

**THE UNIVERSITY OF COLORADO DENVER
ANSCHUTZ MEDICAL CAMPUS AND DOWNTOWN CAMPUS**

**UC DENVER
DESIGN AND CONSTRUCTION STANDARDS**

PART 3.0

**UC DENVER SERVICE PROVIDER REQUIREMENT AND HIGH
PERFORMANCE BUILDING PROGRAM**

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3.1 UC Denver Facilities Operation G/C:**A. Service Entrance:**

1. Specific service requirements for projects are to be included in the project program plan. In the design of new facilities, consideration should be given to the following:
 - a. The use of campus buildings may change overtime. In the design of service areas, allow for flexibility in general use or the buildings.
2. Other general considerations should include the following:
 - a. Locating the service entrance adjacent to storerooms, waste compactor, waste and recycling collection rooms and service elevator, as applicable.
 - b. Parking spaces for service vehicles. Service driveway should accommodate one 30-foot tandem axle vehicle.
 - c. Provisions for drainage and snow/ice removal. Provide weather protection where practicable.
3. The program for some facilities may require an elevated receiving bay or other receiving facility. In an effort to prevent personnel injuries, provide a 5000 lbs. capacity, weatherproof dock leveler. Unless the program requires an elevated receiving bay, provide for grade level loading and unloading.
4. In order to facilitate shipping and receiving, provide a six-foot by seven-foot service entrance door opening. Provide one active and one passive leaf with delayed action closure.

B. Service Elevator:

1. Consider providing a service elevator in buildings two stories and higher, located adjacent to the service entrance, as applicable.
2. Consider providing elevator service to all floors in a building, including the roof, where mechanical rooms are located.
3. Service elevator interior and cab door opening dimensions: See Part 3.2 UC Denver MM, H. Materials Handling Matrix below.
4. A "Door Hold" button shall be provided to facilitate loading and unloading.
5. In order to limit access of mechanical rooms to authorized personnel, elevators that open directly into mechanical rooms shall be equipped with a keyed switch, in the car station panel, designated for that landing.
6. Interior cab materials or protective coverings must be provided for the walls and floor, to minimize damage during the movement of any heavy equipment, carts, etc.
7. Consider requiring an analog telephone in every service elevator.

C. General Custodial Requirements:

1. General:

- a. During each design phase, verify the custodial requirements with UC Denver Facilities Operation through the UC Denver Project Manager. The equipment and supplies for each building will depend on the interior finishes, program requirements and the size of the building.
- b. Consider including a custodian's multipurpose room (lockers/office/break area) and a bulk storeroom located adjacent to the service entrance in buildings exceeding 25,000 gross square feet of floor area. The sizes of these rooms shall be appropriate to the building area and use, and will be determined during the design phase.
- c. Provide a minimum of one custodial closet per floor. Locate the custodial closet so that the maximum distance between closets is approximately 250 feet and the area served by each does not exceed 15,000 gross square feet of floor area.

2. Custodial Equipment and Supplies:

- a. The following is a list of the type, approximate size and quantity (to be determined by finishes and square footage) of equipment and supplies that will be stored in the buildings:
 - 1) Auto scrubber, minimum of three feet by five feet floor space, one per floor.
 - 2) Carpet extractor, minimum of three feet by three feet floor space, one per floor.
 - 3) 36-inch diameter trash barrel, one per custodial closet.
 - 4) Vacuum cleaner, minimum of three feet by three feet floor space, one per closet.
 - 5) 24 inch diameter floor buffer, one per floor and five, one- gallon pails of floor wax.
 - 6) Case of toilet paper, minimum of two feet by three feet floor space, one per closet.
 - 7) Case of paper towels, minimum of two feet by three feet floor space, one per closet.
 - 8) Cleaning materials such bleach, cleansers, mop heads.

3. Custodial Closets:

- a. A minimum of 50 square feet in area, with not less than a six foot width, is necessary for all custodial closets.
- b. Include a 6" deep floor mounted slop sink, hot and cold water, hose faucet with four feet of hose, mop rack for 3 mops, GFI duplex outlets and 20 feet of heavy duty shelving for cleaning supplies. In order to minimize the damage from overflowing slop sinks, spilled cleaning chemicals and spilled equipment reservoirs, provide a floor drain adjacent to the slop sink. Provide a five foot long board six feet above finish floor with hooks or pegs at six inch intervals in order to hang brooms, dust mops (hung by the head with the handle down), vacuum cleaner hoses and dust pans.
- c. In order to accommodate the storage of custodial equipment; provide doors 42-inches wide that open out.
- d. Provide adequate ventilation to compensate for the hydrogen gas that is produced when the battery operated equipment is recharged.

