cable.

E. Data System Patch Panels:

Provide a full complement of data system patch panel labels, allowing each data system distribution and feeder cable connector to be clearly identified. Both copper and fiber connectors shall be labeled.

3.11 IDENTIFICATION

Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecom rooms, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA-606-A. Furnish electronic record of all drawings.

3.12 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

B. Category 6 UTP Cabling Tests:

1. Tests shall include all tests of Category 6, conducted from 1 to 300 MHz.

2. Channel and permanent link tests shall be performed with a tester that complies with...
performance requirements in TIA-568-B.2, Level III. Include tests for longitudinal or transverse conversion loss.

3. Performance shall comply with minimum criteria in TIA-568-B.1 & B.2.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

3.13 TESTING AND DOCUMENTATION

A. General:

1. Acceptance testing by the University Representative shall not occur until all work in the Telecom Room is completed, including but not limited to mounting and installation of fiber riser cables, backboards, terminating boxes and cabinets, and grounding blocks, and termination of fiber riser cables, copper riser cables, station wires, or any other work necessary for the completion of the installation. Acceptance testing shall be in compliance with TIA-568-B.1, B.2 & B.3.

2. The University Representative shall have the right to schedule acceptance testing at its convenience.

3. A University Representative, at the option of the University Representative, shall be present during testing.

4. Such acceptance testing shall in no way reduce the Contractors’ obligations regarding restoration, clean up, or warranty.

5. Contractor shall perform tests necessary prior to acceptance testing to ensure that the installed cables will pass acceptance testing performed in conjunction with University Representative.

6. Contractor shall be responsible for performing, tracking, and recording the results of tests.

7. Contractor shall be responsible for providing equipment and materials necessary for as long a period of time as necessary to complete testing to the satisfaction of the University Representative.

8. Test record forms shall be agreed to by the University Representative prior to the commencement of acceptance testing.

9. When testing is completed on cables, the Contractor shall deliver typewritten records of the test results to the appropriate University Representative within 72 hours of completion of such tests.

B. Telephone and Data (copper & fiber) BDF to IDF Riser Cables:

1. A visual inspection shall be made to ensure that the cables have been terminated on the punch down block in proper color code order. An end-to-end continuity test is to be made for each pair to insure wire continuity and correct tip and ring polarity. Riser cables will be tested from the BDF 110 frame punch down blocks to each IDF Telecom Room patch panel that the cable serves.

2. Vertical and horizontal riser cables will be tested to ensure that they meet the current requirements of TIA cabling standard for premises horizontal wiring for the category of cable being installed, i.e., Category 3 cable shall meet Category 3 parameters within a 25-pair binder group. Documentation will include cable ID; pair ID, from and to points, pair ID marked on the punch down blocks, results of testing, and as-built information.

3. Bad pairs in copper cables shall be limited to a maximum of 0 percent of the total number of pairs.

4. Measures taken to correct unacceptable test results will be recorded, along with loss measurements taken before and after corrective measures.

5. Acceptance testing shall be completed prior to completion of Contractor’s contractual
obligations.

6. Documentation will include cable ID, from and to points, strand ID, bi-directional attenuation figures in dB, OTDR wave forms, and as-built information.

7. Use of an OTDR may require that a "launch reel" be used to overcome the OTDR's dead zone. Include this information in the as-build documentation.

8. Fiber jumpers used with the OTDR, light source, and power meter must be of the same size and type as the fiber being tested.

9. Fiber jumpers used with the light source and attaching the jumper from the light source via a coupler to the jumper from the power meter shall zero power meters out. This reading noted will become the reference level to obtain a true attenuation reading (some power meters can be zeroed to allow reading the attenuation level directly).

C. Horizontal Station Cables:

1. Visual inspection will be made to ensure that all cables have been terminated on the punch down block and on the eight-position station jack in proper color code order.

2. Four-pair station cables attached between station voice jacks and floor equipment room punch down blocks will be link tested with a cable analyzer to ensure compliance with current TIA cabling standard Category 6 parameters. Four-pair station cables attached between data station jacks and floor equipment room jack fields will be link tested with a cable analyzer to ensure compliance with current TIA cabling standard Category 6 parameters. All pairs shall test good and meet Category 6 parameters. Open, split, miss-terminated pairs, deviations from the manufacturer's installation specifications, defective connections, and bad installation practices will not be accepted and must be corrected.

3. When station wire is determined to be acceptable, University Representative may spot test the plant using a certified Category 6 handheld tester, such as the Fluke Networks Versiv DSX-8000 CableAnalyzer test set with LinkWare Management Software.

4. Test results shall meet or exceed the Category 6 test requirements as specified in the TIA cabling standard for premises horizontal wiring specifications. The approved Category 6 handheld tester will have the capability to be programmed with current Category 6 requirements as specified in the TIA cabling standard for premises horizontal wiring.

5. Documentation will include cable ID (same as jack ID) to be marked on the punch down block in the communication closet, station jack ID to be marked on the station jack, and results of Category 6 channel testing done with the cable analyzer. Analyzer documentation of testing shall consist of test result recorded in a " .txt" or " .csv" file on a USB drive and on hard copy installed in a ring binder. The designated University Representative as part of the inspection and acceptance procedure shall verify test results.

D. Test Equipment:

1. It will be the Contractor's responsibility to provide the test equipment necessary and document to the University Representative the test equipment available for testing and the last date of certification.

2. Testing Equipment:
   a. Continuity tester.
   b. Power meter/source.
   c. OTDR (Optical Time Domain Reflectometer).
   d. Appropriate types of fiber jumpers.
   e. Equipment for two testers to communicate.
   f. Fluke Networks Versiv DSX-8000 CableAnalyzer with LinkWare Management Software.

E. Documentation:
1. The contractor shall submit three (3) copies (drawings hard copy 24" x 36" and USB drive) of the following as-built record drawings and documentation in a 3-ring binder following completion of testing (and re-certification, as necessary):
   a. Construction Drawings: The as-built documentation shall be in AutoCAD min R2018 dwg or dxf equal and shall consist of the construction drawings with the station location numbers (faceplate identification numbers, e.g. 1A-V12, 1A-C15, etc.) inserted next to the symbol for each location. Also, Equipment Rack and Wall elevations to include Copper and Fiber riser diagrams shall be provided.
   b. Fiber Optic riser Test reports (OTDR and Power Meter).
   c. Copper riser Test reports (Cable No. and pair counts, opens, shorts, grounds, etc).
   d. Cat-6 Test reports to be provided in pdf file format and shall include and be arranged in:
      1. Overall Summary Page (numerical order)
      2. Telecom Room (BDF/IDF), Patch Panel (A thru Z) (numerical order)

F. The documentation format (Test reports) will be agreed upon between the University Representative and the Contractor. The Contractor may be required to furnish licensed system software if the University is unable to view any of the Test reports submitted.

END OF SECTION 27 15000
## DIVISION 27 – CAMPUS COMMUNICATIONS DESIGN & INSTALLATION GUIDELINES

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1.0 GENERAL - PURPOSE

A. The intent of this document is to provide a standard design and installation guideline and best practices that will be used for all UC Riverside (UCR) facilities requiring cable installation. This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate UCR's requirements.

Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types for a specific UCR facility will be provided as an attachment to a Request for Proposal. If the bid documents are in conflict, the Request for Proposal specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cabling system described in this document.

This document is intended to provide general design and installation guidelines for new construction, and performance criteria for additions/renovations to existing facilities. Since all new construction will have telephone/data communication service raceways provided by an electrical subcontractor under the general contract, the specifications included in this document are intended as supplemental information to ensure an acceptable, effective installation.

This document is intended to be used in conjunction with UCR Specification Sections 27 1500 Communications Horizontal Cabling, 27 1300 Outside Plant Backbone Cabling, and 27 0543 Underground Ducts.

1.1 CONTRACTOR QUALIFICATIONS

A. Contractor must possess a valid State of California Contractor's License C-7 Low-Voltage and have successfully performed at least three projects of low voltage cable installation with similar size and work scope, within two years of the date of the job they are bidding on. Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the start and end dates, and contact information. For projects that require a Request for Proposal this information will be required as part of the submittal. See section 1.3. For work that does not require a Request for Proposal, this information should be available upon request.

All contractor personnel who will be performing work on this project shall have been trained on the work they will be performing. They shall have been trained on the Contractor's company policies with respect to personnel safety, telecommunications industry cabling quality and neatness standards, and use of Construction Standard Institute (CSI)-standard specifications and drawings.

Contractor, at all times during performance and until work is completed and accepted, shall have on the premises a competent supervisor, satisfactory to the Customer and with authority to act for the Contractor. The supervisor must be a BICSI certified Installer and BICSI member in good standing.

As a requirement to bidding and performing awarded work, the Contractor must have a current BICSI certified Registered Communications Distribution Designer (RCDD) on staff as a full-time employee. At UCR's discretion, on a project-by-project basis, an RCDD consultant may be hired by the University to inspect work during and after completion. Based upon the inspection by UCR's hired RCDD consultant or Information Technology Solutions staff the Contractor will be responsible for correcting any work that does not meet requirements detailed in this document.

For projects that require a Request for Proposal the RCDD certificate and BICSI member number will be required as part of the submittal. See section 1.3. for work that does not require a Request for Proposal, this information should be available upon request.

For jobs that require more than 24 data connections, weekly inspections and approval of all work performed shall be conducted by the contractor's RCDD certified employee. The contractor will submit a weekly status report to the UCR ITS Staff detailing what work has been completed and inspected. The report will also include any issues encountered as part of the install.
Contractor must provide at least one lead technician on site at all times during project who is a BICSI certified installer and a BICSI member in good standing. For projects that require a Request for Proposal a copy of certificate and BICSI member number will be required as part of the submittal. See section 1.3. For work that does not require a Request for Proposal, this information should be available upon request.

1.2 APPLICABLE REGULATIONS

A. RELATED DOCUMENTS

Equipment and material shall be Underwriter's Laboratories listed and labeled. The latest editions of the following standards are minimum requirements. If a conflict exists between applicable documents, then the order in the list below shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.

1. ANSI/TIA-569-D Telecommunications Pathways and Spaces
2. ANSI/TIA 568.0-D Generic Telecommunications Cabling for Customer Premises
3. ANSI/TIA-568.1 -D Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
5. ANSI/TIA-568.3-D Optical Fiber Cabling Components Standard
6. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure
7. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
8. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling National Electrical Manufacturers Association (NEMA)
9. National Electrical Code, latest revision (NEC)
10. National Fire Protection Agency (NFPA) — 70
11. Local, State and Federal Codes including Nevada Revised Statute (NRS)278.583
12. UL 497 Protectors
13. UL 1459 Standard for Safety for Telephone Equipment
14. UL 1863 Standard for Safety for Communications Circuit Accessories
15. UL 2024 Standard for Safety for Optical Fiber Cable Raceway
17. UL 1581 Standard for Safety for Reference Standard for Wires, Cables and Flexible Cords

1.3 SUBMITTAL

A. For jobs that require submittals, the Contractor shall furnish the following in a single consolidated submittal with an Approval copy to UCR Staff at the time of submission:

1. Contractor's license number and proof of qualifications.
2. Reference sheets which provide three references. Each reference shall include a brief description of the project, the start and end dates, and contact information and contract value. The format shall be as follows for each of the three references:
   - Name of Client:
   - Address:
   - Contact
   - Person:
   - Contact Phone
   - #:
Contact E-mail:  
Description of Service/Project:  
Contract Price: $___________  
Dates of Service/Project (Start to End Dates):

3. The make and model of the materials to be used.

B. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to the Customer at the time of award:

1. A copy of the RCDD certificate and BICSI member number as described in the above Contractor Qualifications section.
2. A copy of the BICSI certificate and the BICSI member number of the lead technician as described in the above Contractor Qualifications section.
3. A copy of the BICSI certificate and the BICSI member number of the supervisor as described in the above Contractor Qualifications section.
4. A copy of a valid manufacturer certified installer certification.

C. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to UCR Staff upon request:

1. For all Category 6 installation technicians, provide the training certificates with a brief description of the training courses associated with each certificate.

1.4 DESIGN REQUIREMENTS
Work must conform to the design requirement for each identified element.

A. BUILDING SERVICE
Plans for all new buildings shall include a design for extending the campus voice, data and video networks to the building. Consistent with this design, network trunks shall be extended as a part of the initial construction and equipment shall be installed to provide connection to the building. Every building, regardless of size, shall be constructed to allow for an air-blown fiber tube-cell conduit to enter through individual 4” conduits from the campus underground plant from two diverse locations. Exact air-blown fiber tube-cell conduit size will be determined by UCR Information Technology Solutions on project by project basis. Communication cables shall enter from the campus underground plant from one location. In addition, every building shall be equipped with at least two empty 4” conduits to the campus underground plant for later use by UCR after installation of all voice and data cables. All raceways to have 800 lb. nylon pull strings installed. All new service entrance conduits shall be a minimum 4” trade size and of sufficient number to provide 50% growth capacity and will terminate 4” above finished floor in the equipment room (ER) inside the building.

1. SERVICE — DATA
Data communication service to each building shall consist of a minimum of 24 strands of 8.3/125-micron single-mode fiber and terminated at two separate major distribution locations on campus as determined by UCR Information Technology Solutions. Fiber optic cable is to be contained in its own air-blown fiber tube-cell conduit. Single-mode fiber is to be terminated with LC style connectors, UPC. Single-mode fiber will be terminated in a separate rack-mounted fiber optic enclosure. Contractor will install an air-blown fiber distribution unit in all MDF and BDF/IDF locations. Each fiber optic enclosure must be labeled with building, IDF room number and fiber enclosure identifier of opposing end. Patch panels to be mounted in such a manner as to allow the maximum usage of each rack. Appropriate wire management, determined by consultation with Information Technology Solutions and with regards to building design, shall be installed. Service loops of fiber-optic cable will be coiled, to meet manufacturer specifications, at both termination points. Complete IDF room design, including rack layout, power requirements, cable management will be provided by UCR Information Technology Solutions.
2. SERVICE — VOICE
Voice communication service to each building shall consist of a minimum of one 50-pair, 24 AWG, solid annealed copper cable. Cable pair count to be determined by UCR on a per project basis. Cable to enter building through a separate, dedicated conduit. Cable to be terminated on 110-type punch blocks at telecom backboard. Lightning protection to be provided as required per design specifications and/or applicable codes and regulations.

B. SERVICE ENTRIES
Elements of the service entry facilities design are to include type, size, gauge, and insulation of distribution cables. Every copper cable shall be bonded and grounded for lightning protection per NEC 800-30A at both terminations using solid-state 5-pin protectors, 50 to 100-volt range.

Building entry conduit shall allow for 50% growth and have a minimum of two 4” conduits from manhole to ER room.

C. COMMUNICATIONS ENTRANCE PROTECTION

BUILDING ENTRANCE TERMINALS
1. Outside Plant copper cables entering the ADF/BDF/IDF shall be terminated on wall mounted building entrance protector terminal(s) equipped with digital solid state (4B1FS240) protector modules; 4B1FS-240 includes heat coils for sneak current protection.

2. Building entrance terminals shall not be located directly above the room entrance conduits, slots or sleeves. Terminals shall be mounted in a location on the backboard that shall allow enough space for future cable and cross-connect installations.

3. Copper entrance cables up to and including 300 pairs shall be terminated on protected building entrance terminals equipped with a splice chamber and factory installed large 710-type splice modules in the splice chamber (field side) and 110 type terminations on the output (equipment side) and lockable cover; Circa model 1880ECS1-100 (as shown below), or equal. Cable shall be blocked with an approved manufactured seal to prevent the gel filled compound from escaping.

4. Copper entrance cables 301 pairs and larger shall be terminated on individual 100 pair protected terminals equipped with a factory installed, 26AWG swivel cable stub in the splice chamber (field side) and on the output (equipment side): stub-in, stub-out configuration. Cable stubs shall be no shorter than 2 feet in length after installation. Circa model 2000-100(as shown below), or equal;
5. Factory cable stubs shall be spliced with 25-pair 710-type splice modules to the outside plant copper. An indoor rated splice closure shall be securely mounted to the plywood back board. Indoor closures shall not be encapsulated.

6. Contractor shall extend the copper backbone cable from the building entrance terminal to a separate 110-type termination block field.

**Building Entrance Terminal Layout**
All terminals shall be labeled in accordance with Spec 27 1300 Section 1.37-1.38 Labeling and Identification for Backbone Cabling Communications Systems and properly grounded to the Telecommunications Grounding Busbar (TGB) in accordance with ANSI-J-STD-607-C.

D. VAULTS

All new cable vaults shall be as specified in Specification Section 27 0543 and as detailed in drawings or ITS approved equivalent and encased in concrete. All cable is to have service loops and be racked and mounted. Each vault shall have drainage holes and be engineered so water will not accumulate. Vault lids shall be adjustable torsion spring assisted openings with safety latches, lift handles, and hold down bolts. Vault labels shall meet labeling specification referenced in Section 1.4. F.4.e. Top of vault lids shall be flush with paved areas, or 4" above finished grade in landscaped areas. Vault lids shall be Traffic Rated.

E. CABLE SPLICING

Copper cable splicing is only allowed where previously approved by UCR Information Technology Solutions. Fiber-optic cable will only be spliced at the termination point. Fiber-optic splicing must be fusion based with two fibers optic strands of the exact make and model on each end using factory terminated connectors on pigtails. Splicing is not acceptable outside of Tele/Data rooms. Epoxy based splices shall not be acceptable.

The following cable splicing techniques and materials for copper cable shall be utilized:

1. Preparation for Splices
   All copper cables shall be thoroughly cleaned and scuffed in a manner to insure a good mechanical bond when splicing. 3M Scotchcast 4435 non-conductive aluminum oxide abrasive strip, or UCR approved equal shall be used. All cable shall be thoroughly cleaned with a nontoxic solvent, 3M Scotchcast 4414 or 4415 or UCR approved equal.

2. Splicing requirements
   a. No splice cases will be permitted in cable trays.
   b. All splice closures for use on underground non-pressurized systems shall be manufactured of clear, self-extinguishing, tongue and groove fitting PVC.
   c. End caps must be tapered and flexible and be capable of separate cable entries.
   d. Rigid bonding and strain relief bars must be an integral part of the finished closure.
   e. Re-enterable, polyurethane compound shall be used.
   f. All cable splices must be tagged or marked showing the cable number and pair count spliced. Markings may be placed on the splice closure or on both the in and out cables.
   g. Supports: All cable splices shall be supported by a minimum of two cable hooks. Horizontal racking for support may utilize 3M Brand RC-100 rack adapters, manhole racks, or UCR approved equivalent.
   h. Closures: 3M or PLP splice closures or UCR approved closures will be used for splicing throughout the system.
   i. Protection: All cable splices must be protected from damage at sheath openings by mechanically protecting all conductors utilizing 3M Scotchcast Pair Saver 4458 or approved equivalent.

E. BUILDING VOICE AND DATA TERMINAL ROOMS

All new building structures shall have minimum one primary Data communication room in which the outside cable terminates, henceforth referred to as the Building Distribution Frame (BDF). Each building may have additional data rooms for end wiring, henceforth referred to as Intermediate Distribution Frame (IDFs).
1. BUILDING DISTRIBUTION FRAME (BDF) SPECIFICATIONS
   a. The BDFs shall not contain any equipment not specified by UCR Information Technology Solutions. This includes, but is not limited to, equipment, transformers, sinks, fire, or building alarm equipment. They shall be kept clear of all other equipment.
   b. Each BDF will be provided with an isolated electrical panel with 200-amp service.
   c. The BDF will require the installation of a secondary bonding busbar (SBB) to building primary bonding busbar (PBB) that is directly bonded to the AC electrical ground system with a conductor the same size as the largest telecommunications bonding backbone (TBB). The connections of the telecommunications bonding conductor (TBC) and the TBB to the PBB shall utilize exothermic weld, Listed compression two- hole lugs, or two-hole exothermic lugs. All equipment racks shall be connected to the secondary bonding busbar (SBB) with a telecommunications bonding conductor (TEBC) that is continuous copper conductor not less than #6 AWG. The SBB shall:
      • Be provided with holes for use with correctly matched listed lugs and hardware. Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
      • Have minimum dimensions of 1/4 in. (6.35mm) thick by 2 in. (50mm) wide and shall be long enough to accept all current connections with additional room for growth.
      • Be listed.
      • Where a backbone bonding conductor (BBC) is required it shall be bonded to the SBB.
      • The BDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding conductor through a telecommunications equipment bonding conductor (TEBC) using an irreversible compression connector sized to match the conductor gauges. The TEBC is then bonded directly to the SBB that is continuous copper conductor not less than #6 AWG.

   The RBB shall:
      • Be provided with holes for use with correctly matched listed lugs and hardware.
      • Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
      • Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall be 19 in. (482.6mm) long.
      • Shall mount to the back-rack rails at the top of each rack.

d. Each BDF will have two quad 20 amp, 110 V.A.C. outlets, terminated with NEMA 5-20Rs, two 30 amp 208 V.A.C. outlets, terminated with NEMA L6-30Rs. All outlets will require dedicated electrical circuits. When available, all outlets will be serviced by the emergency power system and colored orange or otherwise marked as such. All outlets will be positioned within 4 feet of the rear of the provided racks at standard outlet height.

e. All BDFs shall be accessible only from inside the building. No outside entrances are permitted. All doors between the outside and the BDF must be at least 36" wide and 80" high.

f. Rooms will be rectangular or square, have a minimum clearance height of eight feet without obstructions (sprinklers, etc.), be at least 14’ x 12’, and not have false floors or ceilings.

g. No exposed water or gas pipes shall enter in or run through the main terminal room or data room. No drains, ducts or clean-outs will be permitted.

h. A separate HVAC thermostat control will be installed for all BDF rooms and shall be air conditioned with separate zone or air conditioning unit 24 hours a day, seven days a week. A positive pressure shall be maintained with a minimum of one air change per hour.

i. All BDFs shall be secured using a UCR-approved card access reader and striker. The access of which is to be managed by the Campus Facilities Department and/or Maintenance Department.
j. All BDFs shall be provisioned with at least one standard data rack, as manufactured by CPI, bolted
to the floor. These rack(s) shall be placed side-by-side, with vertical cable management, in between
and on both sides. Vertical cable management shall have doors on both front and rear of the cable
managers. The racks must have a minimum of 36” of clearance front and back and at least 24” on
one side. OIT provided room drawings must be followed. Please refer to Specification Section 27
1500, Part 2.15 for Rack and cable management specified CPI part Ladder rack shall be provided
and installed sufficient to secure the equipment rack to the adjacent wall(s) as determined at
installation and to provide support for incoming cables.

k. A minimum of two walls must be covered by backboards.

l. Floor loading shall be designed to support a minimum of 1000 pounds of equipment per data rack
provided.

m. All other elements of room to be designed and provisioned per ANSI/TIA 569-D or better.

2. INTERMEDIATE DISTRIBUTION FACILITY (IDF)

a. The IDF s shall not contain any equipment not specified by UCR Information Technology
Solutions. This includes, but is not limited to, transformers, sinks, fire or building alarm equipment.
They shall be kept as clear of all other equipment.

b. Each IDF will be provided with an SBB connected by a TBB to the PBB. The TBB shall be no smaller
than a #6 AWG conductor and/or use the recommended sizes in accordance with ANSI-TIA-607-C.
All equipment racks shall be connected to the SBB with a TEBC that is continuous copper conductor
not less than #6 AWG.

The SBB shall:

- Be provided with holes for use with correctly matched listed lugs and hardware.
- Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed
  as specified by the International Annealed Copper Standard (IACS).
- Have minimum dimensions of 1/4 in. (6.35 mm) thick by 2 in. (50.8mm) wide and shall be
  long enough to accept all current connections with additional room for growth.
- Be listed by authority having jurisdiction.
- Where a backbone bonding conductor (BBC) is required it shall be bonded to the SBB.

c. The IDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding
conductor through a telecommunications equipment bonding conductor (TEBC) using an
irreversible compression connector sized to match the conductor gauges. The TEBC is then
bonded directly to the SBB that is continuous copper conductor not less than #6 AWG.

The RBB shall:

- Be provided with holes for use with correctly matched listed lugs and hardware.
- Be made of copper, or copper alloys having a minimum of 95% conductivity when
  annealed as specified by the International Annealed Copper Standard (IACS).
- Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall
  be 19 in. (482.6mm) long.
- Shall mount to the back-rack rails at the top of each rack.

d. Each IDF will have two quad 20 amp, 110 V.A.C. outlets, terminated with NEMA 5-20Rs and two 30
amp 208 V.A.C. outlets, terminated with NEMA L6-30Rs. All outlets will require dedicated electrical
circuits. When available, all outlets will be serviced by the emergency power system and colored
orange or otherwise marked as such. All outlets will be positioned within 4 feet of the rear of the
provided racks, at standard outlet height.
e. All IDFs shall be accessible only from inside the building. No outside entrances are permitted. All doors between the outside and the IDF must be at least 36" wide and 80" high.

f. Rooms will be rectangular or square, have a minimum clearance height of nine feet without obstructions (sprinklers, etc.), be at least 10’ x 10’, and not have false floors or ceilings.

g. No exposed water or gas pipes shall enter in or run through the main terminal room or data room. No drains, ducts or clean-outs will be permitted.

h. A separate HVAC thermostat control will be installed for all IDF rooms and shall be air conditioned with separate own zone or air conditioning unit 24 hours a day, seven days a week. A positive pressure shall be maintained with a minimum of one air change per hour.

i. All IDFs shall be secured using a UCR-approved card access reader and striking. The access of which is to be managed by the Campus Facilities Department and/or Maintenance Department.

j. All IDFs shall be provisioned with at least one standard data rack, as manufactured by CPI, bolted to the floor. These rack(s) shall be placed side-by-side, with vertical cable management in between and on both sides. Vertical cable management shall have doors on both front and rear of the cable managers. The racks must have a minimum of 36” of clearance front and back and at least 24” on one side. OIT provided room drawings must be followed. Please refer to Specification Section 27 1500, Part 2.14 for Rack and cable management specified CPI part numbers.

k. Enough rack space must be provided to terminate all fiber and copper, with associated cable management, plus 200%.

l. Ladder rack shall be provided and installed sufficiently to secure the equipment rack to the adjacent wall(s) as determined at installation and to provide support for incoming cables.

m. A minimum of two walls must be covered by backboards as defined in Part II.

n. Floor loading shall be designed to support a minimum of 1000 pounds of equipment per data rack provided.

o. All other elements of room to be designed and provisioned per ANSI/TIA 569-D or better.

3. ROOM SIZING

1. There shall be a minimum of one Telecommunication Space (TS) per floor. One additional TS for each area up to 10,000 sq. ft. shall be provided when the floor area to be served exceeds 10,000 sq. ft or the horizontal distribution distance to the workstation exceeds 295-feet.

2. If the floor area is over 10,000 sq. ft., then the TS size shall be increased, based upon 0.75 sq. ft. for every additional 100 sq. ft. of usable space the TS will support.

3. The sizes of all telecommunications spaces (BDF/IDF) listed are minimum requirements. Depending on the requirements and services performed by the building occupants, additional space may be required. Larger size buildings and building programs may require additional rows of equipment racks or cabinets. Contact the University’s Representative for specific instructions.

<table>
<thead>
<tr>
<th>Serving Area</th>
<th>Minimum Room Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDF</td>
<td>9-feet wide by 12-feet long</td>
</tr>
<tr>
<td>BDF</td>
<td>10-feet wide by 15-feet long</td>
</tr>
</tbody>
</table>
4. TYPICAL TS (BDF/IDF) LAYOUT

F. BUILDING INTERIORS

1. UNDERGROUND PLANT

The cables from the underground plant shall enter the building in a BDF room. Appropriate wire management shall be installed such as ladder racks, D-rings, and hook and loop tape so as not to exceed the acceptable cable bend radius.

2. DATA ROOMS

Additional IDF(s) shall be provided on each floor, and if necessary, to prevent total length of data cable runs from exceeding 295 feet. IDF rooms in multistory buildings shall be aligned vertically with the BDF room, if possible.

3. INTERNAL BACKBONES (RISERS)

A minimum of two 4" conduits shall run between every IDF and the BDF within buildings. Pull strings shall be provided in every conduit. Data interconnections between each IDF and the BDF shall be via fiber optic cable containing a minimum of 12 strands of single-mode fiber. Fiber optic cable is to be an armored interlocked cable with a yellow plenum rated sheath. Patch panels are to be mounted in such a manner as to allow the maximum usage of each rack. Refer to Specification 27 1500, Part 2.9 and 2.14.
4. STATION WIRING

a. Data Outlets:
   - All outlets shall be constructed using single gang, 4-port faceplates, color to match the electrical outlets, or similar. All outlets shall have at least two Category 6 network drops each, black in color. The remaining open ports shall have blank inserts with the same color as the faceplate.

b. Copper Cabling:
   - All drops shall be connected with blue network cabling from patch panels to each drop location and terminated on black data jack. Every cable shall be continuous and unspliced, with data cables attached to a single port in the patch panel at one end and to a single jack at the station end. All connections are to be done using the T568B wiring scheme. No cable run from patch panel to connection point may exceed 295 feet. All cabling must terminate in an IDF or BDF room on the same floor as the outlet unless building plans, certified by UCR Information Technology Solutions, specify otherwise. Additional specifications for cabling, patch panels and data jacks as per Specification 27 1500, Part 2.2 –2.8.

c. Habitable Space Provisioning:
   - Every habitable space shall be provisioned a minimum of one data outlet (with 2-Cat.6 Data Jack Inserts) per person planned for the space or one outlet per 60 ft², whichever is greater. If the number of people planned for a space is not known, the 60 ft² guideline must be used.

d. Non-habitable Space Provisioning:
   - Every non-habitable space shall be provisioned with two data outlets every 500 ft² minimum of 1 per enclosed space. Exceptions may be granted for unusual circumstances by Information Technology Solutions, in writing.

e. Labeling:
   The labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cable’s origin and destination. Station identifiers shall match the corresponding patch panel port number for each drop. The drops will be in consecutive order whenever possible. They shall increment from left to right then top to bottom on each individual faceplate. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Faceplate labels will be the manufacturer’s labels provided with the outlet assembly unless otherwise specified.

   The labeling scheme shall be as follows:

   All labels will be in the format of (as an example) “LLC-A26”. Where “LL” is the IDF or BDF Floor Level, LL being the Lower Level, “C” is the closet/room number or letter, C being Closet C, “A” is the Patch Panel identifier, and “26” is the port that the drop terminates to in the patch panel.

   Cable Wrap labels:

   Wrap labels are required within 6 inches of the cable's termination point at both ends. Wrap labels will follow the format listed in this section, i.e. “LLC-A26” The font size will be the largest size that fits the required information but no smaller than 8-point font.
Station labels:

The Station label will follow the format listed in this section. However, the top label includes both top ports i.e. "LLC-A26,27". The first patch panel port number will always be the left face plate port and the second patch panel port number will always be the right face plate port. The bottom label will follow the same guidelines when used. When unused the label will be left blank. The font size will be the largest size that fits the required information but no smaller than 10-point font. See Specification 27 1500, Part 3.10, Faceplate Diagram

Data Room Patch Panel:

The patch panel identifier will be labeled by the installer on the left side of the patch panel in a place that is easily visible. Counting from the top of the rack down, the first installed patch panel will be identified with the Letter A, the second with the Letter B and so on. The patch panel port label will be in the format listed above "LLC-A26". Space limitations will require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly above the port they are labeling or in other manufacturer provided locations for port labels.

Tube Cell Conduit:

The marker plate for tube cell conduit shall be 1 "x 3" in size and must be made of a material able to withstand environmental conditions (e.g., extreme heat, underwater, and dirt/dust). The marker plate shall be placed approximately one foot from the conduit entry and exit. The marker plate label will be in the format of V-41-D to V-44-D, where V stands for vault and 41 is the previous vault number and 44 is the next vault number. The letter D shows which section of campus the vault is located in.

ABF Tube Cable:

The air blown fiber tube identifier will be labeled by the installer within 6 inches of the tube leaving the TDU. The label shall be four lines with the first being the Tube Cable ID #. The second line shall be the Tube Cable Type (indicating the tube count "7TOX"). The third line shall show the TDU where the Tube is originating from. The final line will show the TDU where the Tube will terminate into. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

ABF Individual Fiber Microducts:

The individual microduct identifier will be labeled by the installer within 6 inches of the microduct leaving the TDU. The label shall be three lines with the first showing the Tube Cable Type (i.e. “1TGX”). The second line shall show the TDU where the Tube is originating from. The final line will show the FTU where the microduct will terminate into. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

Fiber Optic Cables:

The individual non-air-blown fiber identifier will be labeled by the installer within 6 inches of the fiber leaving the FTU. The label shall be three lines with the first line showing the number of strands and type of fiber. The second line shall show the distant termination points for this fiber strand (IDF or BDF #). The third line shall show the local termination point for the fiber strand (IDF or BDF #).
All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

**Fiber Enclosures:**

The fiber enclosure identifier will be labeled by the installer on the left side of the enclosure in a place that is easily visible. Counting from the top of the rack down, the first installed enclosure will be identified with the alphabetic identifier of A, the second with the B and so on. At the BDF, the fiber enclosure label will be in the format of "AB-12SM to LLC-AAB", where "AB" are the slots the fiber terminates in, "12SM" is the fiber type and strand count, "LLC-AAB" is the distant end IDF room location, "A" is the fiber enclosure number, and "AB" are the slots the fiber terminates in the distant end. At the IDF enclosure end the labeling will be vice versa of the BDF enclosure end. Space limitations could require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly in front of the slots they are labeling or in other manufacturer provided locations for labels.

**MDF Fiber Enclosures:**

The MDF fiber enclosure identifier will be labeled by the installer on the left side of the enclosure in a place that is easily visible. Counting from the top of the rack down, the first installed enclosure will be identified with the alphabetic identifier of A, the second with the B and so on. At the MDF, the fiber enclosure label will be in the format of "AB-24SM to BOURNE-AAB", where "AB" are the slots the fiber terminates in, "24SM" is the fiber type and strand count, "BOURNE" is the BDF Building Name, "AAB" is the distant end BDF FTU location, "A" is the fiber enclosure number, and "AB" are the slots the fiber terminates in the distant end. At the BDF FTU enclosure end the labeling will be vice versa of the MDF enclosure end. Space limitations could require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly in front of the slots they are labeling or in other manufacturer provided locations for labels.

**Multipair Copper Backbone Cables:**

The individual Multipair Copper Backbone Cables identifier will be labeled by the installer within 6 inches of the cable leaving the Telecom Room. The label shall be three lines with the first line showing the number of pairs and type of cable with a specific cable number. The second line shall show the distant termination points for this cable (MPOE or BDF/Building Telecom Room #). The third line shall show the local termination point for the cable (MPOE or BDF/Building Telecom Room #). All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

**Multipair Riser Cables:**

The individual Riser Cables identifier will be labeled by the installer within 6 inches of the cable leaving the Telecom Room. The label shall be three lines with the first line showing the number of pairs and type of cable with a specific cable number. The second line shall show the distant termination points for this cable (IDF/Telecom Room #). The third line shall show the local termination point for the cable (BDF/Building Telecom Room #). All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.
Multipair Copper Cables Termination Blocks/Panels:

The individual Multipair Copper Cables Termination Blocks identifier will be labeled by the installer on the designated block/panel strips in the individual Telecom Rooms. The labels shall coincide with the same labeling as the cable labeling. First showing the number of pairs and type of cable with a specific cable number. Second shall show the distant termination points for this cable (IDF/Telecom Room #). All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink.

Vault Lids:

The vault lid identified will be labeled by the installer by welding the label near the center of the vault or manhole covers. If the cover has two parts, the label shall be welded near the center of the north or west part. The vault lid label will be in the format of “V-###-XXX” or “MH-###-XXX”, where “V” is a vault and “MH” is a manhole. “###” shall be the number assigned based on the master Campus CAD file and “XXX” shall correspond to the section of campus assigned on the master Campus CAD file.

5. WIRELESS - 802.11

a. Data cabling at wireless locations shall be terminated in electrical boxes that are mounted parallel to the ceiling, above the drop-ceiling grid panels. Two blue data cables shall be directly run from the IDF and will be terminated on black Category 6 data jacks. The jacks will be mounted in a faceplate and the faceplate will be mounted to the electrical box. For new and existing buildings, the contractor will provide a minimum of 20 feet of data cabling service loop at the electrical box.

b. Electrical boxes used for wireless AP installations shall be mounted to a wall/ceiling or secured to equipment that meets local NEC, ANSI/TIA-568-D, and ANSI/TIA-569-D standards. The boxes will be mounted as close to the AP location as possible to eliminate the use of long patch cords. No cable from IDF to connection point may exceed 295 feet.

c. At each access point location, connect the access point to the horizontal cabling using contractor provided patch cords. All patch cables will use appropriate J-hook/supports or dressing.

d. Wireless locations that are placed in locations with a hard-lid ceiling will have the cables be terminated inside of the electrical box but not placed in a faceplate. The electrical boxes at these locations shall be 4-inch square boxes with a depth of 3 1/4 inches, or 5-inch square boxes. Each box must maintain the minimum bend radius of the cable.

e. Access point installations shall require the Contractor to use a UCR provided bracket. This might require the Contractor to cut a hole in drop ceiling acoustic tile.

f. For new buildings only, the Contractor will be required to move the APS and electrical boxes utilizing the service loop as required after UCR completes a wireless survey.

6. WIRELESS ACCESS POINT PLACEMENT AND WIRELESS OVERLAY FOR 802.11

Locations will be specified by consultation with UCR Information Technology Solutions. The use of 3rd party professional RF Engineering design may be required under the special conditions. These conditions include but are not limited to the following:

a. Any wireless bridge installation which requires rooftop cabling and mounting of wireless bridging hardware, antennae and masts.

b. Installations which require access points to use antennae other than the standard dipole antennae.

c. The finished ceiling plan is exposed, and UCR has specified that wireless hardware and antennae placement must be as limited as possible in order to meet aesthetic requirements of the building.

d. Wireless Access Points shall be furnished by the owner and installed by the low-volt contractor.

e. Consultation with UCR Information Technology Solutions is required for all 802.11 Wireless infrastructure design.
7. CABLE TRAYS
All cable trays must be UL rated and approved by UCR Information Technology Solutions prior to their inclusion in specifications.

a. Supports
Cable trays for horizontal distribution cables will utilize threaded rods of not less than 3/8" in diameter.

b. Capacity
Cable trays shall be sized for a minimum growth of 50%.

c. Grounding
Cable trays shall be grounded in accordance TIA-607-C.

8. CABLE INSTALLATION

a. Copper
Installation is to meet or exceed TIA 568-D and TIA 569-D. All terminations are to follow TIA 568-B.

Completed installation is to be Certified Category 6 using the TIA 568-C.2 testing standard or better. Test documents/results to be supplied to UCR in .PDF and CAD format. Completed installation is to be approved by UCR Information Technology Solutions.

b. Fiber
Installation is to meet or exceed TIA 568.3-D and TIA 569-D. Fiber terminations will be completed using one of the following methods:
- No epoxy/no polish connectors
- Factory-terminated pigtails with fusion splicing

Single-mode will be terminated in a separate rack-mounted fiber optic enclosure.

Completed installation is to be certified using TIA 568.3-D testing standard or better. Test documents/results to be supplied to UCR in .PDF format. Completed installation is to be approved by UCR Information Technology Solutions.

9. PULL AND SPLICE BOXES

a. Location
- Pull boxes must be installed in easily accessible locations. It is not permissible to locate a pull box in a fixed false ceiling unless immediately above a suitably marked access panel.
- All pull boxes shall be placed in a straight section of conduit. Align the corresponding conduits at each end. All boxes shall be properly and adequately secured. They are not to be supported by the conduits entering the box. Install boxes for station cabling immediately above the suspended ceiling.

b. Access
- Provide boxes with a suitable cover.

c. Grounding
- If the pull box is comprised of metallic components, it shall be bonded to ground in accordance with the authority having jurisdiction.
### Pull Box Configurations:

<table>
<thead>
<tr>
<th>Maximum Trade Size of Conduit (Inches)</th>
<th>Size of Box</th>
<th>For Each Additional Conduit Increase Width (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width</td>
<td>Length</td>
</tr>
<tr>
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</tr>
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<td>12</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>

### 10. Pathways and Communications Systems

Cable Support (General):

The main routing and support systems for communication cables on the Campus are:

1. Cable tray system (Main pathway down corridors)
2. J-hooks and adjustable cable support (bags) (accessible false ceiling areas)
3. Conduit home runs (hard ceiling areas, inaccessible ceiling areas, in-floor boxes, masonry walls). Combined system shall be an overhead distribution method
based on the use of a cable tray and J-hook system for routing and an EMT conduit stub-up to the WAO device boxes. All cable trays shall be divided with a metal divider for shared space. Each building cabling system (800 MHz radio, Access control, CCTV, etc.) shall have their own dedicated secondary J hook cable support from the cable tray.

11. HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

COMMUNICATIONS J-HOOKS:
1. J-hooks shall be spaced at a maximum of 48-inches in the main bundle, 48 to 60-inches apart in the secondary bundles and within 6-inches of an EMT conduit stub-up.
2. Main cable bundle shall be made up of 4-inch saddle bags and supported on a minimum of 3/8-inch rod.
3. Secondary cable bundles shall be made of minimum 2-inch j-hooks with a closer. Support secondary cable bundles with pencil rod. Cable supports shall not exceed 30 percent fill ratio. Refer to manufacturer’s recommendations. Secondary pathway to 90 off cable tray and contains no more than 25 cables. Location of J-hooks shall be indicated on the Electrical Design and/or Telecommunications drawings.
4. Cables shall not be secured to the J-hook with cable ties or vinyl tape.
5. Contractor to provide drawings indicating Primary and Secondary pathways before installing cable to University’s Representative for approval.

12. CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

Installed interior conduits shall:
1. Be installed in the most direct and accessible route possible (parallel to building lines and located in and above accessible hallways).
2. Contain no more than two 90-degree bends in any dimensional plane or exceed 100-feet in length between pulling points or interior pull boxes.
3. A pull box is not to be used in place of a conduit sweep.
4. Stub up to an accessible ceiling area and within 6-inches of a J-hook or cable tray from a device box.
5. Be reamed at both ends and have a plastic bushing installed on each end to prevent damage during cable installation.
6. Have a pull string installed in all conduits with a minimum test rating of 200 lb.
7. Not be installed through areas in which flammable materials may be stored or over and adjacent to boilers, incinerators hot water lines or steam lines.
8. All conduits shall be bonded and grounded in accordance with the CEC and ANSI-J-STD607-C, where applicable.
9. Interior conduits and/or sleeves shall be properly sized in accordance with TIA 569D, Table 4.

CONDUIT BEND RADIUSES

<table>
<thead>
<tr>
<th>Internal Diameter</th>
<th>Minimum Bend Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inches or less</td>
<td>6 times the internal conduit diameter</td>
</tr>
<tr>
<td>2 1/4 inches or more</td>
<td>10 times the internal conduit diameter</td>
</tr>
</tbody>
</table>
Wall-mounted riser conduits and/or sleeves entering a Telecommunications Space (ER/TR) shall have a plastic spillway installed onto the end of the conduit to prevent kinking of the installed cable bundle.

G. GROUNDING

1. REGULATIONS
   All conduit and cable tray systems, supports, cabinets, equipment, etc., shall be properly grounded in accordance with the latest edition of the National Electrical Code (NEC), TIA-607C, and all other applicable codes and regulations.

2. INSTALLATION REQUIREMENTS
   Provide all bonding wire and jumpers, grounding bushings, clamps, etc., required for complete grounding. Route ground conductors to provide the shortest, most direct path to the ground electrode system.

3. GROUNDED CONNECTORS
   Provide a separate grounding conductor, securely grounded on each side of all conduit and cable trays that do not provide a continuous, metallic path. Size shall be in accordance with the National Electrical Code (NEC). All ground connections will have clean contact surfaces, tinned and sweated while bolting. Avoid splices in bonding or grounding conductors. If splices are required, they must be cad welded. Any grounding or bonding conductor that is run through a metallic conduit should be bonded to the conduit on both ends. Do not use a gas or water pipe as the grounding electrode.

2. PART II - PRODUCTS AND ACCEPTED MATERIALS

2.0. GENERAL
   All material required for a complete installation shall be furnished by the Contractor unless otherwise specified by UCR Information Technology Solutions.

   All materials provided by the Contractor must be new, free from defects and must meet UCR's specifications. A parts list for the approved manufacturers can be found in Specification 27 1300 Outside Plant Backbone Cabling and 27 1500 Communications Horizontal Cabling. For projects that require a Request for Proposal, bidders shall submit the make and model of materials that will be used as part of their submittal. (See section 1.3 of this document.)

   All fixtures and hardware must be installed as per requirements detailed in this document. No custom items shall be used except as reviewed and approved by UCR ITS. The contractor shall be held financially responsible for any work or re-work required due to improper approval and/or acceptance of that work performed which differs from the construction documents.

   All products shall be new and brought to the job site in original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label.