4. Exterior Services Closet:

- a. Where appropriate consider providing a closet for exterior services; 80 sq. ft., exterior entrance, grounded duplex outlet and power for sprinkler controller.

D. Waste Disposal:

1. During each design phase, verify with UC Denver Facilities Operations, through the UC Denver Project Manager, the requirements for the waste collection areas and the method of disposal, compaction, and hauling. These requirements will vary depending on the program needs and the size of the building.
2. If the volume of trash warrants, a stationary compactor should be located at the service entrance. This will reduce collection costs and keep the dock area clean and clear of trash.
3. If applicable, provide a room, located adjacent to the service entrance, for receiving, storing and disposing of wastes, including recycling. This room should be a minimum of 100 square feet.

E. Hazardous Wastes:

1. Verify with UC Denver Health Safety Department, through the UC Denver Project Manager, the space requirements for the collection and control of hazardous wastes including, but not limited to, fluorescent light tubes, batteries, waste motor oil lubricants and solvents and paint. Hazardous wastes may be generated by either program or maintenance and operations procedures.

F. Recycling:

1. Designate space throughout the building for “3 to 4” (2 recycling and 1-2 trash containers). The containers are a group of comingled separate waste containers (recycle cans and bottles, recycle newspaper, recycle office paper, trash). Each 3-4 container requires approximately 16 inches x 60 inches of floor space.
2. Provide space for a recycling / waste adjacent to each entrance within each classroom, laboratory, conference room, etc. For either open office designs, private offices or offices suites, provide dedicated space in a central location for one quad per every 10 to 15 people.

G. Public Toilet Rooms:

1. Provide ceramic tile finishes on the floors and walls.
2. Toilet room ceilings shall be painted drywall, plaster, concrete or other approved moisture resistant material.
3. In order to facilitate maintenance, provide accessible isolation valves for each toilet group. In toilet room where there are 10 or more fixtures located back to back, provide a two two-foot wide maintenance pipe chase with a man door.

H. Mechanical and Electrical Equipment Rooms/Spaces/Locations:

1. References:
 - a. Manual Part 4.0, Division 15 Mechanical, Section 15000 - General Provisions.
 - b. Manual Part 4.0, Division 16 Electrical, Section 16000 - Design Standards.
2. It is UC Denver’s experience that mechanical and electrical equipment rooms are often not designed or constructed to accommodate preventative maintenance and repair activities. Some example of unsatisfactory mechanical room design and construction are:

- a. Accessing a piece of equipment requires maintenance personnel to crawl under or over ductwork.
 - b. Piping is run across the floors.
 - c. Where light fixtures are located above equipment, ductwork or piping, the only way to relamp or repair the fixture is to install temporary scaffolding or use a mechanical lift.
 - d. Equipment located above other pieces of equipment preventing access to the upper equipment.
 - e. Equipment located in such a way that maintenance personnel have to stand on other pieces of equipment or piping in order to conduct maintenance service.
 - f. Inadequate clearance around equipment, such a wall needs to be removed in order to access it for repair or replacement, or to change filters.
 - g. Access panels swing in the wrong direction, away from the open access instead of towards the passageway.
 - h. Valve stems, wheels, etc. either too close to or imbedded in walls.
3. It is critical that mechanical and electrical equipment rooms are designed and constructed with adequate access to and clearance around equipment so that routine preventative maintenance can be conducted.
4. Incorporate the following items into the design of mechanical and electrical equipment rooms:
- a. Indicate on the construction drawing the necessary maintenance service areas adjacent to the equipment (1-1/2 times the length of the chiller tube is required to service the tube, etc).
 - b. Design the equipment rooms so that the necessary maintenance service areas adjacent to the equipment are free of other equipment.
 - c. The service door into the rooms shall be a minimum of six foot wide by seven-foot high opening, with one active and one passive leaf and a delayed action closure.
 - d. Equipment rooms should be on a level served by an elevator. Stairs to the equipment room floor are prohibited.
 - e. Provide a wall mounted service sink, with a hose attachment on the faucet, in all mechanical rooms.
 - f. Provide lifting eyes or a beam/trolley/chain fall lifting point (beam must be free of fireproofing, or insulation, to be utilized), if applicable, in order to facilitate the removal of chiller end caps, and the replacement of elevator hoist machines and elevator generators.
 - g. Provide floors to drains at all pumps, chillers, and air handling units.
 - h. Pitch floors to the floor drains.
 - i. Provide emergency lighting so that maintenance and operations staff can exit safety during a power outage.
 - j. Consider the safety of maintenance personnel when locating equipment. Provide adequate lighting (consider painting mechanical rooms as a means to increase light levels), electrical outlets, ventilation, access routes, walkways, stairs, protective enclosures, barriers, etc.
 - k. Provide service platforms to equipment when applicable.
5. Service platforms at heights of four feet or greater must have either guardrails per OSHA 29 CFR 1910.23 or safety belt anchor points located to minimize a free fall not greater than the distance to the floor or six feet whichever is smaller.