   All station cables shall be CMR Riser rated when entire cable runs are installed in conduit and cable tray. All station cables shall be CMP Plenum rated when any section of the cable run is not installed in conduit.

   The Contractor shall inspect all products and materials prior to installation. Damaged cable or any other components failing to meet specifications shall not be used in installation.
2.1. BACKBOARDS
All backboards required in the IDF/BDF rooms shall be plywood, \(\frac{3}{4}'' \times 4' \times 8'\) sheets, grade A, treated on one side with fire resistant paint or material, installed with finished side exposed with the bottom of the plywood at 8" above finished floor. When a fire-rated backboard is provided and installed, the official fire-rated stamp shall not be painted over until UCR inspector has approved the product and installation.

2.2. CABLE SPECIFICATIONS

A. WARRANTY
All copper and fiber cabling installations must be covered by an end-to-end manufacturer warranty of no less than 25 years. Vendors must be certified installers of the products they select for installation. The warranty is required to cover cabling, components, and performance. Parts and labor for replacements must also be included in the warranty.

B. APPROVED CABLE MANUFACTURERS

1. Copper Installation:
   Vendors are required to install the Belden Category 6 products identified in Specification Section 27 1500 Communications Horizontal Cabling, or a pre-approved equal by UCR.

   Products selected must meet requirements detailed in this document.

   a. New Building
      All copper installations in new buildings on campus will be completed using products from Belden Manufacturer or a pre-approved equal by UCR. All cabling and components will be certified Category 6 and will meet all requirements listed in Spec 27 1500, Section 2.2.

   b. Existing Building
      In cases where vendors install cabling in existing IDF's, installers shall use open ports on existing category 6 patch panels. The warranty requirement listed in Specification 27 1500 will apply to these installations. This will require vendors to be certified Belden installers for the new components into the existing panels in the IDF. The installer shall use Belden Part #AX104630 adapter bezel in order to adapt the Belden REVConnect jack insert into the existing CommScope patch panel. If there are no open ports, not enough ports to complete the job or the existing patch panel is not Category 6, the contractor will use a Belden REVConnect patch panel as specified in Spec 27 1500 and approved by Information Technology Solutions staff.

2. Fiber Installations:
Vendors are required to install the Sumitomo Electric FutureFlex Air-Blown Fiber optic systems products for Backbone Fiber Optic installation as identified in Specification Section 27 1300 Outside Plant Backbone Cabling and Belden Fiber Optic cable products for BDF to IDF inside building installations as identified in Specification Section 27 1500 Communications Horizontal Cabling, or a pre-approved equal by UCR.

Products selected from these vendors must meet requirements detailed in this document.

   a. Building to Building:
      All fiber installations for building to building interconnects will use air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.

   b. New Building:
• All fiber installations for new buildings on campus, including building to building interconnects and MDF to BDF connections will use air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.

c. Existing Building:

• All fiber installations for buildings with existing air-blown fiber infrastructure will be installed using air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.

• All fiber installations for buildings without existing air-blown fiber infrastructure will be installed using traditional fiber cabling. Contractors shall install components from Belden as specified or a pre-approved equal.

d. Fiber Optic Cable Label Sequence (Cable Tag):
C. DATA COPPER
All copper data cable for existing buildings will be Category 6, 4 pair, UTP (Unshielded Twisted Pair) unless specified differently, and must meet or exceed TIA and ISO Category 6 requirements. All copper data cable for new buildings will be Category 6, 4 pair, UTP (Unshielded Twisted Pair) and must meet or exceed TIA and ISO Category 6 requirements. Only materials from accepted manufacturers in Specification 27 1500 will be installed. Cables will be rated as plenum or riser based on installation requirements.

D. PATCH CABLES
All patch cables installed by the contractor will be factory terminated and tested to meet requirements stated in Specification 27 1500, Part 2.13.

E. EXTERIOR CABLE
All telephone cable that supports devices external of a building such as emergency phones use outdoor-rated Category 3, 4 pair, UTP (Unshielded Twisted Pair) and must meet or exceed TIA and ISO requirements.

F. SINGLE-MODE FIBEROPTIC
All single-mode fiber optic cable must be 8.3/125. All single-mode terminations are to be LC, UPC finish. A 12- or 24- fiber adapter panel must be used in the fiber optic enclosure.

G. AIR-BLOWN FIBER COMPONENTS
Tube cell count for tube-cell cabling will be determined by UCR Information Technology Solutions Staff on a project by project basis.
All new building IDF s and BDFs will require the installation of fiber distribution boxes. Other locations such as manholes and other splice or junction locations will require fiber distribution boxes as needed.

2.3. DATA TERMINATIONS

A. COPPER DATACOMPONENTS

1. PATCH PANELS
   All data patch panels for existing buildings are to be a Belden REVConnect patch panel, (Refer to Spec. 27 1500, Part 2.8) or pre-approved equivalent, that has been viewed, tested and approved by Information Technology Solutions Staff. Equivalent patch panels must accept keystone Category 6 jacks, in 2U, 48 port configurations, and must meet or exceed TIA and ISO/IEC Category 6 requirements. They must also be capable of housing keystone data jacks from other manufacturers, be viewed, tested and approved by Information Technology Solutions staff.

   Every group of 48 must be separated by 2U of horizontal cable management (Refer to Spec. 27 1500, Part 2.15). All cabling will route through the rear cable management prior to termination in the patch panel. All terminations are to follow TIA 568-B.

   The first 12-ports of the first patch panel of each IDF will be dedicated for Station Outlet analog voice lines. These ports will be populated with the Belden REVConnect Grey Category 6 Jack Inserts RV6MJKUGY.

2. VOICE COPPER TERMINATION BLOCKS
   All voice wire terminations are to be terminated on Category 6 patch panel(s) in data rack(s) and cross-connected to the voice feeder patch panel for connection to the Campus copper backbone.

3. DATA JACKS
   All data jacks for existing buildings shall be modular, unshielded, 4-pair, 8P8C, Category 6, black unless otherwise specified, and must meet or exceed TIA and ISO/IEC Category 6 requirements. Jacks shall be Belden REVConnect Category 6. Data jacks must be compatible with patch panel from Section 2.3.A.1.

   All data jacks for new buildings shall be modular, unshielded, 4-pair, 8P8C, Category 6, black unless otherwise specified, and must meet or exceed TIA and ISO/IEC Category 6 requirements.

   All terminations are to follow TIA 568-B.

4. FACEPLATES
   All faceplates shall be 4 port (colored to match electrical outlets), single gang, low profile, with a window for labels. All unused ports must be covered with a blank insert.

B. FIBER OPTIC

1. Terminations
   Terminations will be completed with one of the two following methods: No epoxy/no polish connectors
   Factory-terminated pigtailed with fusion splicing
   Fusion splices will be protected in splice cases or other suitable enclosures.

2. Connectors
Single-mode fiber is to be terminated with LC style connectors, UPC Polish.

3. Fiber enclosures
Fiber optic enclosures for inter-building traditional fiber optic installations are based on Specification 27 1500, Part 2.9 for BDF and IDF racks. Sizing of enclosures will be based on total strand counts.

Fiber optic enclosures for building to building air-blown fiber optic installations are based on Specification 27 1300, Part 1.16 – 1.20 for MDF, BDF and IDF racks. Sizing of enclosures will be based on total strand counts. Equivalent enclosures can be approved by Information Technology Solutions on a case-by-case basis.

4. Fiber Adapter Panels
Single-mode fiber will terminate in 12- or 24-fiber standard adapter panels.

2.4. DATA EQUIPMENT RACKS
All racks are to be two post, open frame, tapped holes, black, manufactured by CPI or pre-approved equal. Substitutions must be authorized in writing by UCR Information Technology Solutions.

2.5. CABLE TRAYS
All cable trays for distribution of data cables within a building are to be a minimum of 18" wide by 4" deep, solid trough or ladder and will be approved by UCR Information Technology Solutions.

2.6. EXCEPTIONS
Due to unique constraints and requirements of existing BDFs and IDF, exceptions may be authorized for existing buildings only with approval of UCR Information Technology Solutions and shall be granted in writing.

3. PART III - EXECUTION
The University may have drawings detailing existing cable runs, terminal cabinets/closets, risers, etc. Copies may be obtained from UCR Information Technology Solutions to facilitate the requirements of Part III - Execution.

Unless otherwise expressly provided in the Contract, any provisions of the standard specifications, which require the University to inspect certain material or work, shall mean that the University has the option, rather than the obligation, to do so. Any warranty or guarantee provisions contained in the Contractors'/Vendors' standard specifications shall be of no effect and the warranty and guarantee provisions, if any, of the Contract shall apply.

3.1. DEMOLITION
A. COORDINATION WITH UNIVERSITY OPERATIONS
No telecommunication or data jacks, cabling terminals, or other hardware will be moved, disconnected, or removed without prior approval of UCR Information Technology Solutions. Coordination of demolition activities with the departments will be strictly enforced to minimize service disruptions.

B. WORK TO BE PERFORMED BY OWNER
Upon notification by contractor, UCR Information Technology Solutions will dispatch a technician to the requested work location. The technician will determine if the telecommunications or data facilities hardware to be moved or removed are in service (hot) or out of service (dead). If station cabling is dead the technician will ensure that all cross-connects have been removed. If the facilities to be moved or removed are determined to be in service, the technician will
take the necessary actions to render the facilities dead. Under NO circumstances will removal of telecommunications or data facilities begin until UCR Information Technology Solutions has ensured that services are dead.

C. DISPOSAL OF SURFACE-MOUNT RACEWAY
Surface mount raceway that has been vacated, or otherwise determined not required, will be removed after all cabling has been properly removed.

3.2. EXCAVATION
No trenching will commence until UCR Facilities/Construction Department and UCR Information Technology Solutions grants approval. The University may have drawings of existing underground utilities to assist the Contractor to locate all underground utilities. All Contractors are to contact Underground Service Alert of Southern California (DigAlert) by Calling 811 or at www.digalert.org. All lines damaged by Contractor will be repaired at Contractor's expense.

Asphalt and concrete pavement shall be sawed or cut to a depth necessary to bring about a straight-line break parallel to the sides of the trench, so as not to disturb the adjoining pavement.

All underground construction work, during progress and after completion, shall conform truly to lines and grades.

If the trench is excavated to a greater depth than that given, the Contractor shall, at his own expense, bring such excavation to required grade with such material as directed, notwithstanding that it may be necessary to bring such material from other localities or to purchase suitable materials.

The material excavated shall be deposited along the side of the trench in such a manner as to create the least inconvenience possible.

Contractor shall not obstruct the gutter of any street or driveways but shall use all proper means to provide the free passage of surface water along the gutters into storm water inlets. Contractor shall provide channels where required.

Special care shall be taken to keep all fire hydrants and gate valves on water mains accessible at all times. Fire lanes are to be kept open.

Wherever required, sides of the trench shall be sheeted and braced in strict accordance to the rules, orders and regulations of the State, County, and the City. Trenches shall be barricaded.

Grass will be replaced by a method approved by the University.

Bricks, blocks and other debris removed from trenches will not be used as fill for trenches.

3.3. INSTALLATION

A. REGULATIONS
All work and materials will comply with all federal and State laws, municipal ordinances, codes, regulations and direction of inspectors appointed by proper authorities having jurisdiction.

If there are violations of codes and/or industry standards, the contractor will correct the deficiency at no cost to the University.

Working conditions must meet the industry standards for safety and work procedures, and protection of property established by prevailing rules, regulations, codes, and ordinances.
B. QUALITY ASSURANCE

Workmanship and neat appearance shall be as important as the mechanical and electrical efficiency of the system. All testing and clean-up shall be completed to the satisfaction of UCR Information Technology Solutions before sign-off. This includes, but is not limited to, cable testing, proper labeling, debris removal, and proper cable bundling and routing.

C. DAMAGE OF EXISTING FACILITIES

The Contractors shall be responsible for replacing, restoring, or bringing to at least original condition any damage to floors, ceilings, walls, furniture, grounds, pavement, etc., caused by its personnel and operations. Any damage or disfiguration will be restored at the Contractor's expense.

D. COORDINATION

Contractor is responsible for insuring minimal disruption of existing television, telemetry, telephone and data communications facilities and networks.

Outages shall be scheduled only with permission from UCR Information Technology Solutions at its convenience. All work areas shall be cleared of all litter, and properly disposed of by Contractor on a daily basis.

At its own expense, Contractor shall erect temporary fencing where required or deemed necessary by University personnel, or where deemed necessary by the Contractor for securing materials.

Contractors shall provide all necessary temporary equipment and material, shall maintain them in a safe and adequate manner, and shall remove them immediately upon completion of work requiring their presence.

E. CABLE SUPPORT AND ANCHORS

All cables, wires and equipment will be firmly anchored. Fasteners and supports shall be adequate to support loads with ample safety factors.

All data cables installed without conduit in plenum spaces will be secured using j-hooks or other Information Technology Solutions approved mounting hardware.

F. FIRESTOP SYSTEMS

A firestop system is comprised of an item or items penetrating a fire rated structure, the opening in the structure, the sealing materials, and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and pressurized water stream. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating items i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped using state approved fire-resistant materials installed in accordance with the manufacturer's tested methods. All penetrations through fire rated surfaces shall comply with the following:

2. ASTM E 119: Methods of Fire Tests of Building Construction Materials
3. ASTM E 814: Standard Method of Fire Tests of Through-Penetration Firestops
4. ASTM C 719: Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement
6. UL 263: Fire Tests of Building Construction Materials
7. UL 723: Surface Burning Characteristics of Building Materials
8. UL 1479: Fire Tests of Through Penetration Firestops

G. CONDUIT

1. Conduit shall be Electrical Metallic Tubing produced in accordance with ANSI C80.3 standard and run in the most direct route practical.

2. Conduit runs containing more than two 90-degree bends, or a reverse (180 degree) bend require a pull box.

3. All offsets shall be considered equivalent to a 90-degree bend.

4. Sections of conduit longer than 100 ft. require a pull box.

5. Conduit bend radii will be a standard ten times the outside diameter of conduit unless otherwise approved by UCR Information Technology Solutions.

6. Conduits entering the IDF through the wall shall be reamed or bushed and terminated not more than 4 inches from the wall surface.

7. Conduits entering the IDF from below shall be terminated 4 inches above finished floor.

8. Conduit runs for distribution cables (both horizontal and vertical), except station outlets, shall be not less than 4” in diameter. They will be equipped with a plastic or nylon number 12 or larger pull line that is rated at 800-1b. test minimum.

9. Conduit installed for data and/or voice cabling may not be shared with any other cable.

10. All conduit runs for station outlets shall be not less than 1” in diameter. They will be equipped with a plastic or nylon number 12 or larger pull line that is rated at 800-1b. test minimum.

11. After installation, all conduits shall be clean, dry, unobstructed, capped for protection and labeled with their destination (by room number) for identification.

12. Allowable fill capacity is 40% or as defined by the National Electric Code, whichever is lower.

13. Conduit runs for horizontal distribution cables, utilizing the trapeze hanger method to support the conduits, shall utilize threaded rods of not less than 3/8” in diameter.

14. Conduit shall not block access to existing services.

15. All junction boxes will maintain the minimum bend radius for the cable being installed. Special consideration should be taken concerning the use of Category 6 cabling, data termination jacks, and the minimum bend radius with required twelve (12) inch minimum excess cable at each outlet.

16. Pull boxes will be installed in position and relationship to adjoining work, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.
Maximum Fill Requirements for Riser Cable
*Internal diameters are taken from the manufacturing standard for electric metallic tubing and rigid metal conduit.

<table>
<thead>
<tr>
<th>Conduit</th>
<th>Area of Conduit</th>
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<tbody>
<tr>
<td>Trade Size (Inches)</td>
<td>Internal Diameter* (Inches)</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>1.05</td>
</tr>
<tr>
<td>1¼</td>
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</tr>
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<td>3.55</td>
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Maximum Allowable Conduit Fill Based Upon 40% Allowable Fill

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<thead>
<tr>
<th>Trade Size **</th>
<th>Inside Diam. inch</th>
<th>5.6 mm (0.22)</th>
<th>6.1 mm (0.24)</th>
<th>7mm (0.28) *</th>
<th>7.9 mm (0.31)</th>
<th>9.5 mm (0.35)</th>
<th>13.5 mm (0.53)</th>
<th>15.8 mm (0.62)</th>
<th>17.8 mm (0.70)</th>
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<td>1-1/4</td>
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<td>16</td>
<td>11</td>
<td>9</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>1-1/2</td>
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<td>12</td>
<td>7</td>
<td>6</td>
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<td>4</td>
<td>4.02</td>
<td>149</td>
<td>136</td>
<td>93</td>
<td>78</td>
<td>52</td>
<td>14</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

typ 4-pair CAT5E cable

typ 4-pair CAT6 (w/o divider) cable

typ 4-pair CAT6A (w/ divider) or 4-pair ScTP
typ 12-pair CAT3 unshielded or RG6 Quad shielded
typ 25-pair CAT3 unshielded cable
typ 50-pair CAT3 unshielded cable
typ 100-pair CAT3 unshielded cable
H. CABLE INSTALLATION

1. All cable shall be installed free of kinks. A kink is defined as a violation of the manufacturer's specified Minimum Bend Radius for each type of cable. Cable shall not be formed into a condition that causes the outside sheath to wrinkle.

2. Any cable to be placed through an electrical room or any other potentially hazardous conditional shall be placed in conduit.

3. All cable will be secured to the backboard in such a manner as to allow cross connections to be made without crossing over any cables.

4. All data outlets will have a minimum of 12 inches of cable stored at each drop after the cable has been terminated. Cable shall not be stored in loops.

5. All data cabling will have a service loop with a minimum of 10 feet of data cabling that will be placed on the BDF/IDF ladder rack.

6. Where installation of conduit is not required, plenum cable will be used. Cables are not permitted to lie atop a lay-in ceiling or simply drape over pipe and ductwork; appropriate J-hook/supports or dressing will be used.

7. All cabling in an open ceiling and/or open-plenum space will be ran in conduit or cable tray.

8. Cable supports are to be anchored in accordance with TIA 569-D and NEC.

9. Cable pulled in a cable tray with existing cable should not be pulled where stress would be applied to the existing cable.

10. All cable is to be terminated at both ends, tested, labeled and ready to provide service to and within the building.

11. Hook and loop tape are the only approved product for bundling cable. Tie-wraps shall not be used bundle cable.

12. Installation to meet or exceed TIA 568.0-D and TIA 569-D. UCR Information Technology Solutions must approve completed installation.

I. CABLE TESTING

All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. The contractor, prior to system acceptance, shall verify all conductors of each installed cable. Any defect in the cabling system installation including but not limited to cable, connectors, feed-through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% usable conductors in all cables installed.

1. Copper Data Cable

All Data cables shall be tested in accordance with TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard or better and best industry practices. If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of UCR Information Technology Solutions. All results shall be PASS. Any *PASS test results will require troubleshooting and repair of the cable in question to achieve a PASS test result.
a. Testing

Each cable shall be tested for wire map, length and performance. The data cables shall be bidirectional tested using a TIA 1152 level III or better cable analyzer. The cable analyzer shall be within the calibration period recommended by the manufacturer. Manufacturer to be Fluke DSX-8000 as specified in Specification 27 1500.

- Wire Map
  Each pair of each installed cable shall be tested for continuity, opens, shorts, pair reversals, split pairs, transposed pairs, and any other miss-wiring. The test shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable retested prior to final acceptance.

- Length
  Each installed cable shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the longest pair length shall be recorded as the length for the cable.

- Performance Verification
  Category 6 data cable shall be performance verified using an automated test set. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:

  1. Return Loss
  2. Insertion Loss
  3. NEXT (Near-End Crosstalk)
  4. PSNEXT (Power Sum Near-End Crosstalk)
  5. FEXT (Far End Crosstalk) Loss
  6. ACRF (Attenuation to Crosstalk Ratio Far-End)
  7. PSACRF (Power Sum Attenuation to Crosstalk Ratio Far-End)
  8. TCL (Transverse Conversion Loss) — recorded for information only
  9. ELTCTL (Equal Level Transverse Conversion Transfer Loss) — recorded for information only
  10. Coupling Attenuation
  11. Propagation Delay
  12. Propagation Delay Skew
  13. PSANEXT (Power Sum Alien Crosstalk) Loss
  14. Average PSANEXT Loss
  15. PSAFEXT (Power Sum Alien Far-End Crosstalk) Loss (connecting hardware only)
  16. PSAACRF (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
  17. Average PSAACRF
  18. ACRN (Attenuation to Crosstalk Ratio Near-End) — recorded for information only
  19. PSA CR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) — recorded for information only
  20. DC Loop Resistance
  21. DC Resistance Unbalance (Channel Test)
Equipment:
Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA 568-C.2 Standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed and the actual test result achieved. All test results to be provided to UCR Information Technology Solutions in .PDF format prior to acceptance of completed project. All test results must be labeled with the specific data cable that was tested by its identifier on the patch panel.

2. Fiber Optic
Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA 568.3-D Standard, and the result shown as pass/fail. The test results shall include all tests performed and the actual test result achieved. All test results to be provided to the UCR Information Technology Solutions in .PDF format prior to acceptance of completed project. All test results must be labeled with the specific data cable that was tested by its identifier on the patch panel.

Test evaluation for the panel to panel (backbone) shall be based on the values set forth in the TIA-568.3-D, Optical Fiber Cabling Components.

Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

The expected results for each cable (or group of cables of the same nominal length) shall be calculated before the start of testing and recorded in a space provided on the Contractor's test matrix. Each strand of fiber in the respective cable shall be evaluated against this target number. Any fibers that exceed this number by more than -0.5dB shall be repaired or replaced at the installers' cost.