6. Provide section drawings through mechanical rooms and review with UC Denver Facilities Operation, through the UC Denver Project Manager, who shall make the final determination if the adequacy of maintenance accessibility is in question.
7. Locate light switches at the entrance to equipment rooms.
8. Vertical ladders shall not be used for access to areas where maintenance personnel need to carry toolboxes, etc.
9. Include means to provide access for future equipment replacement (access panels, knock-out panels).
10. Provide a designated electrical circuit to accommodate a welder.
11. Locate equipment which requires service in equipment rooms. When is it located in other spaces (ceiling or floor plenums, chases, etc.) it is difficult to service, creates interruptions to activities in occupied spaces and can be unsafe to access to maintain.

I. Provide, and be aware of, access to change lamps in light fixtures in all building areas.

J. Access Panels/Doors:

1. Provide panels for access to valves, cleanouts, dampers, controls and other mechanical and electrical components requiring servicing, adjustment or replacement wherever such items are concealed in ceilings or walls. Panel material and finish shall be resistant to damage or soil by normal anticipated use.
2. Provide roof access scuttle or an access door, accessible from a non-public area, for access to all major roof areas where rooftop equipment needs to be serviced, if roof level is not served by an elevator.

K. Chutes are PROHIBITED. Trash is collected in containers and taken directly to collection rooms located adjacent to the service entrance.

L. Accessibility:

1. Projects shall be designed according to the Americans with Disabilities Act Accessibility Guidelines and codes referenced in Part 1.0, Section 1.B.5.

M. ATM Machines:

1. Placement and installation of all ATM machines on the UC Denver Anschutz Medical Campus or Downtown Campus where authorized by UC Denver shall be subject to the following guidelines:
 - a. Placement and installation of ATM machines must provide access for service and maintenance of the equipment. Coordinate placement, media, and media pathway requirements with IS. Vendors should not arbitrarily install equipment without prior coordination.
 - b. ATM's must not protrude into the exit corridor. ATM machines must be recessed flush with the line of corridor walls, or in an alcove area.
 - c. ATM machines not located on "ground" floor may require special security equipment such as a security camera and/or alarm system.
 - d. ATM machines must be securely anchored.

- e. ATM machines should be installed in “public” areas that are readily observed from other occupied spaces.
2. The following are not permitted:
- a. Exterior ATM machines.
 - b. Stand-alone ATM machines or facilities.
 - c. ATM machines in isolated locations.
 - d. Exterior signage or advertising, including interior signage visible from exterior areas.

3.2 UC Denver Materials Management G/C:

A. Materials Handling:

1. Excellent service requires a pattern for smooth movement and coordination with vendors and the institution. UC Denver's role is to provide adequate receiving, vehicle circulation and parking at each building. This includes docks with levelers or lifts, ramps and parking designated for loading and unloading.
2. Carriers also provide a valuable service in shipping packages, letters and samples. To facilitate the pick up process, space in buildings should allow for letter drop boxes for FedEx, UPS, and USPS Priority letters. Space for the temporary storage of packages, packaging supplies, and preparation of packages should be provided.

B. Receiving and Vehicular Circulation:

1. All new lab and clinical buildings should have accessible dock space, with elevated receiving docks and dock levelers. All new administrative and educational buildings should have accessible dock space, with elevated receiving docks and dock levelers or scissors lifts. Vehicles used by outside vendors have varying bed heights, ranging from 30" to 50". The majority of straight trucks and truck trailer combinations have a bed height of 48" which is the recommended dock height for all buildings. For buildings with more than one dock, those with high receipt activity, such as lab and clinical buildings, each dock bay should have dock leveler, allowing a fast, efficient method to offload goods.
2. Dock doors eight feet wide by ten feet high allow for the loading and unloading of larger sized items without the risk of damage to the operator, equipment or merchandise. The door should have some overhang or protection from the elements to prevent rain and snow entering the building during inclement weather. Each dock door should be equipped with a flexible lamp for lighting the interior of the truck, providing a safe work environment. The exterior of the dock should be well lighted for security.
3. An area of twenty feet from the edge of the dock should be provided as a circulation and maneuvering space to allow access into the truck and the turning of pallet loads or carts with product. Docks must have a space separation between dock doors of ten feet for temporary staging and circulation. This circulation area must have adequate lighting.
4. Provision for snow removal, snow melting and drains for the driveway leading to the dock and in the dock parking area needs to be included in any design.
5. Adequate secured staging area should be provided at all buildings to hold materials until internal building delivery is accomplished. Building exceeding 100,000 gsf of building space should have 500 sq. ft. of storage area per 100,000 gsf of building space. This area provides a holding area of delivered good until distribution can be made.
6. Adequate secured staging area should be provided at all buildings to hold materials handling equipment used in the facility. Typical equipment consists of manual pallet jack(s), flat bed cart(s), 2 wheel dollies, delivery carts, compressed gas dolly and drum dolly. A power pallet jack is required for buildings in which excessively heavy equipment is used (i.e., large ultra cold freezers) and for the movement of compressed gas cylinders and pallet loaded deliveries to one location.
7. All new buildings will provide adequate turning space for access by vehicles expected to service the building type, with room for safe backing of vehicle and circulation around the vehicle while parked.