Where concatenated links are installed to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. After the link performance test has been successfully completed, each link shall be concatenated and tested. The test method shall be the same used for the test described above. The evaluation criteria shall be established between UCR Information Technology Solutions and the Contractor prior to the start of the test.

a. Single-mode:
Single mode optical fiber attenuation shall be measured at 1310 nm and 1550 nm using a laser light source and power meter. Tests shall be performed at both wavelengths in one direction on each strand of fiber. The set-up and test shall be performed in accordance with TIA-526-7-A Standard, Method IA. Two-meter patch cords shall be used as test references and for the actual test. This test method utilizes a one-jumper reference, two-jumper test to estimate the actual link loss of the install cable plus two patch cords. Single-mode fiber optic cable must meet or exceed the following limits:

<table>
<thead>
<tr>
<th>Maximum Loss Measurements for Installed Fiber Optic Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mated Connector Loss:</strong> 0.5 dB per mated pair</td>
</tr>
<tr>
<td><strong>Connector Loss:</strong> 0.5 dB per connector</td>
</tr>
<tr>
<td><strong>Splice Loss: Fusion Multimode</strong> 0.15 dB</td>
</tr>
<tr>
<td><strong>Fusion Single-mode</strong> 0.06 dB</td>
</tr>
<tr>
<td><strong>Fiber loss: Multimode (Legacy)</strong> 3.5 dB/km @ 850 nm</td>
</tr>
<tr>
<td><strong>1.0 dB/km @ 1300 nm</strong></td>
</tr>
</tbody>
</table>
Fiber loss: Single mode

<table>
<thead>
<tr>
<th>Loss (dB/km)</th>
<th>Wavelength (nm)</th>
<th>Type (Cable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>1310</td>
<td>Outside Plant</td>
</tr>
<tr>
<td>0.3</td>
<td>1550</td>
<td>Outside Plant</td>
</tr>
<tr>
<td>1.0</td>
<td>1310</td>
<td>Inside Plant</td>
</tr>
<tr>
<td>0.75</td>
<td>1550</td>
<td>Inside Plant</td>
</tr>
</tbody>
</table>

3. **OTDR**

Each cable shall be tested with an Optical Time Domain Reflectometer (OTDR) to verify installed cable length and splice losses. The OTDR measurements for length shall be performed in accordance with TIA 568-C.2. The measurements to determine splice loss shall be performed in accordance with manufacturer's recommendations and best industry practices.

4. **As-Builts**

All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. The As-built drawings shall clearly identify the patch panel label and its corresponding station side location. As-builts will be created from latest digital architectural drawings, to most closely resemble exact building conditions, as possible. Hand drawings are not acceptable. As-builts & test results must be provided in both .PDF and CAD format. In the CAD format, two layers shall be required for documentation. The first layer shall document the cable path from the station to the IDF. It shall show the conduit, junction boxes, cable tray, etc. locations used for the cabling. Any cable path in conduits does not need to be documented. The second layer shall document the endpoints of the cabling (station and IDF) with the cable labels. Upon acceptance of contract, vendor will be required to provide an acceptable timeline for provision of As-Built drawings. Acceptable timeline shall be verified by UCR Information Technology Solutions. Ample time must be allocated for verification of As-builts & test results and subsequent corrected versions of those documents. Network equipment (Including Voice, Data and A/V services) will not be provisioned until this documentation is provided.

**J. GROUND TESTING**

Two-point ground and continuity testing will be performed to determine if there is an acceptable maximum level of resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system.

a. Prior to performing a two-point test, a visual inspection shall be performed to verify the bonding and grounding system is installed according to TIA-607-C-1 guidelines.

b. For the test to be valid it must be done prior to the installation of the telecommunications equipment.

c. The recommended maximum value for resistance between any point is 100 milliohms.

d. The following areas will be tested:

e. PBB/SBB to the electrical ground from each IDF/MDF.

f. PBB/SBB to the building steel (if present).

g. PBB to SBB

h. Building steel (if present) to the electrical ground.

i. The printed test results shall include all tests performed and the actual test result achieved. All test results to be provided to UCR Information Technology Solutions in .PDF format prior to acceptance of completed project.
# DIVISION 27 – COMMUNICATIONS

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SECTION DIVISION 27- COMMUNICATIONS

1.1 COMMUNICATIONS DESIGN STANDARDS

A. Following are UCR Network and Academic Computing Services (NACS) Project Planning Guidelines, which may be used when designing telecommunications facilities for new campus buildings. D&CS, through the Architect and General Contractor, is generally responsible for the design and provisions of the equipment rooms, outside entrance conduits, and inside wiring distribution systems (conduits, raceways, cable trays).

B. Because each project may vary somewhat from these guidelines, the requirements of the PPG or DPP shall overrule information included in the section.

1.2 UNDERGROUND DUCTS AND RACEWAY FOR COMMUNICATION SYSTEMS

PART 1 GENERAL

A. SECTION INCLUDES

1. Publications and Standards
2. Related Sections
3. Telecommunications Submittals
4. Quality Assurance

B. PUBLICATIONS AND STANDARDS

1. National Electrical Code (NEC) (ANSI/NFPA 70):
   a. Chapter 8: “Communications Systems”
   b. Article 250: “Grounding”

2. Electronics Industry Alliance/Telecommunications Industry Association (EIA/TIA): EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications

3. Federal Communications Commission (FCC) Part 15 and Part 68

4. Rural Utilities Services (RUS), formally REA

5. Lightning Protection Code - ANSI/NFPA 780


7. National Electrical Manufacturer’s Association (NEMA) Publications


10. Underwriter’s Laboratories Inc. (U.L.) Publications
   a. 6-1981 (R86) Rigid Metallic Conduit
   b. 514B-1982 Fittings for Conduit and outlet Boxes
   c. 651-1981 Schedule 40 and 80 Rigid PVC Conduit
   d. UL 467 “Grounding and Bonding Equipment”
   e. UL 497, 497A, and 497B “Communications Circuit Protectors”

C. RELATED SECTIONS
   1. Contract Terms and Conditions
   2. Section 27 1500 – Telecommunications

D. SUBMITTALS
   1. Submittals shall be made for the following products:
      a. Underground Conduits and Supporting Components
      b. Pull Boxes and related hardware
      c. Warning Tape
      d. Pull Rope
      e. Grounding and Bonding Hardware
      f. Conduit tags

E QUALITY ASSURANCE
   1. For products or workmanship specified by association, trade, Federal, or State Standards, the Contractor shall comply with the requirements of the standard. When more rigid requirements are specified, the Contractor shall comply with the most stringent code.
   2. The Contractor shall conform to reference standard by date of issue current on final design documents.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS UTILITY VAULTS

A. All utility vaults to be installed shall be specifically designed for telecommunications applications, with no exceptions.

B. Materials
   1. The Contractor shall provide pre-cast utility vaults meeting ASTM C 478 with 28 day 5500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading per AASHTO HB 14. See conduit construction drawings for vault sizes. The Contractor shall install vaults to meet all manufacture requirements. The contractor shall furnish and place sand bedding to allow
proper weight distribution and leveling of all vaults.

2. Utility vaults shall have tongue-and-groove double sealed joints on mating edges of pre-cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer’s installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer’s printed instructions.

3. Conduit Entrances
   a. For conduit installed on this project, knockout panels or pre-cast individual conduit openings may be used.
   b. For existing utility vaults, new ducts shall enter the utility vault with factory-formed bell end of the conduit, and a seal around the conduit shall be applied after installation. Existing utility vaults that shall be re-used to install new copper and fiber cables shall be retrofitted with the required racking and grounding and bonding per the TIA/EIA Bonding and Grounding Standards.

4. Covers
   a. The Contractor shall provide solid covers (traffic rated), with a 76.2 cm (30 in.) diameter clear opening.
   b. Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
   c. The covers shall be of indented type with solid top design.
   d. The upper side of each cover shall have the letters “Communications” cast or burned by welder, in integral letters no less than 2 inches high. The ring of the casting shall be field stamped with utility vault or pull box numbers as indicated on the conduit drawings.
   e. Double lids are required for vaults over 12 feet in length as per OSHA.

C. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal

2.2 COMMUNICATIONS PULL BOXES

A. Pre-cast pull boxes shall meet the standards defined in Subsection 2.1.B. (1).

B. Joints and seals shall be provided and installed as defined in Subsection 2.1.B. (2).

C. Conduit entrances shall be provided as defined in Subsection 2.1.B. (3).

D. Pull boxes shall be equipped with cable racking hardware suitable to support large copper cables.

E. All pull boxes shall be equipped with traffic-rated spring loaded hinged lids with a locking mechanism. All lids shall have the identification marking of “Communications” permanently affixed to the cover. The upper side of each cover shall have the letters “Communications” cast or burned by welder, in integral letters no less than 2 inches high. The cover shall also be field stamped with two inch high pull box identification numbers as indicated on the conduit drawings.

F. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal

1.2 OUTSIDE PLANT REQUIREMENTS AND DESIGN ISSUES
A. Underground Entrances (Telecommunications Entrance Facilities)

1. The quantity and size of conduits for underground telecommunications service entrances according to the ultimate number and types of cable that the entrance will accommodate.
   a. The current University standard to feed a building is four (4), 4” conduits.

2. All cables will terminate in the Main Distribution Frame (MDF) of the building and in the underground service box. (i.e. pullbox or manhole, see sizing of manhole and pullboxes for more information).

B. Conduit System Planning

1. Conduit routes can be classified into two basic groups:
   a. New routes (no existing conduit).
   b. Existing routes (existing conduit and the existing structure must be reinforced, expanded, extended, etc.).

2. Most design factors are the same in both an existing or new conduit route. However, when planning to use an existing route, the designer must decide whether to use the existing Maintenance Hole (MH) based on whether they provide:
   a. Sufficient room to accommodate the racking and splicing of the needed cables and the associated equipment.
   b. A safe work environment.

C. Finished Conduit System Design

1. The designer designs the conduit system and specifies the types and quantities of material needed. A finished design should consist of construction plans showing the:
   a. Location of all existing and proposed conduit.
   b. Size and configuration of MH's.
   c. Total duct length (linear length times number of ducts) of conduit (adjacent MH wall-to-wall measurements).
   d. Type of conduit material.
   e. Special conduit fittings required.
   f. Conduit (ductbank) formation and depth requirements.
   g. Encasement specifications and materials.
   h. MH or cable entrances.
   i. Locations of any existing substructures.
   j. Restoration requirements.
   k. Required cuts (e.g., concrete, asphalt).
   l. Location and depth of other structures (profile).
   m. Traffic control plan.

2. Maintenance Hole (MH) Locations
3. The safety of personnel, and the general public, is a primary concern when selecting MH locations. A desirable location will:
   a. Provide a safe work area (WA).
   b. Allow for adequate traffic control when the MH is open (e.g., the placing of traffic warning devices to alert motorists of upcoming construction).
   c. Provide sufficient space for cable trailers, pulling trucks, etc., during construction.
   d. Be suitable for placing, splicing, and maintenance of cables and associated equipment.
   e. Not jeopardize vehicular or pedestrian traffic flow.
   f. Be located out of the roadway (when possible).

4. MHs should not be located in or near an intersection or near the point where a curve occurs in a road or within a dedicated fire lane.

D. Clearances

1. The minimum recommended separations between telecommunications conduit systems and outside surfaces of foreign structures are:
   a. 3 inches from electric light, power, or other conduits.
   b. 6 inches when crossing pipes (e.g., gas, water, oil, etc.).
   c. 12 inches when parallel to pipes (e.g., gas, water, oil, etc.).

2. For personnel safety and the protection of telecommunications equipment, follow clearance requirements by the NESC.

E. Conduit Depth

1. Conduit should be located at a sufficient depth (normally 24 to 30 inches) below surface grade so the loads (live and dead) can be sustained by the conduit structure. Live loads have a greater effect on conduit than dead loads.

2. HandHoles/Pullboxes
   a. Hand holes (HH’s) are smaller than maintenance holes (MH’s), but the covers provide full access to the entire space inside the hole. HH’s are manufactured as concrete, polyethylene, or composite structures. They can be placed in the same areas that MH’s are placed in. When planned for traffic areas, they must be traffic rated.
   b. When HH’s are used in an underground installation, they are used as pull-through points. HHs shall not be used as splice points.
   c. Conduit entering a HH should be aligned on opposite walls at the same elevation. Some hand holes are available without bottoms for drainage. When installed without bottoms, these HH’s should be equipped with a 4 inch layer of small rock in the bottom to prevent mud from intruding into the HH.

3. Emergency Phones (Blue Telephone)
   a. On the campus of UCR, emergency phones are found scattered throughout. For residential designs, factor (1) emergency phone per
thousand students, the location will be verified by the UCR Police. The Emergency phones infrastructure will be connected to the closest building MDF or IDF. The conduit size will be a min of 1¼", if additional emergency phones are connected to this conduit, then upsize by one trade size for each additional emergency phone. Manufacture of the Campus standard emergency phone is available upon request to TAPS.

F. Media

1. Copper: With the advent of the new Voice Over IP, (VoIP) the typical building on campus will require (1) 200 pair gel filled 24 gauge copper cable that will connect to the closest Ericsson Line Interface Module (LIM Site), which there are 7 most commonly utilized on campus, or splice case with spare pairs reserved for the building in question.

2. Fiber: The typical building fiber consists of (2) different fiber systems. (1) UCINet and (1) FacNet connection. The UCINet fiber standard is (24) single-mode fibers and (12) multimode fibers (62.5/125), the FacNet fiber standard is (6) single-mode fibers and (12) multimode (62.5/125) fibers. In most cases the UCINet fibers will terminate in/or next to the copper LIM sites as noted above. However, the FacNet has additional sites for the primary connection that is fed from.

1.3 INSIDE PLANT REQUIREMENTS AND DESIGN ISSUES

A. General Requirements for Telecommunications rooms or Main Distribution Frames, (MDF) or Intermediate Distribution Frames, (IDF)

1. The main equipment room is where inside and outside cables and conduit terminate. It is usually referred to as the MDF (Main Distribution Frame). It is also the usual location for most of the electronic hardware associated with the building's telecommunications facilities, including data equipment. They could even house PBX switching equipment if necessary. Ancillary equipment rooms are usually referred to as IDF’s (Intermediate Distribution Frames). The changing technology along with user's data requirements has caused a corresponding increase in the electronics required in the equipment room, thus an increase in space, power and HVAC requirements.

2. Design specifications to consider for the MDF, in addition to the requirements in Section 01:

   a. The MDF is generally located in the basement or bottom floor of a building. IDF's located on the floors above are generally "stacked" above the MDF to allow for ease of cable distribution and limit cable distances. Cable distance is an important factor for data users. Most data communications systems are limited to 300 feet maximum, to allow for 1000 Mbps over 23-24 AWG twisted pair telephone cable. Because of these factors, it is extremely important to know the user's requirements for data as early in the design phase as possible.

   b. MDF/IDF's shall not be co-located with electrical equipment due to the
EMI- mechanical noise transmitted from the electrical equipment. This noise interferes with most voice and data equipment, thus the reason for segregation.

c. Room size: (MDF) 12' W x 8' H x 10' L minimum, (IDF) 8' W x 8' H x 8' L minimum. The size may increase depending on the amount of communications equipment needed. IDF communication room doors to swing outward where code allows.

d. Backboard size: 8' x 8' x 3/4" white intumescent painted with exposed fire-stamp treated stamp, plywood backboard for cable terminations and electronic equipment, with a minimum 4' clearance in front. It is mandatory that this room lock securely. If a double door is used, there shall be no center posts or sills.

e. It is recommended that four 4" entrance conduits terminate in the MDF. If necessary, NACS will provide D&CS with an outside conduit design, identifying a route to the point of connection (LIM site). Pull rope must be installed in each of the 4" conduit.

f. Provide a minimum of (1) STI single bank floor kit consisting of (4) series 44 firestop devices, and a floor grid system (part #EZDG444), or equal with pull ropes between each IDF on every floor.

g. Lighting shall be 30-50 foot-candles measured at 3' from the floor. The lighting fixtures shall be hung at 8'-6" from the floor. No ceiling tiles shall be installed in a telecommunications closet.

h. A grounding bus bar shall be installed in all Equipment rooms/MDF/IDF's. All of the terminals that feed from this MDF shall have a common grounding system.

i. Sleeves, cable trays, floor distribution conduit may terminate here to pick up cabling for horizontal distribution on each floor.

j. Maximum distance from the furthest jack to the terminal room on the floor shall be 250 feet. Another terminal room shall be provided if the distance is exceeded.

k. Power for lighting should not come from the power panel inside the MDF/IDF. At least one light should be on normal power, and one light should be on emergency power, if available.

l. Media: The riser cabling of any typical building will consist of the following: (total count of (120) pairs) of Cat6 (if available) or Cat5E (if not available) riser rated copper pairs to each floor, and a 24 strand multimode (50/125) riser rated to each floor originating from the MDF of the building.

1.4 INSIDE PLANT CABELING REQUIREMENTS AND DESIGN ISSUES

A. Horizontal Distribution Systems

1. Horizontal pathways include:

a. Physical pathways such as conduit and cable tray used for containment of telecommunications cabling.

b. Non-physical pathways such as the space between open-top cable supports (J-hooks) through which cable is placed between physical support or containment components.

NOTE: Pathways themselves do not include pull boxes, splice boxes,
or TP/CP locations, which are considered “spaces” or locations that provide access to or contain cable connections and terminations.

c. The horizontal cabling system includes:

1. Telecommunications outlets (TO's) in the work area.
2. Recognized cable.

NOTE: Horizontal cabling does not include work area equipment cables or IDF/MDF equipment cables. However, the length and type of cable required to connect telecommunications equipment to horizontal cabling will significantly affect end-to-end system performance and should be taken into account when planning any system.

2. Design Considerations

a. Take into consideration the fact that cable-related work (change, relocation, etc.) is a common occurrence within horizontal distribution. Therefore, anything that can be done at the design stage that reduces unit change time and cost (in materials, labor, and occupant disruption) will have a large impact on the overall life cycle maintenance and operations costs of the horizontal distribution system. This, in turn, requires that careful consideration be given to the choices made in selecting both the pathway and cabling components of the horizontal distribution system. The horizontal pathway system should be designed to make maintenance and relocation of cabling as easy as possible.

b. When designing the horizontal distribution system, the designer should observe the following requirements:

1. California Electric Code [ANSI/NFPA-70 (National Electrical Code® or NEC®)]

2. For other safety regulations:

1. ANSI/TIA/EIA-569-A, and ANSI/TIA/EIA-569-B
2. Additional TSB’s and addenda related to telecommunications pathways and related spaces of ANSI/TIA/EIA-569-A are currently under development by Telecommunications Industry Association (TIA) working groups.
3. Horizontal pathway systems consist of structures that conceal, protect, support, and provide access to horizontal cables.

B. Grounding and Bonding

1. IMPORTANT: Improper grounding of telecommunications pathways may pose a serious safety risk. Pathways must be grounded and bonded in compliance with the requirements and practices in the NEC, except where other codes or authorities impose more stringent requirements. In addition to creating a
serious safety risk, improper grounding of telecommunications pathways may increase susceptibility to EMI.

2. When grounding telecommunications pathways, ensure that:
   a. The installation conforms to applicable practices and codes (ANSI/TIA/EIA-607, the NEC, and local building codes (CEC).
   b. An approved ground is available in the IDF for cross-connect frames and patch panel racks.

C. Wet Locations

1. Intrabuilding horizontal pathways shall be installed in “dry” locations that protect cables from moisture levels that are beyond the intended operating range of “inside” premises cable. For example, slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand, gravel, etc.) are considered to be “wet locations.” See the NEC, Article 100, for definitions of damp, dry, and wet locations.

D. Pathway Types (accepted and non-accepted)

1. When telecommunications horizontal pathways or cabling are placed in a hazardous location, such as an explosive or combustible atmosphere, observe all requirements of applicable codes. (These different designs can/may be used in combinations.)

2. The main types of approved horizontal pathways are:
   a. Conduit. (Flex conduit beyond 1’ is not accepted)
   b. Cable tray.
   c. Access (raised) floors.
   d. Ceiling distribution. (i.e. J-hook, ceiling support wire caddy clamps, etc.)
   e. Hollow wall. (When approved by UCR Designated Campus Fire Marshal (DCFM), use of hollow non-rated wall space can be utilized as an alternative to conduit and boxes installed in the typical office wall. Use this as a cost reductive alternate design only.)

3. The main types of unapproved horizontal pathways are:
   a. Underfloor ducts (one-level or two-level).
   b. Cellular floors.

NOTE: If the above is being considered please contact NACS for design assistance.

E. Fire Alarm/Energy Management/Security

1. Currently on the Campus there are two different types of Fire Alarms.
   a. Standard analog dial tone and,
   b. Digital Ethernet (both copper and fiber).

2. In both cases a conduit from the Alarm panel to the MDF/IDF is required. (See sizing conduits) If the panel(s) is located in an MDF/IDF place a conduit
from the panel to the proposed backboard, to protect the cable to limit the chance of accidental cutting.

3. Energy Management systems also are found throughout all the buildings on campus. A connection is needed from the Main Electrical room and/or other areas in which the building is monitored to connect the building to the campus and allowing it to be able to be monitored. As above with Fire Alarms, refer to the conduit sizing and placing to protect these circuits from any potential damage.

4. Security circuits are more and more becoming to be Ethernet based, when designing pathways and media types, be aware of the extra space on the backboard, or additional backboard space due to this new emerging technology.

5. Please refer to Fire alarm and security sections for more details.

F. Fire Stopping

1. It goes without saying that all penetrations shall have a firestop design. If there is no current UL listing for a 4" riser conduit system, then install a 3" that has a UL listing.
2. Please refer to the UCR DCFM for more details.

G. Wireless Network Designs

1. Although it is not the designer’s responsibility to design a wireless network, it should be noted that sheetrock that is coated with foil, or other unique materials designed into a building should be made known to NACS for the wireless design process. Typically any metal covered large flat panels located within the building will inadvertently impede the signal propagation. Please notify NACS if these types of building materials are proposed for any of the walls within the building. Additionally, wireless locations are requested to be placed on the top of buildings. Currently all new buildings are requested to have (3) separate 1.25” conduit paths from the rooftop single gang weather tight boxes to the closest IDF/MDF. Although cables may not be placed during the original cable installation, the path is requested for emerging technologies. The smallest size of conduit to be placed will be a 1” conduit.

H. Station Wiring Conduit

1. One 3/4” conduit "home run" with pull strings for each telephone outlet back to the nearest IDF/MDF; or
2. 3/4” conduits with pull strings stubbed up into the ceiling near the cable tray, or
3. For items 1 or 2, a 4” x 4” outlet box shall be covered with a standard single gang ring to which our dual receptacle jack faceplate will attach.
4. "Mud rings" (metal rings placed in the wall to receive telephone jack faceplate) with pull strings installed in the wall.
5. 4" channel is becoming an economical and functional alternative to conduits.
Care is to be taken to the location of these channels around modular furniture.

6. For looping conduits once the conduit must be increased one trade size for each additional location, starting with a 3/4” conduit.

7. As a value engineering solution, it is permitted (with DCFM approval) to use mud rings and pullstring, eliminating the ¾” conduit and electrical box to reduce the cost in the typical office location. Other locations can also be done this way upon notification of the selected areas with NACS.

I. Relocation Of Existing Telecommunications Facilities

1. Construction of new buildings sometimes requires the relocation of existing telecommunications facilities. Consult with the University to minimize this situation.

2. If necessary, the University will provide the design for new outside building infrastructure.

3. This cost is over and above the telecommunications budget.

J. Miscellaneous

1. Elevator telephone wiring and phones are usually provided by the elevator supplier in the contract. NACS will install wiring from the IDF to the elevator room at the request of the project manager. A proper telephone service request is required.

2. Payphones will be installed by payphone vendor. The service requests forms shall be coordinated by NACS.

3. Temporary telephone service to the job site will be the contractor’s responsibility.

1.5 ELECTRICAL SCOPE OF WORK FOR INSTALLING CENTERALIZED UPS

A. Provide and install circuit breaker (size based on 208/120V UPS system purchased by NACS and installed by the electrical contractor) in the emergency distribution board (EDB).

B. Provide and install feeder from the EDB to a step-down K-4 transformer (if 208/120V source is not available to provide 208V power to UPS).

C. Provide and install grounding for the transformer per CEC (NEC) 250-26 (if transformer is required).

D. Provide and install feeder from the transformer to a disconnect switch if step-down transformer is provided (size based on the UPS system).

E. Provide and install feeder from the disconnect switch to the maintenance bypass panel (MBP) main input.

F. Three breaker position MBP is provided by the University NACS and to be installed by
G. Provide and install seal tight flexible conduit feeder from the output SW1 of MBP to UPS main AC input. The flexible conduit feeder should have sufficient slack (approximately 3 feet), so the UPS can be easily accessed for maintenance.

H. Provide grounding electrode, conduit and wire for the UPS per CEC (NEC) 250-30 and UPS schedule for sizing as provided by the manufacturer.

I. Provide and install seal tight flexible conduit with 4 wire and ground feeder from the UPS main output to the input SW3 of MBP. The flexible conduit feeder should have sufficient slack (approximately 3 feet) so the UPS can be easily accessed for maintenance.

J. If the UPS is not provided with an internal isolation transformer, the contractor shall provide and install a (208V/208V) low impedance isolation transformer including required grounding.

K. Install 3 wire and ground feeder from MBP load output feed to the input of isolation transformer.

L. Provide and install 4 wire and ground feeder from the output of isolation transformer (neutral bonded to ground) to the UPS electrical distribution panel.

M. Provide and install a 120/208V, 3Phase, 4Wire UPS electrical distribution panel with required 20A, 1P and 20A, 2P panel located on the same floor as the UPS and MBS box.

N. Utilize the available spare 20A, 1P breakers and provide additional necessary 20A, 2P breakers in the commercial power panels located on each floor.

O. In the main Network/Telecom terminal equipment room of each floor, provide and install a wall mounted junction box at 9'-0" AFF and provide and install conduit and required number of wires to commercial power panel located in the electrical room on each floor.

P. In the main Network/Telecom terminal equipment room of each floor, provide and install a second wall mounted junction box at 9'-0" AFF and provide and install conduit and required number of wires to UPS panel.

Q. In the main Network/Telecom terminal equipment room (MDF), provide and install Seal tight flexible conduit and required number of wires from the commercial and UPS power wall mounted junction box to the following described outlets: (2) 20-amp, 208v NEMA 6-20 receptacle from UPS panel, (2) 20-amp, 120v NEMA 5-20 receptacle from UPS panel, (2) 20-amp, 208v NEMA 6-20 receptacle from commercial (non-emergency) panel, (2) 20-amp, 120v NEMA 5-20 receptacle from commercial (non-emergency) panel.

R. In all other Network/Telecom terminal equipment rooms (IDF), provide and install Seal tight flexible conduit and required number of wires from the commercial and UPS power wall mounted junction box to the following described outlets and boxes: (2) 20-amp, 208v circuits pigtailed in boxes with blank cover plates from UPS panel, (2) 20-amp, 120v NEMA 5-20 receptacle from UPS panel, (2) 20-amp, 208v circuits pigtailed in boxes with blank cover plates from commercial (non-emergency) panel, (2) 20-amp, 120v NEMA 5-
20 receptacle from commercial (non-emergency) panel.

S. Coordinate with the University to mount the receptacles to overhead ladder rack and as close as possible to the location of network equipment rack.

T. Verify all existing documents and dimensions before pricing and / or proceeding with the work. Notify the University’s representative of any discrepancy or variations.

1.6 AUDIO VISUAL PROGRAM

A. This program document outlines the audiovisual requirements for the Presentation rooms. Two room types are considered:

1. The assignable general purpose Lecture Halls and Conference Rooms/ Colloquia. The program will be divided into baseline design presumptions followed by descriptions of room implementations. Audio visual equipment and installation are not part of this scope, with the following exceptions:

   a. Projection screens; complete with power and controls that can interface with user input signal for remote control.
   b. Necessary Structural backing, electrical power receptacles, and communication cabling pathway to support equipment provided and installed by others.

B. Audio Visual Baseline Design Presumptions

1. These rooms are assembly rooms used for presentations using audio and video devices. Projection screens are to be located with clear sightlines for all viewers. Video sources include computer images from an Owner provided computer (networked) or a laptop computer provided by the presenter. Most display content will come from a computer that includes DVD playback. An S/VHS and DVD player is provided in the lectern and/or projection room. Provision shall be installed for occasional portable devices such as a camera stand.

2. In rooms large enough to require speech reinforcement, ceiling loudspeakers driven by an automatic microphone mixer connected to wired microphone inputs and wireless microphones where requested. Although smaller rooms utilize the ceiling mounted loudspeakers for audio playback, larger rooms have loudspeakers mounted at the front of the room adjacent to the projection screen. Surround loudspeakers, subwoofer and a surround sound decoder are not provided.

3. Audiovisual equipment is attached to equipment racks for operational reliability. Racks contain wiring terminations, audio and video amplifiers, switching and routing equipment. User operated equipment such as playback VCRs and DVDs are mounted in podiums or credenzas.

4. Audio conferences are supported in designated rooms. Designated rooms are also equipped with cameras for distance learning, video conferencing or class archiving. In multiple camera rooms, an operator controls multiple remote control cameras that are used for distance learning or for documentation of presentations.
C. Audio Visual Room General Requirements

1. Recurrent and repeated video displays are loaded on the server and played from files using the network. Display requiring video is played from an MPEG player and delivered to the selected display room as component video. Non-recurrent playback will typically come from a portable computer. This includes data files as well as video playback.

2. Network connections are installed at all video display devices including video projectors and video display panels. These network connections are for power control, input switching control, for delivery of program content and for remote diagnosis.

3. Network connections are installed at all user locations. These network connections are for projector control, and where possible, for content.

4. It is assumed that most projected displays are video. Only incidental use of slides, overhead projections and other direct projections will be used. Video display devices include video projectors and video monitor panels.

5. Audiovisual control uses a local remote control system. User input is through a touch screen or button panel.

6. Technician support for any classroom is available on a dial-up basis. The centralized technical staff is able to view the status of the room’s presentation using network VPN. The staff can not only view the progress of a presentation, be can also control devices as requested. A centralized technician is online and when called can access the status of the system, trouble shoot and even operate the auditorium remote controls using a web browser.

7. Technical staff can not only assist presentations from a central location, but can conduct room specific and global diagnostics of all audiovisual equipment. Besides play time and operating status for all devices, the technician can view lamp life and the operating condition of each projector.

8. Audio systems include ceiling loudspeakers for speech reinforcement. In some locations, these ceiling loudspeakers are used for playback. Ceiling loudspeakers are used for installed audio teleconferencing because ceiling loudspeakers do not load the tabletop microphones with audio and provide improved gain for the echo canceller.

9. Playback audio systems shall include front two or three channel audio playback loudspeakers mounted adjacent to the projection screen(s) for directional realism with the projected image. Specialty audio systems can include three front channels, subwoofer and surround sound if requested.

10. An operator controls multiple remote cameras for future distance learning or for documentation of presentations.

D. Audio Visual Room Descriptions
1. Lecture Halls

a. The Lecture Hall is a formal local display room with multiple display capability from multiple sources. The room is used for local presentation and is not expected to be used for distance learning.

1. One HD 16:9 aspect ratio 20’ wide motor operated front projection screen is centered in the front wall.
2. Two 10’ wide motor operated 4:3 aspect ratio front projection screens are installed left and right of the middle screen.
3. One 30’x 4’ three layer vertical slide-over permanent white marker board installed at sending wall.
5. Media: Each lecture hall will have (4) Cat6 to the podium, (6) Cat6 in the ceiling (wireless), and (1) wallphone next to the podium. Additional locations will be required for the control room if existing.

b. Provide empty conduit and rough-ins for the following equipment that is provided by others:

1. Provide custom lecterns at each classroom to house required source equipment and computer, monitor, keyboard, and mouse.
2. Provide cable nook at top of lectern to support access and storage of VGA with audio cables.
3. Lectern shall be designed with the following display inputs: Computer, monitor, keyboard and mouse, XGA laptop interface, high definition DVD player, VHS VCR, SXGA resolution document camera. XGA slide to video projector, auxiliary video connection, and 16 input x 16 output RGBHV Ultra-wide bandwidth matrix switcher.
4. Provide display system such as 6500 lumen Sanyo XGA (4:3, 1024x768) data projectors with long throw lenses.
5. Provide (2) professional loud speakers powered by a high performance 260 Watt x 2 ch power amplifier for program audio.
6. For speech audio system provide a center speaker cluster designed for high intelligibility, minimal feedback and high output capability. Provide (2) wireless professional UHF series handheld microphone systems, (2) wireless professional UHF series body pack with lapel microphone systems, and (1) 18” lectern mounted gooseneck microphone.
7. Provide wireless assisted listening system to meet current ADA requirements, including a wireless transmitter and (4) wireless body packs with ear buds.
8. Provide AMX 12” color recessed touch panel. Panel will be used to connect and select sources; select destinations; control the projectors and screens, lighting, and volume; and allow source control over DVD, VCR, document camera, and slide to video presenter.
9. Provide AMX Netlinx controller wired with a single connection to the network to support remote access application. Integrate
each lecture hall into the UCR Classroom Scheduling software.

10. All source equipment shall be housed within the lectern. All audio amplifier and video switching shall be housed within a booth rack.

11. Video and RGBHV cable shall be capable of passing ultra-wideband high-resolution signals. Speaker wiring shall be minimum 16 gauge.

12. Media: Each smart classroom will have (4) Cat6 to the podium, (2) Cat6 in the ceiling (wireless), and (1) wallphone next to the podium.

c. Building connections

1. Input connectors installed in the floor and walls connect analog Composite, VGA and both line and microphone audio.

2. A remote control system with connectors at the presenter’s location operates the video projector functions; display input selection, audio and video playback control and also audio and video teleconferencing functions such as dial-out. Connections will be installed for confidence monitors and distance return monitors so the instructor can view image choices while presenting at the front of the room.

3. Presenter audio including microphones and playback will be reproduced in the room as well as sent out to distant sites. Conduit will be installed for future wired student table microphones, but wireless will be used in the beginning.

d. Network Electronic Systems

1. The buildings will have fiber optic connection to the network for high speed file transfer.

2. 4 each Cat 6 wires will be provided to all podium locations for data connection.

e. Architectural (needs to be confirmed by project program)

1. Camera locations will be installed on the walls and ceiling (over the presenters desk location).

2. A control room will be provided in the back of the room to support an operator for presenter assistance and to house the video projectors while facilitating maintenance.

3. The operator will operate and make camera selections and operate the audio during any potential broadcast class. An operator will not be required for normal classroom use of the room.

4. A closet will be installed at the front of the room for storage of instructional materials including marker board materials, wireless microphones, and specialty items.

5. The rooms will have energy efficient general lighting such as fluorescent. The lighting will be zoned. The front 1/3 will have separate control from the 2/3 coverage at the rear of the room. All energy efficient lighting fixtures will not be dimmable.

6. Dimmable incandescent task lighting will cover the entire seated audience area.
7. Presentation dimmable incandescent fixtures will be provided to illuminate the presenter on the platform.

f. This room will not be used for Cinema (video) playback or performance. Conduit will not be installed for surround sound and subwoofer loudspeakers nor for connecting specialty equipment.

2. Colloquia Rooms (needs to be confirmed by project program)

a. Colloquia rooms have movable work tables for discussion. One single video display is centered on two end walls so that most people in the room can see without moving their chairs, the rooms can be isolated and each room can have video display capability. The video displays are projected from a ceiling-mounted video projector on each side of the room. The projected image will be a 16:9 aspect ratio image on motor-operated front projection screens.

b. Any person seated at the any table can present to the group using the video display. Input connectors installed in the floor and one wall connects analog composite video, VGA and line level audio.

c. An installed remote control button pad installed in the wall adjacent to the screen will operate the video projector functions including ON/OFF, display input selection and volume control.

d. Ceiling loudspeakers will provide stereo playback but not speech reinforcement.

e. The podium will follow the campus standards for large conference rooms.

f. The room will require video cameras mounted on wall and/or ceiling if confirmed by the project program.

3. Electronics Work Rooms and Computer Lab Classrooms

a. Each of the classrooms will have work benches or rows of desks. A single video display is centered on one end wall so that most people in the room can see without moving their chairs. The video display is projected from a ceiling mounted video projector. The projected image will be a 16:9 aspect ratio image on a motor-operated front projection screen. An installed remote control button pad installed in the wall adjacent to the screen will operate the video projector functions including ON/OFF, display input selection and volume control.

b. Ceiling loudspeakers will provide stereo playback but not speech reinforcement.

c. The room will require video cameras mounted on wall and/or ceiling if confirmed by the project program.

4. Conference Rooms

a. Conference rooms have a central table for discussion. A single video display is centered on one end wall so that most people in the room can see without moving their chairs. The video display is projected from a ceiling mounted video projector. The projected image will be a 16:9 aspect ratio image on a motor-operated front projection screen.

b. Any person seated at the central table can present to the group using the video display. Input connectors installed in the floor and one wall connects analog composite video, VGA and line level audio.

c. An installed remote control button pad installed in the wall adjacent to
the screen will operate the video projector functions including ON/OFF, display input selection and volume control.

d. Ceiling loudspeakers will provide stereo playback but not speech reinforcement.

e. Media: Each conference room will have (3) faceplates with (3) Cat6 cables.

5. Dean’s Office Lobby / Reception Rooms (needs to be confirmed by project program)

   a. Lobby / Reception room rooms have a single video display is centered on one end of wall. The video display is projected from a ceiling mounted video projector. The projected image will be a 16:9 aspect ratio image on a motor-operated front projection screen.

   b. Input connectors installed in the floor and one wall connects analog composite video, VGA and line level audio.

   c. An installed remote control button pad installed in the wall adjacent to the screen will operate the video projector functions including ON/OFF, display input selection and volume control.

   d. Ceiling loudspeakers will provide stereo playback but not speech reinforcement.

E. Audio Visual: Tel/Data

1. All presentation rooms are connected to the IDF on each floor and to the MDF room for distribution within the building and for distribution to other buildings on campus. Student and staff files are backed up on a central server, which also provides video and audio streaming to presentation rooms and selected public display locations. The server is sufficient for file sharing, real-time video playback, and new uses provided by developing technologies.

2. All audiovisual systems within the building will have IP addresses. A campus audiovisual technician can log onto the network and look at the status of any system in the building. Each video projector will have a network connection so that the central audiovisual service can poll the projector and determine lamp life and maintenance. The audiovisual systems can therefore be polled not only for maintenance, but also for reference. When there are problems with a presentation, the presenter can call and the central audiovisual technician can determine the problem, or, the switching positions to talk the user through to a successful presentation.

3. Besides the tel/data UTP and fiber connectivity, two analog systems are installed throughout the building.

4. Telephone and Data

   a. Tel/data UTP and fiber connectivity is designed by others but will be needed for the audiovisual system building interconnectivity.

   b. Because of the distance learning capability, off campus connectivity must provide bandwidth for video conferencing in addition to voice calls and data.

F. MATV
1. One building wide analog broadcast television system is installed throughout the building. The coax installed is to be compatible with the forthcoming digital cable signal.

2. Television drops will be installed in all presentation and conference rooms. This system can be fed by antenna (limited number of channels), satellite, or, local cable vendor. At least one channel can be inserted for local messaging.
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SECTION DIVISION 28- ELECTRONIC SAFETY AND SECURITY

1.1 SECURITY SYSTEM

A. This Section covers the University’s Access Control System (ACS). If required by the Project Program, ACS shall link with the existing campus central station control and alarm monitoring system which is located within the University Police Department. The central station system is monitored by campus police dispatch center.

B. Provide the detail design of the system, furnish and install hardware, modify the existing campus central station database and software as required to accept this building, start-up and commission the system, and then warrant the completed system including equipment, appurtenances, and existing campus central station modifications.

C. The ACS shall include, but not be limited to, necessary hardware, existing campus central station hardware and/or software modifications, remote alarm terminal printer, initial database programming, floor terminal controllers, door smart terminal interface panels, door alarm/status sensing devices, access cards, card readers, exit request push-button stations, step-down power supply transformers, conduit, wire and cable, communication devices (modems) required to enable the building to communicate with and receive data from the existing campus central station.

D. The identification and location for security access is related to the building design and building type. In general, floors of a laboratory building shall be isolated. Building public entrances and service entrances shall be isolated. Close coordination with curtain wall systems, adjacent materials, hardware, parking, adequate lighting, and recessed telephone boxes with a nearby phone book for visitor night access shall be considered for each Project. Coordination for this issue with Lock Shop Supervisor and University representative is essential.

E. Security systems shall be as specified in the following table:

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controllers</td>
<td>Shall be Identiv-Hirsch UTRUST Model M8N2 with downloadable firmware to protect panel from becoming obsolete. Firmware must be latest revision at time of installation.</td>
</tr>
<tr>
<td>Card Readers</td>
<td>Shall be Identiv-Hirsch Models TM110 wall mount or TM15 mullion mount unless otherwise specified by the campus Lockshop.</td>
</tr>
<tr>
<td>Reader Mounting boxes</td>
<td>Shall be flush mounted unless existing construction prohibits then surface mount may be substituted.</td>
</tr>
<tr>
<td>Line Modules</td>
<td>Shall be Hirsch model MELM-2.</td>
</tr>
<tr>
<td>Door Contacts</td>
<td>All doors shall have door position switches and they shall be flush mount type unless construction prohibits then surface mount may be substituted.</td>
</tr>
<tr>
<td>Request to exit sensors</td>
<td>All doors shall have RQE sensors and they shall be motion activated with ability to select area of coverage. Openings with panic hardware RQE function may be incorporated in panic bar with switches.</td>
</tr>
<tr>
<td>Computer workstation</td>
<td>Shall be compatible with Hirsch Velocity software current version. See Hirsch Electronics for current computer specification. Computer to be delivered directly to campus Lockshop.</td>
</tr>
<tr>
<td>Handicap operators</td>
<td>Doors with handicap operators shall be wired with handicap operator on one relay and locking hardware on a separate relay.</td>
</tr>
<tr>
<td>All installations</td>
<td>Must communicate over campus network through Velocity software to campus card access central servers.</td>
</tr>
<tr>
<td>Panel Location</td>
<td>All control panels and related items shall be mounted in IDF or other rooms NOT IN ELECTRICAL ROOMS.</td>
</tr>
<tr>
<td>Keypads</td>
<td>Shall Be Identiv-Hirsch Scramble pad DS47Hi for exterior and DS47L for interior doors.</td>
</tr>
</tbody>
</table>

(NOTE: See APPENDIX (page 14) for specification and date sheets for equipment)
F. The central control panel shall have and network card to allow connection to the campus network. Security system wiring shall be segregated from other systems. The central control panel shall be located in the MDF telephone room and include a hinged, lockable cover.

G. Quality Assurance During Construction

1. The installation contractor shall have an established engineering, sales, installation, and service presence within Southern California. This office shall have been in operation for a period of not less than five years prior to the bid date of the project.

2. The Installation Contractor shall be a Branch office, a Main Office, or an authorized dealer and/or Installer of the system manufacturer and shall have done at least two (2) projects similar to this project in size and type in the last three (3) years.

3. The Installation Contractor shall be responsible for the complete installation and proper operation of the ACS, including the initial data input, system debugging, and initial calibration of system components.

4. A full-time Project Manager with a minimum of five (5) years’ experience with facilities of this size project and complexity shall be assigned to manage both the engineering/design and system installation/start-up phases of the projects. Close coordination and approval from and with the Design Professional is required.

H. Function

1. Design and install an access control system including necessary hardware and software to perform the functions intended in accordance with installation specifications.

2. The system shall be fully integrated to the existing campus Cardkey security system and the existing hardware and software shall be modified to include the extended system.

3. The system shall provide all functions required by the university as specified by Facilities Services Administration, Key and Lock Shop supervisor. Contact the Key and Lock Shop Supervisor for specific details.

4. Operation of a valid card on an access control reader shall release the lock mechanism for a preset time.

5. Request to exit as detected by the motion sensor shall release the lock mechanism for a preset time.

6. While the lock mechanism is released, the alarm contacts shall be shunted to prevent an alarm.

7. If the alarm contacts are opened or are not closed at the end of the lock release preset time, a local alarm shall sound. This alarm shall be repeated to the control security station.

8. Card readers in elevator cars shall be linked to elevator controls to allow travel to selected floors. The system shall be capable of restricting access to floors not permitted by the access card.
J. Components

1. The Access control system shall comprise the following principal hardware.
   a. Intelligent Terminal Controller to support the Smart Terminal Interface Programming Equipment and communications with the existing central controller. Controller shall have a battery sized to provide six hours of power in event of primary power failure.
   b. Smart Terminal Interface units for connection of door hardware and access reader.
   c. Card Readers shall use equivalent or better technology as used on the campus. Card readers shall be suitable for their installed locations
   d. Access cards shall be Weigand “effect” security cards as used on the campus. Access cards shall be provided with the system preprogrammed with the University’s facility code.
   e. Door hardware shall consist of:
      1) Electric strikes as furnished in door hardware. Verify the strikes’ power and connection requirements and provide equipment necessary to interface with the electric strike. Coordinate and provide necessary hardware for connection to any automatic disabled access control doors.
      2) Request to exit shall consist of a motion sensor mounted above the door.
      3) Door alarm contacts shall be coordinated with the door construction.
      4) Door alarm sounder shall be provided by each access control door to signal an alarm condition at that door.
      5) Where an access control door is installed on a means of escape, an emergency pull station shall be provided. The pull station shall release the door lock and signal an intrusion.

K. Installation

1. Provide conduit and wire from dedicated 120 VAC emergency power circuits.
2. Power supply wiring (120 VAC) shall be run in dedicated conduit. Power conduit shall be separated from control and signal conduits by a minimum of 3 inches.
3. ACS equipment shall be located such that it is accessible for service while maintaining clearances or walkways required around other equipment or obstacles.
4. Control elements located in outdoor installations shall be weatherproof.
5. Splices in shielded cables shall not be permitted. Terminations of shields and conductors shall be done in accordance with the manufacturer’s instructions.
6. Cabling and wiring within panels shall be harnessed with tie wraps and secured in a neat and orderly fashion.
7. Cable runs shall be kept as short as possible, allowing extra length for making connections to termination points.
8. Each cable or individual conductor shall be labeled with a unique tag for quick identification during checkout, testing, and troubleshooting. Each component shall be permanently labeled with the device name and at each terminal point per Section 26.
L. System Testing and Checkout

1. Prior to the acceptance test, the contractor is to perform the following tasks:
   a. Check for electrical continuity, eliminating shorts and open circuits, and verify grounding.
   b. Install, calibrate, adjust, debug and set system's initial operating parameters including the existing campus central station.
   c. Check out systems to verify the provided engineering documentation and approved submittals have been followed.

2. The ACS, including the interface with and programmed responses of the existing campus central station, must operate continuously for seven (7) days with no operational malfunctions or problems before setting an acceptance test date. Simulate different access and egress scenarios for worst case condition and simulate other alarm conditions to test the ACS's response and handling of situations. Keep a detailed log of tests conducted, problems encountered, and the corrective action that was taken.

3. Prepare and submit an Acceptance Test Plan for approval. This test shall include verification of communications, control, and response from the existing campus central station to a floor terminal controller, to a smart terminal interface, and finally to the sensor and controlled device to demonstrate the proper operation of control loops, conditional control and default sequences in accordance with the project documentation.

4. Obtain the approval of the University's Representative as to when the acceptance test will be performed.

5. Conduct the acceptance test in the presence of the University's security supervisor and/or of their designated Representative, following the approved Acceptance Test Plan.

6. The University's Representative shall check off and initial each successfully tested item. Demonstrate that the electromechanical systems are operating properly, and that the system is providing the required control sequences, alarms, graphic displays, and report generations.

7. An ongoing punch list shall be maintained throughout the test of items. This list shall contain items that must be corrected prior to accepting the system for beneficial use and commencement of the warranty period.

M. Training

1. Furnish the services of competent instructor(s) who shall give a maximum of four hours instruction and orientation to the University's designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements of the equipment, the affected systems, and the software provided. The training shall be customized to reflect the actual system installed rather than being a general (canned) training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach.

1.2 FIRE DETECTION AND ALARM SYSTEM

A. General

1. Fire detection and alarm systems shall be designed in accordance with the latest
building occupancy requirements, Designated Campus Fire Marshal (DCFM) requirements, the applicable codes and standards including National Fire Protection Association (NFPA) 72, UL 864 9th edition, National Fire Alarm Code, CBC Title 24, and California Fire Code.

2. Automatic fire detection and audible alarm systems shall include fireman's communication system, if applicable and Digital Automated Communication Terminal (DACT) for communication by phone line modem with Campus Central Alarm Panel. Where a fire suppression sprinkler system is provided, coordinate with the Mechanical or Fire Protection Engineer and incorporate fire sprinkler flow and tamper switches into the detection and alarm system. Building with elevators shall include elevator status annunciators into the detection and alarm system. Where building requirements include duct mounted smoke detectors and/or smoke/fire dampers, include furnishing of duct detectors and annunciation of smoke alarms and control of smoke dampers. Provide in a separate room, a fireman's control panel in buildings with smoke exhaust system or chemical exhaust system.

3. The building shall be zoned into multiple zones on a level by level basis and / or area separating walls. Each building shall be reviewed individually to establish the applicable zoning.

4. Fire alarm systems are to be Simplex 4100u Series to match existing systems, except residential projects which might vary. A complete system is required which meets the DCFM, Codes and ADA requirements. Drawings shall show device locations, riser diagram, devices, and voltage drop calculations, other requirements of this Standard, and connection to the central monitoring system. Plans shall be reviewed and approved by DCFM.

B. System Description and Function

1. The system shall consist of local fire control panel equipment (if applicable), audio alarm transmitter, DACT, campus GCC network interface card and fiber media cards (future use), automatic detection devices, manual reporting stations, speakers, visual alarms, a separate fireman's communications system shall be provided as required, and wiring. The entire system shall be equipped with an emergency battery back-up system. The control panel shall be located at the main electric room or as instructed by DCFM. The fire alarm annunciator panel shall be placed on the exterior of the building in a NEMA 3R waterproof enclosure. The final location shall be determined by the DCFM.

2. The system shall be capable of being expanded at any time up to the pre-determined maximum capacity of the system.

3. The basic system shall be capable of operating both addressable and non-addressable photoelectric smoke detecting devices, heat detectors, manual stations, tamper switches, and water flow switches.

4. The control panel shall provide power, annunciation, supervision and control for the fire detection and alarm system. The control panel shall be modular in construction, and contain equipment necessary to operate. The system shall be designed so that alarm indications override trouble conditions. The panel shall be capable of measuring the sensitivity of the addressable photoelectric detectors connected to it. The control panel shall provide an enhanced CPU with dual configuration programs and capacity for up to 2000 points. The system power supply and charger shall provide at least 9 Amps of on-board and 3 on board NAC circuits. Provide 25% additional capacity on all designed circuits.
5. The system wiring shall be a Class "B" wiring system unless noted otherwise. Labs shall be Class "A" indicating circuits. Loss of any conductor shall not prohibit alarm initiation from any initiating device or alarm indication from any alarm device.

6. The system shall function as follows when any smoke detector, duct detector, manual station or water flow switch operates:
   a. Sound the audio alarm and cause visual signals to flash throughout the entire building.
   b. Automatically notify the Campus Police Dispatch Center.
   c. Display individual detector number on GCC with Owner’s Representative defined message.
   d. Print individual detector number with defined message, date, and time on Network printer terminal.
   e. Light an indicating lamp on the device initiating the alarm or on the device remote indicator.
   f. Shut down the HVAC system, except for a building with chemical fume hoods.
   g. Activate elevator recall and alternate recall sequences when the associated smoke and/or heat detector(s) are in alarm.
   h. Close magnetically held fire doors and/or smoke dampers.
   i. Unlock security doors.

7. Activation of any fire sprinkler tamper valve switch shall cause a supervisory signal.

8. There shall be no limit, except the maximum system capacity, as to the number of addressable devices which may alarm simultaneously.

C. Materials

1. Materials and equipment, accessories, devices and other facilities and appurtenances shall be new, best suited for the intended use, and shall conform to applicable and recognized standards for their use. The system shall be Simplex only to match campus standards, except for certain housing projects. Confirm with University the manufacturer of existing system when project is for housing.

2. Conductors
   a. Fire alarm conductors shall be solid conductors. Provide 14 AWG minimum for horn and bell or smoke detector power circuits. Provide 18 AWG minimum for alarm initiating circuits and remote annunciator panel circuits. Provide twisted and twisted shielded cable as recommended by the manufacturer.
   b. Fire Alarm Conductor minimum requirements
      1) Control and Communication Cable 18GA Twisted Shielded Pair (TSP);
      2) Addressable initiating devices 18GA TSP;
      3) Addressable Audio/Visual devices and speaker circuits 14GA Twisted Pair w/o shield.
      4) Indicating devices 14GA THHN;
      5) Conductors located in wet locations shall be THWN or equal;
      6) All cable and wire shall be jacketed to meet the requirements of their installed environment.
      7) Conductors insulation/jackets shall be colored orange and/or grey;
3. Control Equipment

a. Individual addressable detection device alarm threshold shall be adjustable from the control panel. The detection system shall remain 100 percent operational and capable of responding to an alarm condition while in the routine maintenance mode. Addressable detection devices shall be individually identified by the system, and any quantity of addressable detection devices shall be in alarm at any time up to the total number connected to the system.

b. Panel annunciator shall be a 2x40-character alpha-numeric display, which shall provide a University-definable message associated with each detection device or zone.

c. Dynamic supervision of the system electronics, wiring, detection devices and software shall be provided by the control system. Failure of the system hardware or wiring shall be indicated by type and location on the alpha-numeric annunciator. Software and processor operation shall be monitored by an independent hardware watchdog, which will indicate their failure. The system will provide failsafe operation; i.e., incoming alarms shall automatically override other modes of operation, and the panel shall automatically return to normal operating mode from any operator initiated mode.

d. Fault detection shall be provided for initiating and audible circuits. System modules shall be capable of operation in any unused panel location. Lamp test capability shall be provided to test visual panel indicators and associated software. Provisions shall be made for remote trouble and remote alarm silencing switches. The control panel shall be equipped with a silence before reset feature, designed to prevent accidental system reset during an alarm condition. The system alarm lamp shall flash upon receipt of any alarm condition. Acknowledgment of the alarm by operation of the silence switch shall silence the audible alarm and cause the alarm lamp to light steadily. Receipt of subsequent alarms shall cause the audible devices to resound and the alarm lamp to flash.

e. System trouble lamp shall flash and an integral trouble buzzer shall sound upon the occurrence of any trouble condition. Acknowledgment of the trouble condition by operation of the silence switch shall silence the audible alarm and cause the trouble alarm to light steadily. Receipt of subsequent troubles shall cause the trouble buzzer to resound and the trouble lamp to flash.

f. Individual input and output device addressability as well as remote sensitivity measurement shall all be performed on the same pair of wires. Wiring shall be Class "B" and no special wiring sequence shall be required on addressable device circuits. An unlimited number of writing branches shall be permitted with no loss of supervision.

g. Service mode shall permit the arming and disarming of individual detection or output devices as well as manually operating output devices. Status of these devices shall be displayed upon command from the control panel. The panel shall automatically return to the normal mode in the event the panel remains unattended in the service mode.

h. Panel shall be capable of receiving and processing alarms even when in the service mode.

i. Control panel shall operate from a three-wire 120 VAC power supply and internal 24 V back-up battery system with a charger capacity of up to 110 amp hours. Battery(ies) shall be 12 volt sealed, lead-acid type. Power connections, both AC and DC, shall be separately fused within the control panel. Light emitting diodes (LED's) shall be included to indicate system power (green), trouble (yellow), and alarm (red). Trouble and alarm shall also be annunciated on an alpha-numeric display which will give device number and location plus diagnosis of trouble. Momentary contact switches shall provide for
Local, Next Alarm, Next Trouble, Acknowledge/Silence and Reset. An audible device shall sound within the control panel for alarm or trouble. This device shall have two distinct sounds and shall be silenced by the acknowledge/silence switch. Alarms shall override any trouble condition.

j. Control power supply shall be capable of powering up to 960 addressable early warning detectors and at least twelve audible signal circuits. System expansion modules shall interconnect through a card edge connector and shall require no inter-module wiring.

k. Control panel shall be capable of measuring and adjusting the sensitivity of detectors. An alpha-numeric display shall be provided to display custom messages and give readings of the detector sensitivity, detector by detector. Each device on an addressable initiating circuit shall be checked continuously to include the following: sensitivity, response, opens, shorts, ground faults, functionality and status.

l. Control panel shall report a device's transmitting component(s) failure, open, or shorted transmission, on an addressable initiating circuit. The device shall be recognized and identified by location within the circuit to the specific device, and other devices on the circuit shall continue to function.

m. Control panel shall report, by specific device number, any device removed from an addressable initiating circuit. Other devices shall continue to function.

n. Control panel shall allow changing the status of configured circuits (arming and disarming or changing status of relays). If any change in status degrades system operation as configured, a trouble condition shall be reported and remain until system operation again meets configured status.

o. Control panel shall have the ability to perform multiple operations at the same time. These operations shall include, but not be limited to, timed functions and multiple configured sequences.

p. Control panel shall have the ability to support a printer terminal. This printer shall be used for permanent records of the system's status and detector chamber voltages, and shall also be capable of system control as configured.

q. Control panel shall allow for expansion and shall be configurable without system inter-wiring.

r. Unacknowledged alarms and troubles shall be distinctively displayed on both the visual display and the printer, and differentiated from previous alarms and troubles.

s. System shall automatically indicate the total quantity of alarms and troubles which have occurred prior to reset at the control unit.

t. Alarm or trouble indication shall not be re-settable until it has been acknowledged.

u. The network printer shall be capable of listing, upon request:

1) Alarm with time, date and location.
2) Trouble with time, date, and location.
3) Status of output functions, whether "on" or "off."
4) Sensitivity of addressable smoke detectors.
5) Detection device number, type, and location.
6) Status of remote relays, whether "on" or "off."
7) Acknowledgment time and date.
8) Signal silence time and date.
9) Reset time and date.

v. The system shall be capable of:

1) Differentiating among types of addressable detectors such as smoke detectors, manual stations, water-flow switches and thermal detectors.
2) Assigning priorities to types of detectors, zones or groups of detectors.
3) Cross-zoning.

w. Control functions shall be assigned on the basis of system initiation patterns of detection.

x. Each addressable detection device shall report its condition to the system control unit when polled. Failure of the connections to the system control unit, or internal electronics of the device will result in a trouble signal which identifies the specific device zone and/or circuit involved.

y. Addressable photoelectric-type smoke detector sensitivity shall be reported at the control panel. The electronic readout of detector sensitivity shall be equivalent to sensitivity readings made with a meter for non-addressable detector, read at the control panel digital annunciator. It shall be possible to change the detector sensitivity from the control panel within maximum and minimum values as defined by the UL and CSFM listing of the detectors.

z. The system shall be capable of listing detector chamber voltage settings on the printer for permanent record.

aa. Water-flow switches, tamper switches, outside stem and yoke valves, manual stations, and thermal detectors shall be equipped with an electronic address device which shall be supervised identically as addressable detectors.

bb. Water-flow switch alarm operation and automatic sprinkler system supervisory switches shall be wired and annunciated in conformance with the CSFM listing, Title 24 and National Fire Alarm Code.

c. A trouble signal shall be initiated for each addressable device for which the automatic sensitivity measurement is out of the normal sensitivity range.

d. The supervised and powered parallel output circuits shall be capable of use as audible signal circuits, fire extinguishing release circuits, municipal tie, remote station connection or general alarm release service. They shall be capable of providing 2 amps at 24 VDC.

e. Control relays in the fire alarm control unit shall be included. The dry contacts shall be rated at @ amps resistive @ 32VDC. Additional internal relay modules shall be provided to provide dry contacts rated for loads up to 10 amps @ 250VAC Resistive or Inductive.

ff. Remote interface relays shall be rated at up to 120 VAC, 5 amp inductive and be self-contained in a single gang enclosure or encapsulated.

gg. Remote relays located on detector bases or single gang outlets throughout the building shall be controlled in the same manner as panel mounted relays.

hh. The system power supply shall be provided with an integral Uninterruptible Power Source (UPS). This UPS shall provide continuous power to the system in the event of a commercial power failure. Transfer from commercial to standby power shall be instantaneous to insure proper processor operation, and shall be indicated by flashing the system power LED. Batteries shall be sized to provide 24-60 hours of standby operation followed by 5-15 minutes of alarm. Coordinate back-up requirements with the DSFM. A dual rate battery charger shall be provided which is capable of recharging the batteries to 80 percent capacity in 12 hours. Loss of commercial power shall be annunciated as a system trouble. System trouble shall be indicated for over and under voltage conditions, blown fuse or disconnected batteries. The system shall automatically restart upon the return of power. No operator intervention shall be required.

ii. The control panel enclosure shall be beige in color, suitable for surface or semi-flush mounting. A locked door shall be provided to limit access to authorized individuals.

jj. Modules shall be plug-in, dynamically supervised and easily replaceable. Field wiring shall be connected to the panel with removable multi-conductor connectors to facilitate rapid removal and replacement of both the module and
wiring for ease of servicing the panel.

kk. Visual indicators shall be long-life LED's. Modules capable of initiating a system trouble shall display individual trouble indications on the alpha-numeric annunciator.

ll. Provide for future connection to the Campus Fiber Network. Provide a network card and two fiber network modules for future connection by the Campus.

4. Initiating Circuits
   a. Addressable/programmable initiating circuits shall be provided by an Addressable Input Module
   b. Show on plans where devices are to be provided.

5. Output Circuit
   a. An output circuit for operation of DC audible devices shall be provided by a Programmable Signal Module
   b. Show on plans where devices are to be provided

6. Relay Module
   a. A programmable supplementary relay module shall be provided for control of door holders, damper closure and/or fan shut down.
   b. Show on plans where devices are to be provided
   c. The module shall be Underwriters’ Laboratories and California State Fire Marshal listed.

7. Alarm Initiating Devices
   a. The addressable analog ionization type combustion detector shall be a plug-in, twist lock unit which shall be capable of removal from or installation into its base with one hand.
      1) The addressable analog photoelectric smoke detector shall be listed by Underwriters’ Laboratories and California State Fire Marshal.
   b. The addressable analog thermal detectors shall be programmable for rate-compensated and/or fixed temperature type and shall be listed by Underwriters’ Laboratories and California State Fire Marshal. The addressable thermal detector shall be individually annunciated on the control panel, and shall contain an integral alarm lamp.
   c. The addressable programmable interface module shall provide an interface for direct shorting contact devices to the Addressable Input. This unit is used with water-flow switch, tamper switch and outside stem and yoke valves.
   d. The air duct detector shall operate on a cross-sectional air sampling principle to overcome stratification and the skin effect. The air duct detector shall consist of an addressable ionization detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system.
   e. The in-duct detectors, provided where sampling tube designs are not appropriate. Provide where air flow coverage is from 35-600 Ff/Mn.
   f. The remote test switch, on all duct type detectors when the device’s alarm LED is not clearly visible from the floor or the device is mounted higher than 9 A.F.F.
   g. The Manual stations, addressable single-action type, red LEXAN.
with molded, raised-letter operating instructions of contrasting color. Station will
mechanically latch upon operation and remain so until manually reset by opening
with a key common with the control units.
h. Provide a weatherproof enclosure or box for roof mounted or outdoor mounted
devices.
i. Show on plans where devices are to be provided.

8. Audio and Visual Alarm System
   a. Amplifier modules shall be 8 channel digital type and electrically supervised
      such that a loss or reduction of signal shall result in an audible and visual
      trouble indication. Each amplifier shall use on board audio
      NAC’s. Amplifiers shall provide 35, 50 or 100 watts of output. Provide 25
      or 70.7 VRMS amplifiers. No adjustment or calibration controls shall be accessible.
      A trouble signal shall indicate which amplifier or speaker circuit is in a trouble
      condition. Provide sufficient amplifiers to perform functions required, plus 10
      percent spare capacity.
b. Audio equipment trouble: Yellow LED’s shall light when a trouble condition
      exists. Appropriate LED’s to indicate the nature of the trouble shall light as
      follows:
      1) Fire tone
      2) Pre-Amplifier
      3) Amplifier
c. The fire alarm evacuation alarm shall be a slow whoop, produced by a solid
      state tone generator arranged in duplicate so that failure of the primary tone
      generator shall result in a trouble signal and automatic switchover to the
      backup tone generator. Provide a 400Hz primary tone in areas designated for
      experimental animals.
d. Preamplifiers shall be solid state and arranged in duplicate so that failure of the
      primary unit results in a trouble signal and automatic switchover to the backup
      unit.
e. System power supplies and remote power supplies shall be provided in
      sufficient quantities to provide power for all audio/visual components plus any
      spare capacity requirements listed elsewhere in the specification.
f. Visual devices, Audio/visual devices and visual devices on alarm speakers
      shall operate from an addressable indicating circuit connected or controlled by
      the main fire alarm panel. All the visual devices shall be synchronized. The word
      FIRE shall appear on the lens assembly. Visual devices shall be coordinated
      for wall or ceiling mount. Provide sufficient visual coverage to meet the current
      requirements of ADA and NFPA 72.
g. Audio devices: The horns, bells and/or speakers provided shall have a
      minimum sound level of 75db at ten feet. The audible devices shall be
      silenced at the panel without resetting the visual devices. Horns shall operate
      on the same pair of conductors as the visual devices. Provide sufficient audio
      coverage to meet the requirements of ADA and NFPA 72.
h. Show on plans where devices are to be provided.

9. DACT shall be either built-in Simplex unit or Digital Security Controls, model
   PC4020CF. Coordinate with telecom provider to install two
   lines. Coordinate with University to activate phone lines.

D. Acceptance Testing

1. When the fire alarm system is being made ready for operation, the University's
Representative shall be notified. Fire alarm system instruction manuals shall be submitted at least one month in advance of initiation of the system. A walk-thru of the system shall be scheduled with the SFM or DCFM and Facilities Services Administration to acquaint parties with the installation and operation of the system.

2. At least one week before occupancy of the building, a fire alarm test will be scheduled with the SFM or DCFM and Facilities Services Administration or any persons designated by the SFM or DCFM, such as the State Fire Marshal, for a complete functional test of the system.

3. After the system has been tested and accepted and placed in operation, the University will assume responsibility of the system as far as future testing and responding to alarms is concerned. First year warranty problems shall remain the responsibility of the contractor.

END OF SECTION 28

1.3 APPENDIX

A. Hirsch Electronics Product Data Sheet (DIGI*TRAC Model 8 Controller)

B. IDENTIV uTrust TS Readers (Mullion, Wall Mount and Keypad)

C. IDENTIV Alarm Line Modules Data Sheet

D. Card Access Specifications

E. Architectural Detail-Electric Door Opener-Card Reader
SECTIONS 29-30

Reserved for future expansion
DIVISION 31 - SITE WORK

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1.1 GENERAL
A. Site design on the UC Riverside campus is subject to review by the Design Review Board (DRB) and UC Riverside Planning, Design and Construction (PD&C) staff prior to final approval. This process will be coordinated through the University Representative.

B. Basic principles of site design have been set by the campus to alleviate future problems in maintenance and appearance. Emphasis is put on low-maintenance, highly durable designs that provide an aesthetic quality consistent with the University's Long Range Development Plan (LRDP) and quad master plans.

C. LEED-NC credit SS 7.1 heat island effect is required for projects on campus. A minimum of 50% of the hardscape of the project site shall be covered within tree canopy (based on canopy sized at five years’ normal growth) and/or shall be paved with light colored (high-albedo) materials with a Solar Reflectance Index (SRI) of at least 29.

D. Handrails for site stairs are to be steel, either hot-dipped galvanized or stainless. Handrails and guardrail design shall meet applicable code requirements. Provide a handrail design that limits skateboard use. The University has a typical detail that DSA has approved as accessible compliant.

E. Erosion control requirements may be defined in the Project Planning Guide (PPG) and the Environmental Impact Report (EIR). Work shall comply with the requirements of the State Water Quality Control Board and Storm Water Pollution Prevention Plan (SWPPP).

F. Large transformers, backflow preventers, meters, standpipes and other unsightly service elements shall be located out of view from plazas, walkways and main building entrances.

1.2 DRAWINGS AND COORDINATION

A. Projects on the campus do not typically have clearly identified property lines or boundaries. Most buildings are constructed in areas that are currently being utilized as parking lots, pedestrian areas, etc., and may be adjacent to a variety of existing facilities. Project sites may have within their boundaries existing utilities, landscape, or hardscape.

B. Boundary lines shall be established for each project to determine the impact of the work on existing improvements. These boundary lines may be different than the assumed property lines used for building code analysis. The University shall approve the location of these boundaries.

C. The project design drawings shall identify and address areas both within the boundaries and beyond them, such as:

1. Service vehicle access
2. Pedestrian access
3. Existing irrigation systems
4. Existing landscape
5. Fire protection
6. Emergency vehicle access

7. Disabled persons access

8. Identify these areas on the site plans as they exist, and clearly define the work required to address them during construction, as well as their final locations at the completion of the project. The intent is to minimize the disruption during construction, and to have a completed project that blends seamlessly into the campus without any "no man's land" of unfinished work at the project's perimeter.

D. Site drawings for each trade shall be drawn to the same scale, unless plan is an enlargement.

E. Landscape and Irrigation:

1. Review the work area with the University to determine the impact of construction to the existing irrigation system.

2. Identify the location of existing valves, and define the work required to maintain functioning irrigation systems outside the construction site.

3. Temporary irrigation may need to be installed; these requirements shall be clearly defined on the drawings.

4. Verify that existing landscape areas to remain can be accessed for maintenance during construction.

5. Identify trees that are to remain. Provide for protection of trees, including root systems.

6. Provide a mowing edge strip at trees and around perimeter of the building.

F. Fire Department Service

1. Identify existing fire hydrants, Fire Department connections, and Fire Department access to existing surrounding buildings.

2. Maintain fire protection during construction and provide temporary relocation if necessary.

3. Fire hydrants serving existing buildings must be maintained in service at all times.

4. Review changes to Fire Department access with the University's Representative and DCFM.

G. Clearly identify the intent for existing items on site. Designate items as:

1. Remove from site and dispose.

2. Remove and deliver to University.
3. Protect in place.

4. Remove and store on-site for reuse.

5. Items are not to be abandoned.

H. Bollards or service gates shall be installed wherever the need exists to prevent unauthorized vehicle access. Bollards for fire lane access shall be PVC breakaway style per University’s standard details.

I. Site Demolition plans shall show demolition, protection, and repair of existing utilities. New site plans shall not show items demolished or removed from the site, even if shaded.

1.3 PLAZA DESIGN

A. Outdoor plaza spaces shall be oriented to provide convenient and pleasing outdoor spaces while enhancing a building setting and exterior design. They shall be designed to an appropriate scale with the surrounding buildings and pedestrian circulation, and not be over scaled. Outdoor spaces are used to foster intellectual and casual interaction, focus on a particular design feature, and create a sense of intimacy. These spaces shall be strategically located at or near intersections of pedestrian movement to maximize their effect and usage.

B. Plaza spaces shall be well defined by means of either hard edge boundary elements or buildings. At least 50% of the space shall be enclosed by a boundary element, which could include buildings, retaining walls, planter walls, or seating areas.

C. Vertical surfaces shall either be rough surfaced, or coated with anti-graffiti coating. Walk surfaces shall be concrete with exposed aggregate finish, or brick pavers. Concrete surfaces shall be scored and saw cut in a pattern which will control cracking.

1.4 PEDESTRIAN CIRCULATION

A. Pedestrian walkways (including plazas) shall be concrete or masonry. Layout of pedestrian walkways shall be well thought out for pedestrian circulation, and provide the shortest possible route between destination and building access points. If a perceived path is 10% less than a planned route, people tend to use their own path rather than the planned path.

B. Pedestrian circulation shall be routed away from vehicular traffic as much as feasible. Pedestrian pathways shall not occur near dumpsters, trash areas, loading docks or service areas.

1.5 SITE LIGHTING

A. Refer to Section 26 for required foot-candle levels and fixture types.

B. Coordinate the location of light fixtures with existing and proposed trees. Consider the ultimate height and canopy of the trees.

C. The design of safe pedestrian walkways shall address both lighting and landscape. Avoid dense bushes or other plantings along pedestrian paths.

1.6 SERVICE AREAS AND LOADING DOCKS
A. Service access to a building shall be easily recognizable and accessible, while providing a visual separation from normal staff and student pedestrian circulation. Loading docks shall be provided for major buildings, complete with dock railings, levelers and bumpers. Turn-around for delivery trucks shall accommodate at least a 30’ truck with a trailer. Overhanging elements shall allow 13'-6” clear minimum above finished surface unless a lower limit is approved in advance by the University.

B. Service areas shall be well lit and have loading zones for smaller deliveries and service vehicles. Concrete filled metal bollards shall be provided around any building or service elements, which could be damaged by a vehicle. In service areas, provide a recessed stainless steel box for a telephone and phone book to allow outside vendors to contact the building manager.

C. Trash containers or compactors shall be isolated, yet near the loading dock area. The size and type shall reflect the need of the building. The containers shall be at the loading dock level (36” ± below finish floor) to facilitate dumping of trash by maintenance personnel and minimize the need to lift trash over the container edge. Refer to Section 11.

1.7 SITE RETAINING WALLS

A. Retaining walls shall have waterproofing and adequate drainage to prevent additional loading. Provide a gravel and water removal system at the backside, and foundation drains at the base. Drains may be tied into the storm drain or daylighted at an appropriate location. Retaining walls more than 2'-6” in height from top to finished grade are required to have a 3'-6” high guardrail (measured on the high slope side from finished grade) or other approved protective measure. Provide guardrails anywhere on site for any retaining wall to prevent falling accidents.

B. Provide retaining walls for backflow preventers, water meters, electrical manhole vault covers, etc. to provide a flat grade around these and similar devices that require maintenance or access.

1.8 SITE PREPARATION

A. General

1. Identify existing utilities that must remain active during construction. Provide temporary routing of utilities if necessary to accommodate construction activities without limiting service to existing facilities.

2. The utility company shall be the only one to do the work on utility company’s lines or service on campus property, unless otherwise directed by them.

B. Existing Utilities

1. Identify, document, and flag locations of known above-and below-grade utilities, structures, planting and trees, etc. Identify existing utilities and trees, etc. that are to be protected and remain in place during demolition and construction operations. Maintain horizontal and vertical dimensions from fixed points for future referencing. Existing underground utilities in areas of work shall be located by potholing. Potholing is critical on the University’s congested campus and is required to establish critical elevations, especially with gravity lines such as storm or sanitary sewer. Potholing shall include points of connection, utilities near footings or being crossed and utilities being
relocated.

2. Remove and dispose of existing underground utilities that are no longer needed. Piping is not to be abandoned.

3. Coordinate with utility companies or University’s Representative for shutoff if lines are active.

C. Soil Removal

1. Any and all soil to be removed from the project site shall be done in accordance with the approved grading plans and accompanying Geotechnical report for the site. Additionally, all BMP’s shall be in place and all proper safeguards put in place as required by the SWPPP, Geotechnical Report, Civil Engineers requirements and all other project reference documents.

2. All excavations created by soil removal from the site, shall be protected by proper approved shoring and all other safeguards in accordance with the Engineer of Record approved plans and specifications.

3. All existing utilities shall be clearly marked on the ground by the appropriate agency/organization prior to any soil removal taking place.

4. Contaminated soil shall be treated and/or disposed of in accordance with the requirements of the pertinent responsible agency.

5. All removal of soil shall be done in accordance with all regulatory compliance guidelines and under the responsibility and oversight of the University Representative responsible for the project.

1.9 EARTHWORK

A. General

1. Grading plans shall be designed for a balanced site. If site cannot be balanced then plan for removal of excess soils from University property.

2. Identify the quantity of soil to be imported and/or exported, based upon interpretation of the Geotechnical Report specifically prepared for the project or the Grading Plan.

3. At times, the University may have locations on campus available to stockpile excess soil, or borrow sites for soil import. Coordinate with University the availability.

B. Excavation

1. Site demolition includes excavation of pavements and other obstruction visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; earth and other materials encountered that are not classified as rock or unauthorized excavation. Verify the definition of “rock”, with the Geotechnical Report. Rock should be identified and acknowledged prior to excavation or removal. The process is as follows:

   a. Identify and have a written interpretation from the University.
b. Survey the rock prior to disturbing.
c. Remove the rock as required.
d. Re-survey the site.
e. The difference identified is the cubic yards of rock removed that the University may be responsible for.

C. Erosion Control

1. Protect existing storm drainage structures and pipelines from infiltration of silt and debris.

2. Erosion control shall be monitored in accordance with the guidelines set by the State Water Quality Control Board.

3. Provide Erosion Control Plan, mitigation measures and monitoring as required by the project EIR and LRDP measures.

1.10 EXCAVATION AND FILL

A. General

1. Conform to the Geotechnical Report prepared specifically for the project. Geotechnical Report recommendations shall take precedence over these standards where it is more restrictive.

2. Single sack slurry may be used in lieu of compacted fill around piping and conduits.

B. Soil Treatment

1. Termite soil treatment shall be provided for wood framed construction projects, using EPA certified and approved chemical treatments. Chemical applications are also subject to the approval of the UCR Office of Environmental Health and Safety.

2. Provide herbicide treatment of soil below asphalt concrete paving, concrete flatwork, at open soil areas, and areas covered with decomposed granite is required using EPA certified and approved chemicals.

3. Chemicals shall not be harmful to the roots of adjacent plants (non-leaching).

4. In alteration/addition work where no warranty is available, certification of treatment and application rate of chemicals shall be provided.

END OF SECTION
1.1 SUMMARY

1.2 REFERENCES:

1.3 SUBMITTALS

1.4 QUALITY ASSURANCE

1.5 SUSTAINABLE DESIGN REQUIREMENTS

2.1 MATERIALS

3.1 EXAMINATION

3.2 ASPHALT CONCRETE PAVEMENT

3.3 TOLERANCES

ADD: PORCHES AND STEPS

A. All stoops, porches, ramps, docks and steps, exterior and interior should have non-slip surfaces and nosing’s where applicable. Slope exterior porches and treads to drain water in accordance with the current editions of the California Disabled Access Guidelines (CALDAG) requirements and the Americans with Disabilities Act (ADA). Ponding of water in these areas is unacceptable. Exposed concrete finished work shall be accomplished in two pours: the first structural and the second being a two inch minimum finish topping poured near completion of project. Primary entry floors may not be constructed using brick or pavers since these surfaces are excessively noisy when carts are rolled across them.

ADD: MOW STRIPS

A. Include a 2’ wide x 4” thick continuous reinforced concrete mow strips around the building in grassed areas which will require mowing. The mow strip shall be doweled to the building foundation at all door locations. At all other locations the mow strip shall not be doweled to the building foundation unless approved otherwise by the System Civil Engineer.

B. Include a mow strips along and doweled to the back of curb in grassed areas adjoining head in parking areas which are subject to car bumper overhang. Mow strip to be sloped in the direction of drainage. Jointing shall be provided to match that in the adjoining curb.
PART 2 - GENERAL

2.1 SUMMARY

A. Section Includes:
   1. This section specifies preparation of the project site asphalt paving, including asphalt berm.

B. Related Requirements:
   1. Provisions of Division 01 apply to this section.
   2. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.
   3. Section 32 13 13 CONCRETE PAVING.
   4. Section 32 17 23 PAVEMENT MARKINGS.
   5. Completely coordinate with work of other trades.

2.2 REFERENCES:

A. Standard Specifications for Public Works Construction (SSPWC), 2015 edition, and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship, measurement and payment sections of the SSPWC do not apply to this document.

2.3 SUBMITTALS

A. Product data for materials and products.
B. Mix Design.
C. Aggregate Test Report.
D. Compaction Test Report.

2.4 QUALITY ASSURANCE

A. Where a particular type of material or method is specified, no other type of material or method will be permitted, except as described in Section 00 26 00, but balance of Specifications shall apply.
B. Field inspection and testing will be performed under provisions of Section 01 45 23.

2.5 SUSTAINABLE DESIGN REQUIREMENTS

A. Local/Regional Materials:
   Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available. Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site.

PART 3 - PRODUCTS

3.1 MATERIALS

A. Materials shall conform to relevant provisions of Section 203 - Bituminous Materials of the SSPWC.
B. Cement Stabilized Pulverized Base (CSPB) materials shall conform to Section 301-3.4.2 of the SSPWC.
PART 4 - EXECUTION

4.1 EXAMINATION
   A. Verify compacted subgrade is dry and ready to support paving and imposed loads.
   B. Verify surface is clean, dry, and within acceptable temperature range.

4.2 ASPHALT CONCRETE PAVEMENT
   A. Perform all placement of asphalt concrete pavement as defined in Section 302-5 of the SSPWC.
   B. Place paving course at least 12 hours after application of primer.
   C. Place paving course to compacted thickness shown.
   D. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
   E. Roll with consecutive passes to achieve even and smooth finish, without roller marks. Avoid excessive rolling.

4.3 TOLERANCES
   A. Flatness: Maximum variation of 1/8 inch measured with 10 foot straight edge.
   B. Compacted Scheduled Thickness: Within 1/4 inch of design thickness.
   C. Variation from True Line and/or Elevation: Within 1/8 inch measured with a 10 foot straight edge.

END OF SECTION
DIVISION 33 - SITE UTILITIES

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1.1 WATER DISTRIBUTION

A. Description

1. The University owns, with very few exceptions, the water distribution piping on campus for domestic, fire suppression (including fire hydrants), and reclaimed systems. The University's water main system is large, complex and is generally under the care, custody, and control of Facilities Services Administration. Facilities Services Administration acts as the University's water department and has an obligation to protect the supply from contamination and to ensure that it is available for use as the source of fire protection for the campus community. There are no conceivable circumstances where it would be appropriate for anyone to connect to the system without a complete review by and the approval by the Facilities Management Department. As a minimum, strict adherence to these standards is required.

2. The University complies with the Riverside Public Utilities (RPU) "Procedural Guidelines and General Design Requirements" and "Construction Manual" for the design and construction of water and reclaimed water facilities on campus except as modified in this design criteria. When using the RPU documents, references to the District's Representative shall mean the University's Representative. The Campus Building Official, in coordination with Facilities Services Administration-Plumbing Shop will provide plan review and inspection.

3. Domestic water piping on campus property is downstream of RPU meters and cross connection devices. The campus domestic potable water system is served from multiple meters and divided into different pressure zones. Pressure may vary from 140 to 70 psig depending on the location on campus. Confirm pressure available for each construction site.

4. Any reclaimed water system on campus is downstream of RPU meters. Connections to the reclaimed water system do not require cross connection devices, as it is a non-potable water system. See Section 32 “Site Exterior Improvements”, Irrigation System section for design criteria.

5. RPU water meters are not required for projects on University property provided that the connection is downstream of RPU's existing meters. Housing water meters can be located outside above ground to serve a group of buildings. Commercial buildings on campus shall be furnished with water meters located inside the mechanical room unless otherwise directed.

B. Submittals

1. The only submittal to RPU is for any connection or modification to the RPU owned portion of the reclaimed water system. In this case, drawings showing the landscape system and connection to the reclaimed water system shall be submitted to RPU reclaimed water department for their review. For other projects on campus using reclaimed water, plans showing reclaimed water modifications and installations are to be sent to RPU for their information only. Plans are for RPU's use in reporting use of reclaimed water.
2. Fire hydrant locations are to be approved by the State Fire Marshal (SFM) or the UCR Lead Designated Campus Fire Marshal (DCFM). Plans shall be submitted with hydrant locations. Any meetings with the DCFM shall be as determined by the University’s Representative.

C. Design

1. Residential design flows shall be based on a demand of 130 gallons per capita per day. Design flows for other buildings on campus shall be calculated based on estimated water demands for the proposed project unless otherwise directed. The design requirements used to determine fire flow requirements will be determined based on actual hydrant flow tests. See Section 21 “Fire Suppression”, for additional requirements.

2. Pipe sizes for site utilities shall be based on Campus Master Plan for future construction. Branches for buildings shall be based on hydraulic calculations or other approved engineering methods. A minimum 8-inch water service shall serve a fire-suppression main. The minimum size for a fire main to a building larger than 5000 square feet shall be 6-inches except for research facilities shall be 8-inch. The fire main shall connect separately to water main in the street or underground main of adequate size and shall not be combined with domestic potable water service to the building unless approved by the Lead DCFM.

3. Where water lines are run in new streets or service roads, locate the centerline six feet from the face of the curb.

4. The plans shall show, in plan and profile views, the position of other known existing underground utilities as well as proposed underground utilities. Vertical clearance at crossings shall be indicated by showing top of pipe and bottom of pipe elevations at the point of intersection.

5. The number of fire hydrants to be provided shall be accordance with the California Fire Code. Fire hydrant placement is generally stated here.

a. Fire hydrants along streets shall be spaced a maximum of 300 linear feet and a minimum of 40 feet away from any structure.

b. Placement of fire hydrants to protect structures shall be located a minimum of 40 feet from any building with the exception of detached one- and two-family dwellings. The maximum distance from the nearest fire hydrant to any/all points of the exterior of a structure shall not exceed 150 feet for commercial and industrial occupancies or residential occupancies other than detached one- and two family dwellings (R-1’s) shall not exceed 250 feet.

c. The final location approval is a coordinated effort between the University Representative and the UCR Lead DCFM.

d. Fire hydrant requirements on campus include:

1) Provide the number of hydrants required by CFC.
2) Locate a minimum of 40 feet away from any structure, if possible.
3) Maximum distance to any/all points of the exterior of a structure shall not exceed 150 feet except for detached one- and two-family dwellings (R-1).
4) A gate valve shall be placed no closer than six feet or more than ten feet on the fire hydrant lateral and shall not be located beneath a parking place or in a location that would prevent access to the valve. This valve shall be in addition to the branch valve (usually hot-tapped) from the water main.
5) Provide protection from vehicle damage.
6) Six inch diameter pipe is required, except for hydrants over 20'-0" from main or fire hydrants on the end of a pipe run, which shall be 8 inch diameter pipe lateral.

7) Maximum distance of 40 feet from fire department connection.

8) Hydrants and fire department connections (FDC's) shall be located so that a hose line running between the hydrant and the FDC does not cross driveways, obstruct roads or fire lanes, or otherwise interfere with emergency vehicle response and evacuations of a site.

6. Renovation or remodel projects involving existing landscape systems that are presently connected to the potable water system shall be modified to connect to reclaimed water system.

7. Piping systems which must cross over or under High Temperature Water (HTW) lines shall be protected with rigid conduit, ductile iron pipe, etc., and shall have adequate clearance and/or insulation to prevent damage to pipe or contents from elevated temperatures expected at the crossing. Routing of piping a longer distance is preferred to minimize crossing the HTW pipes.

8. Service valves shall be provided as follows:

   a. **Domestic water line valves** are to be located at the connection and fully accessible via curb boxes with a triangular iron lid for domestic potable water.

   b. **Fire hydrant** shut-off valves and reclaimed water valves shall have a triangular iron lid. Valve boxes and valves lids shall be labeled as shown on the campus standard details.

   c. **Water service piping connections** to existing mains and branch mains shall include tapping sleeves and service valves.

   d. The majority of the **older water mains** on campus are Asbestos Cement Pipe (Transite, ACP). Connections to ACP are to be made by the use of specially designed fittings called Mechanical Joint Tapping Sleeves. JCM Industries model JCM 414 Fabricated Mechanical Joint Tapping Sleeve shall be the basis of design. The design shall direct the contractor to pothole and ascertain the exact size of the piping prior to ordering the specialty fitting. It is not possible to order the fitting without measuring the pipe. **There are no conceivable circumstances where a connection to an existing ACP main can be made without the use of a mechanical joint tapping sleeve. In the rare circumstance that the connection will be made to an existing polyvinyl chloride (PVC) or ductile iron (DI) main, a mechanical joint tapping sleeve is still the safest means to make the connection and the one least likely to result in an expensive utility failure.**

9. Water meters, pressure reducing stations, fire department connections, or backflow cross connection devices, when provided, shall be located above grade. Location shall be such that these materials are not an unsightly hazard. Coordinate with landscape materials to provide plants to screen these above ground materials without blocking City of Riverside Fire Department ability to locate the same devices.

10. **Valve Arrangements**

   a. There shall be two control valves at each tee intersection of two distribution mains. If the two distribution mains cross, there shall be three (3) valves and, at major distribution points, there shall be four (4) valves.

   b. On long pipe runs, intermediate valves shall be installed so that no more than twenty-eight (28) dwelling units, six hundred (600) feet of main, or five (5) fire hydrants will be out of service at any time. Additional looping of main lines may be necessary to satisfy this condition and the arrangement of valves within the distribution system will be reviewed to identify the optimum network layout.

   c. Provide shut-off valves to allow phasing of construction and keep shutdowns to a minimum.
11. **Horizontal Separation:** State Health Department regulations require a 10-foot minimum horizontal separation between potable water from reclaimed water, fire mains (piping downstream of cross connection device) and sewer lines. Separation other than the State Health Department minimums must be approved.

12. **Vertical Separation:** Water, sewer, and reclaimed water lines are typically located vertically from the street surface down in order of decreasing quality. Water will be the shallowest and sewer mains will be the deepest. Concrete encasement may be required if the clearances indicated cannot be achieved. Details of approved encasement installations shall be provided to the University Representative on a case by case basis and the length of encasement shall be sufficient to extend a minimum of ten (10) feet on either side of the crossing to provide the required horizontal separation.

13. Continuous steel casing of either a water line or a sewer line will also be allowed on a case by case basis. The length of casing shall be governed by the same criteria as the length of encasement above.

14. Pressure reducing stations are required within every building on campus, even if residual pressure is below 80 psi. Pressure reducing station shall only be provided in site piping when directed by the University’s Representative.

D. Building potable water service installation details shall provide a shut-off valve with valve box at grade near connection to water main.

E. Fire hydrants on campus are considered “public/commercial” type and shall have two-2½” outlets and one-4” outlet/supply connection. Paint hydrants with at least two coats of safety yellow over at least one coat of primer. Hydrants at group housing projects will be considered “public/commercial” also.

F. Fire hydrants shall be all bronze construction.

G. Cross connection devices on campus are required in the connection piping of the fire protection main for sprinkler fire suppression or standpipe systems. Double check backflow assembly shall be installed above grade only. Siamese fire department connection preferred location is at the detector check backflow assembly. Provide a check valve in the pipe to the fire department connection. By-pass meter shall read in cubic feet.

1. Double check backflow assembly acceptable manufacturers shall be as listed in Campus Master Specification, “Domestic Water Piping.” Assembly shall be complete with two OS&Y valves, fusion epoxy coated and listed for fire suppression service.

2. Check valve shall be UL listed for fire suppression service.

3. OS&Y valves shall have break locks or locks that are specified by the DCFM. Two sets of keys shall be given to the University’s Representative prior to Substantial Completion.

H. No metal materials shall be placed underground without protection to isolate metal from contact with the soil.

I. Thrusts blocks shall be per Campus Standard Detail Drawings or as a contractor option; mechanical joint restraint may be used for ductile iron pipe and PVC pipe. Where pipes are capped for future extension, use mechanical joint in lieu of concrete thrust block.

J. Landscape water systems shall only be connected to existing reclaimed water systems and not potable domestic water mains.

K. Ductile iron or copper pipe shall be installed within 5’ of the building and under all footings and slabs. Vertical piping and pipes above grade shall be ductile iron or copper.

L. Minimum cover of water piping shall be:
<table>
<thead>
<tr>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains in paved areas</td>
<td>42 inches</td>
</tr>
<tr>
<td>Mains in unpaved areas</td>
<td>48 inches</td>
</tr>
<tr>
<td>Laterals to fire hydrants</td>
<td>48 inches</td>
</tr>
<tr>
<td>Laterals 4 inches and smaller to buildings</td>
<td>30 inches</td>
</tr>
<tr>
<td>Laterals 6 inches and larger to buildings</td>
<td>36 inches</td>
</tr>
</tbody>
</table>

M. Hydrants generally shall be a minimum of 40 ft. from the structure. This is not always possible as the campus continues to construct buildings only 40 feet apart. Exception to the 40-foot minimum has been acceptable to the DCFM on past projects.

N. Provide blue reflective “Botts” dot in street to indicate fire hydrant location.

O. Curbs shall be inscribed with “W” indicating locations of domestic water services.

P. Temporary blow-off assemblies shall be installed at the end of all mains and large service stub-outs for testing and flushing purpose.

Q. Air and vacuum relief valves shall be installed at all high points of water mains 10-inches and larger.

R. Water mains to be constructed in landscape slopes shall be constructed with ductile iron pipe (DIP), Class 50, and shall have slope anchors in accordance with RPU Standard Drawing S-11. Thrust blocks will also be required at the angle points at both top and bottom of the slope.

S. Maintain minimum 10 foot separation between PVC piping and High Temperature Water (HTW) supply and return piping.

1.2 SANITARY SEWERAGE

A. Sanitary sewers shall connect to University owned piping system under campus streets or on campus property. The University’s sewer system extends off campus and connects to Riverside Public Utilities (RPU) system. Designs shall comply with these standards and details. In those cases where such standards and details do not exist, comply with the RPU “Procedural Guidelines and General Design Requirements” and “Construction Manual” except as modified in this Design Criteria. References to “District's Representative” shall be changed to “University's Representative”.

B. New buildings shall not be built over any existing sanitary sewer piping.

C. The University will not accept sewer mains smaller than 6-inches in diameter. Sewer mains shall not be constructed in a common trench with any other utility. Adequate horizontal and vertical spacing shall be maintained in accordance with Campus Standard Detail 33-W-14.

D. Minimum and Maximum Slope:

1. Sewer mains shall be designed and constructed to provide a mean velocity of not less than two (2) feet per second (fps) when flowing half-full at the estimated peak flow as calculated using Manning’s formula with an “n” value of 0.013. The maximum allowable slope shall be the slope that generates a maximum flow velocity of 8 fps at the peak flow rate as calculated using Manning’s equation and an “n” value of 0.013. Peaking factors shall be per RPU Figure 1.

2. Minimum design of slopes by pipe size:

<table>
<thead>
<tr>
<th>SEWER SIZE</th>
<th>SLOPE AT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.0100</td>
</tr>
</tbody>
</table>
2. These are minimum design slopes. Sewers should be designed to provide steeper slopes whenever possible up to the stated maximum slope. Under special conditions, the Engineer may request slopes of less than the minimums stated. The Engineer must submit this request along with back-up data and calculations to show that the depth of flow at design average flow will be 0.3 of the pipe diameter or greater. The Engineer must also submit computations to show the depths of flow at minimum and average rates of flow. The request shall also detail the reasons why the normal minimum slopes cannot be achieved. The University’s Representative shall review the request and supporting data and convey back to the Engineer the design slope to be used.

E. Flow Design Criteria

1. The flow rate for residential sewer mains shall be calculated using a base generation rate of 130 gallons per capita per day (gpcpd) and the density and peaking factors per RPU criteria. Calculate commercial/industrial flow design criteria based on projected generation rates for the specific project.

2. The design peak flow rate in pipes 12-inches and smaller will be limited by the depth ratio of \( d/D = 0.5 \); 15” pipes \( d/D = 0.67 \) and 18-inches and larger \( d/D = 0.75 \), where \( d/D \) is the ratio of calculated flow depth to pipe inside diameter.

F. Standard Location and Alignment

1. New sanitary sewer mains that will be under a street are to be located six (6) feet from the centerline of the street in the center of the driving lane. Streets with center median strip shall have the sewer mains located in the center of the driving lane nearest to the center of the street, but shall not be located in the median strip or parking lanes.

2. On curved streets and service roads, sewer mains shall be parallel with the centerline of the street by use of horizontal curves for the alignment.

3. A maximum horizontal separation between sewer and domestic water mains shall be achieved by aligning the sewer on the opposite side of the centerline from the domestic water main.

4. The following minimum radii will be used in the design of horizontal curves:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>6”</th>
<th>8”</th>
<th>10”</th>
<th>12”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min R</td>
<td>210’</td>
<td>280’</td>
<td>350’</td>
<td>420’</td>
</tr>
</tbody>
</table>

G. Stationing Procedure: Centerline stations for sewer mains shall be shown and will be independent of street stationing. Manholes are to be numbered and the numbers noted on the plans (example: MH #1). Sewer start shall be 00+00.00 at the downstream point of connection and increases upstream to the last manhole on a sewer line. Intersecting sewer lines will be independently stationed from their downstream point of connection and increase upstream to the last manhole or clean out. Each line shall be independently labeled for identification as “Sewer Line A”, “Sewer Line B”, etc.

H. Minimum Depth: Minimum depth of cover from finish street grade to the top of sewer main pipe shall be seven (7) feet unless otherwise approved by the University. Minimum depth of cover at point of connection to building shall be 24” and shall slope at minimum of
2% or ¼" per foot.

I. Minimum Depth of cover for sewer service lateral shall be:

<table>
<thead>
<tr>
<th>PIPE</th>
<th>GRASS AREA &amp; UNDER WALKWAY</th>
<th>UNDER ACCESS ROAD &amp; FIRE TRUCK ACCESS ROAD</th>
<th>STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>24”</td>
<td>36”</td>
<td>48”</td>
</tr>
<tr>
<td>CAST IRON</td>
<td>18”</td>
<td>30”</td>
<td>42”</td>
</tr>
</tbody>
</table>

J. A manhole will be required at:

1. The end of each line, change in grade or size, change in alignment, or intersection of two or more mains.
2. Along the main at maximum distances 300 feet.

K. Manhole Type and Size

1. Manholes shall be precast reinforced concrete with eccentric cone. Minimum diameter shall be 48-inches and larger sizes may be required as shown in the following table:

<table>
<thead>
<tr>
<th>MANHOLE SIZES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEWER MAIN (INCHES)</td>
</tr>
<tr>
<td>8-15”</td>
</tr>
<tr>
<td>18-24”</td>
</tr>
<tr>
<td>24-36”</td>
</tr>
</tbody>
</table>

L. Clean-Outs:

1. Use of clean-outs shall be limited to the following instances unless approved by the University.
   a. Short sections of sewer main, less than 250 feet, which will be extended in the future.
   b. At the end of a sewer main where the distance to the next downstream manhole is not more than 300 feet.
   c. Commercial and industrial-type building’s sewer lateral installations at the assumed property line.
   d. Between manholes, if there is a reverse curve in the sewer main, to facilitate cleaning of the main line.
   e. Special instances such as on a sewer lateral where the dwelling unit is set back more than 100-feet from the assumed property line, or where there is a large slope up to the building pad from the property line, and a grade change
in the lateral is necessary.

f. On a lateral where the overflow level of the lowest wastewater fixture in the building is below the rim elevation of the uphill sewer manhole on the main line. In this situation, the rim elevation of the clean-out installed at the assumed property line shall be at least 6-inches below the overflow elevation of the lowest wastewater fixture on the lateral.

g. A two-way cleanout per Campus Standard Detail Drawing 33-S-9 shall be installed in the sewer line outside and immediately adjacent to each exit from a building.

h. Provide pipe extension to grade with ferrule and countersunk clean out plug. Provide a triangular cast-iron access frame over clean-out, with heavy duty secured scoriated cover with lifting device.

M. Force Main Criteria: The size of sewer force mains shall be determined during the design phase of the project and only after a comparative study of the construction cost and pumping costs for several alternative sizes. In no case shall a force main be less than 6-inches in diameter. The capacity of the force main shall be the design peak flow from the pump station calculated from Manning’s equation using “n” = 0.013. The nominal design velocity for a force main shall be 3.0 fps, with minimum velocity of 2.0 fps, and maximum allowed 6.0 fps. The discharge shall be into a manhole with a smooth flow transition to a gravity sewer. The manhole shall be epoxy coated on the interior or PVC lined.

N. Separation Between Sewer and Water and Reclaimed Water Line: Horizontal and vertical separation between sewer mains and water and reclaimed water lines will be provided in accordance with Campus Standard Detail Drawing 33-W-14.

O. Sewer laterals shall be constructed from the main line and to each individual building. Sewer laterals shall have a minimum six (6)-inch diameter. Housing projects shall have at least one 6-inch lateral to serve each building in the project that contains more than one dwelling unit.

P. Maintain minimum 10 foot separation between PVC piping and High Temperature Water (HTW) supply and return piping.

1.3 CHILLED WATER DISTRIBUTION

A. Provide within a walkable concrete trench, extension of chilled water-piping system to new buildings and additions for building cooling. Piping, fittings, insulation, etc., for piping in the tunnel or trench shall be per the requirements within Section 23.

B. When directed by University, chilled water piping may be directly buried. Piping, fittings, insulation, etc., for direct burial piping shall be per the requirements of campus master specification.

C. Pipe sizing for branch to building shall be based on criteria in Section 23. Main piping that could be extended for future loads shall be based on size provided by the University.

D. CHW piping systems which cross over or under High Temperature Water (HTW) lines shall be protected with rigid conduit, ductile iron pipe, etc., and shall have 4’-0” clearance and/or insulation to prevent damage to pipe or contents from elevated temperatures expected at the crossing. Routing of piping a longer distance is preferred to minimize crossing the HTW pipes.

E. Soil at the UCR campus is very corrosive in some areas of the campus. Metallic piping, fittings and accessories are to be properly coated and encased in those locations. Follow soils reports conditions and recommendations for this requirements.
F. Install direct burial chilled water lines with a minimum 36-inch cover over the crown of the pipe.

G. Connections to Existing Chilled Water Mains
   1. The University’s preference is for connection to existing utilities using a hot tap and not shutting down the chilled water system. Coordinate with the University’s Representative the location of existing shut-off valves that could be used to isolate piping for connection to existing.
   2. If shutdown is required then request for approval and stating the maximum duration of shutdown. Coordinate the timing of connections to the existing mains to minimize interruption of services to the campus. File written notice at least 21 days in advance of the desired shutdown. In preparation for tie-ins to the utility systems, the University will close the appropriate valves to isolate the area of work and drain and/or blow out the existing piping prior to start of tie-in work.

1.4 HIGH TEMPERATURE WATER DISTRIBUTION (HTW)
   A. Provide within a walkable utility tunnel or concrete trench, extension of campus high temperature water (HTW) piping system to new buildings and additions for building heating, domestic water heating, and low pressure steam generation. Piping, fittings, insulation, etc., for piping in the tunnel or trench shall be per the requirements within Section 23 “HVAC”, HTW Design Criteria section.
   B. High temperature water piping shall never be directly buried. There are some existing HTW pipes direct buried on campus. These direct buried pipes have proven to be a constant source of leaks for the campus and shall never be repeated.

1.5 NATURAL GAS SYSTEM
   A. System Description
      1. When the gas distribution system connects to University’s existing gas piping system, the following applies to the distribution system. There are both University owned underground gas piping systems and Southern California Gas Company owned (a.k.a. “The Gas Company”) underground gas piping systems on campus property.
      2. The University requires that each building’s gas usage on campus be metered. This can be accomplished by either using The Gas Company’s meter or a University’s revenue sub meter.
      3. Medium pressure gas (5 psig and less) may be used inside buildings if needed due to load and pipe length. The preferred distribution is ½ psig or 14” water column inside buildings, with each equipment connection to have individual regulator. Coordinate with Section 22 Mechanical Engineer on pressure and regulator needed.
   B. System Distribution: Includes natural gas piping and appurtenances from point of connection with existing system to a point approximately six inches above grade at the buildings.
   C. Location of Gas Lines: Do not install gas piping in the same trench with wet utilities. The minimum horizontal clearance between gas pipe and parallel utility pipe shall be 2 feet. Do not install gas pipe through catch basins, vaults, manholes or similar underground structures.
   D. Maintain minimum 10 foot separation between PVC piping and High Temperature Water (HTW) supply and return piping.
1.6 SUBSURFACE DRAINAGE

A. Subsurface drainage shall be provided for every sub-grade wall and retaining walls on campus. Subsurface drains shall be minimum 4-inch pipe size and slope by natural grade to storm drain system if possible.

B. If gravity drainage is not possible, provide a sump pump and pit to pump drainage water into storm drain. Sump pumps shall be as in Section 22 “Plumbing”, Plumbing Pumps section.

1.7 STORM DRAINAGE

A. Site drainage is an important consideration to develop for a successful project. These general guidelines shall hold true:

1. Storm drainage shall be directed away from the building. If in the rare case this cannot be accomplished, redundant drainage systems are required.

2. There shall be no potential for ponding water that could flood into the building. The University has experienced problems with the ADA-compliant plaza drains plugging (since the holes are 3/8”) with wood chip wash off and other site debris. Areas shall drain away from buildings 6 feet minimum horizontally and shall daylight at a level at least 4 inches below the building’s finish floor elevation or to an alternate approved location.

3. Building entrances and exits shall be provided with storm water overflow protection such that, if site storm drains fail to function properly, a gravity surface outlet is available at an elevation no greater than six inches below the building finish floor elevation.

4. Sub-grade walls shall have a sub-surface foundation drainage system provided. The drainage system shall have minimum 4” diameter clean-outs at every change in direction, capped, concealed, and marked for future cleaning and maintenance.

B. Description:

1. Storm drainage system on the UCR campus shall drain through piping and open channels for final discharge into the Arroyo, which is a primary tributary to the upper Santa Ana River.

2. Underground storm drain systems shall be provided for:
   a. When flooding or street overflow will cause serious damage to University buildings or property, and to insure building protection for the 100-year storm.
   b. When future upstream development will cause drainage problems.
   c. When a minimum of one through street lane in each direction cannot be maintained above the theoretical design storm frequency.
   d. To eliminate the need for cross gutters.
   e. To eliminate nuisance water surface flow, maximum spacing between catch basins shall be 400 feet, except in residential areas spacing shall be 300 feet.

C. Design

1. Drainage design requirements shall be in accordance with the latest edition of the Riverside County Flood Control District Design Manual and City of Riverside Standard Plans.

2. Design calculations and flow maps for each contributory area shall be submitted with the plans.

3. Drainage systems shall be designed along with site grading to insure building pads are a minimum of one-foot above the elevation of the theoretical 100-year storm flow.
4. During design, consider storm runoff from areas surrounding the site, in addition to storm runoff from the project building and site. Prepare calculations to support design.

5. Storm drain systems must be designed with sufficient cover so that the water mains and service laterals can be built over the top of the storm drain mainline and laterals.

   a. Minimum depth of cover at the point of connection to building shall be 24”.
   b. Minimum depth of cover for storm drain service lateral shall be:

<table>
<thead>
<tr>
<th>PIPE</th>
<th>GRASS AREA &amp; UNDER WALKWAY</th>
<th>UNDER ACCESS ROAD &amp; FIRE TRUCK ACCESS ROAD</th>
<th>STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>24”</td>
<td>36”</td>
<td>48”</td>
</tr>
<tr>
<td>CAST IRON</td>
<td>18”</td>
<td>30”</td>
<td>42”</td>
</tr>
</tbody>
</table>

6. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as SO₄) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1,000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1,000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement pipe.

7. New buildings shall not be built over any existing storm drainage piping.

D. Hydrology

1. Criteria used for hydrology studies shall be as stated in the Riverside County Flood Control District Design Manual, current edition and the latest edition of the City of Riverside Standard Plans. The 25-year design frequency shall be used for sump conditions and storm drains downstream of sump conditions.

2. The hydrology map, grading and street plans shall agree as to the grades, drainage areas, etc.

3. Hydrology Map

   a. The hydrology map shall be on a topographic map of sufficient scale to show legible elevations, drainage patterns and quantities of runoff.
   b. The site must be shown on the hydrology map including on-site and off-site topography showing the entire tributary drainage area.
   c. Show Q’s (with time of concentration) flowing in the streets. Designate Q100, and Q25. If one side of a street carries more Q than the other side, show it.
   d. Show cross-over Q’s and where they occur.
   e. Show street flow confluences and their calculations.
   f. Show Q’s approaching entering, and carried over from catch basins.
   g. Identify catch basins by numbers or letters.
   h. Show and verify with legible contours or other adequate means, Q’s entering the project. If previous studies were used, reference them.
   i. Show Q’s leaving the project.
   j. Show north arrow and scale.
   k. Show names or some other designation for streets in and around the project.
   l. Show name and telephone number of the Engineer who performed the hydrology study.
   m. If the project contains more than one soil group (A, B, C or D), delineate each group.
   n. The drainage areas shall close and the acreage shall be shown. Areas should close at points of confluence and at pickup points.
   o. Off-site drainage areas must be shown with a reasonable analysis of
the interim and ultimate Q’s from those areas. Include the necessary supporting calculations or reference a previous acceptable study, which is either already on file or will be supplied with the submittal.

p. Initial areas should be limited to 10 acres with a maximum flow path of 330 feet.

q. Show Flood Hazard Zone designations, map panel number and effective date in accordance with Flood Insurance Rate Maps (FIRM) published by FEMA.

4. Hydrology Calculations

a. Software shall be AES or equal and previously approved for use by the University for Hydrology Calculations. Non-computer generated hydrology calculations must be in accordance with the Riverside County Hydrology Manual using Q25 for the calculations.

E. Hydraulics

1. Hydraulic Design Criteria shall be as stated in the Riverside County Flood Control District Design Manual, the Riverside County Environmental Management Agency Street Capacity and Inlet Design Aids and this Standard.

2. Grate type catch basins shall not be allowed on streets.

3. Parkway culverts are discouraged and shall not be used without approval from the University.

4. Plan Preparation

a. Storm Drains

1) Show the 100-year and 25-year hydraulic grade line plots, as appropriate, water surface elevations, top of curb elevation at catch basins, and include hydraulic elements: Q’s, Vn, slopes, pipe size, flow line elevations and pertinent stationing.

b. Catch Basins

1) Show sizes including L and H of opening and height of catch basin.

2) Show type.

F. Design Criteria

1. Pipes

a. D-loads shall be in conformance with the Riverside County Flood Control Manual.

b. A bedding detail is required for each type of pipe proposed. City of Riverside Standard Plan 318 may be used with Reinforced Concrete Pipe (RCP).

c. A minimum pipe size of 18” RCP or CIPP pipe shall be used for storm drains within streets or service roads.

d. Use of factor of n = 0.013 for RCP and cast-in-place pipe (CIPP).

e. Concrete collars shall be used as required in accordance with City of Riverside Standard Plan 310.

f. A minimum radius of 22½ feet shall be used for any horizontal bend.

g. Slope anchors shall be provided at each ten-foot change in elevation when the slope exceeds 33%.

h. Asbestos Cement Pipe (ACP) shall not be used. ACP has been installed on some past University projects.

i. Thick wall RCP with 1½” minimum cover inside shall be used when velocity exceeds 20 feet per second. Maximum velocity shall not exceed 45 feet per second.

j. Minimum slope can be 0.005 (0.5%) for pipe smaller than 36 inches and 0.001 (0.1%) for pipe 36 inches or larger.
k. CIPP may be used as an alternate. Accompanying soils report must confirm adaptability of soils to cast-in-place construction. Construction of the CIPP shall conform to the provisions of the ACI Standard 346 and Title No. 66-22. Trench to accept CIPP shall be dug in undisturbed soil, and continuous inspection by the University will be required. Prior to the acceptance of any CIPP storm drain, and in-place loading test may be required at the discretion of the University. Such test shall be in conformance with Section 9.4 of the above-referenced ACI Standard 346 and performed solely at the expense of the Contractor. If the storm drain is to become part of the Riverside County flood control system, written approval for CIPP will be required from the Riverside County Flood Control District prior to start of construction.

2. Open PCC Lined Channels:
   a. Are not allowed in the street right-of-way unless approved by the University.
   b. Structural calculations will be required.
   c. Structural details shall be shown on the plans.

3. Manholes:
   a. Manholes are required at the following locations:
   b. Beginning or ending or curves.
   c. Pipe size changes.
   d. Angle points and as required at junctions.
   e. Maximum 500 feet intervals (300 feet maximum for pipe less than 24” diameter).

4. Manholes shall be restricted to, in order of preference:
   a. Grade areas
   b. Parking lane
   c. Service road
   d. Street
   e. Center of travel lane nearest right curb
   f. Center of travel lane to the left of the travel lane nearest right curb

G. Abandonment of Underground Facilities:
   1. If culverts, pipes, or other facilities are abandoned or removed, provisions must be made for drainage.
   2. If facilities are abandoned, it will be necessary to either backfill with sand or cement slurry and seal the ends with brick and mortar or crush in place. Treatment of abandoned facilities will be as directed by the University.

H. Surface Drainage Transitions:
   1. If it is necessary to grade to drain, the grade on the ditch shall be shown on the plan.
   2. The length of ditch construction shall be shown on the plan.
   3. Keep mud and debris out of drainage by grading around improvements.
   4. Provide AC swales or aprons to protect improvements.
   5. The need for grading 50 feet to 100 feet upstream from proposed improvements must be checked.
   6. Insure ponding does not occur upstream.
   7. Insure water quality and erosion control. File Notice of Intent (NOI) with the State Water Resources Control Board for construction involving one (1) or more acres to comply with NPDES Construction Permit requirements.

I. Grates shall be cast iron and designed and located for bicycle safety and access compliance.
Maximum space between grates shall be ½ inch wide in one direction. If grating have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

END OF SECTION 33