8. In addition to providing each building with an adequate height dock, with levelers or lifts as appropriate, a ramp to the dock should be provided. Ramping allows for vendors to utilize the vendor parking area, unload and deliver without occupying the dock. In buildings where the use of an electric vehicle is used to move radioactive and chemical wastes, the ramp should be eight feet in width. These ramps should also be ADA compliant.
9. Research buildings utilize compressed gas, both high and low pressure release. Cylinders are delivered on a daily basis to a holding area on the dock. Space to store a two-day supply of new cylinders plus empty cylinders must be provided. Storage for cylinders in preparation for extended weekends and special projects by labs must be allowed for. All cylinder must be caged or chained. Special provisions must be made if the cylinders contain flammable or hazardous materials. Both categories of gases require storage away from other gases. All storage areas must meet NFPA standards for gas storage.
10. Building serving one specific purpose should be evaluated for materials handling based on the specific use. Specialized storage may be needed.

C. Trash Removal:

1. Refuse bins or trash compactors must be sized appropriately for each building, and must be accessible for crews working in the evening. Since work in this area often occurs at night, the area should be well lighted for safety.
2. Access to the area must be kept free of snow and ice.
3. Exterior locations must provide a way to reenter the building without compromising the security of the building.
4. The area should be screened from public view.
5. Recycle bins should be provided, with one recycle bin per each type of material being recycled on each floor.

D. Internal Building Delivery:

1. Delivery routes must be planned within buildings creating minimal disruption of daily activities. Delivery routes should not be in public corridors. Routes must be logical and include direct access to service elevators. Since the majority of deliveries are by wheeled transport, the delivery routes should be of a durable surface that handles traffic and spills, and should avoid carpet and ceramic tiles.
2. Service elevators should be sized to handle the receipt of crated equipment and pallet jacks, pallet lifts and furniture dollies to move the equipment. Hoods, refrigerators and ultra cold freezers are example of these items. Service elevators must be able to handle a lifting capacity of the combined weight of equipment, lifting equipment and passengers with a 25% safety margin.
3. Delivery routes need to be sized to accommodate the items being transported within the area. Where electric lifts are required, such as in the delivery of compressed gas, or where large equipment (hoods, ultra cold freezers, etc.) will be replaced, hall width, door sizes and turning radii of combined lift and equipment, must be provided, along with a safety factor to prevent damage to the building.

4. Chemical showers and eye wash stations need to be recessed so as not to interfere with delivery routes.

E. Delivery Vehicle Types:

1. Multiple vehicle types are used as delivery vehicles to service all buildings.
2. Carriers such as FedEx and UPS utilize a package van with 36" bed height.
3. Electric delivery vehicles are used by UC Denver Mailing Services, and by Facilities Operation to service a variety of needs on the campus.
4. Lab and clinical buildings require access by over the road vehicles for direct delivery of large items. Typically, these items are crated, and have special storage and handling needs, as were described in other areas. These vehicles require concrete landing strips to handle the weight of trailers at the driving wheels and landing gear and prevent damage to the pavement.

F. Removal and Disposal of Hazardous Materials:

1. Radioactive Material:
 - a. Radioactive materials generated in the labs are collected by UC Denver **Health Safety Department** and moved to a collection point in each building. To collect radioactive wastes efficiently, space must be available to consolidate loads for movement to the EHS processing facility.
 - b. Buildings with particularly active waste generation must have surfaces that are durable, chemically resistant and easily decontaminated.
 - c. Safety showers and eyewashes are required in any areas where corrosive materials are handled.
 - d. Radioactive materials are heavily used in research and often must be obtained and used quickly. Space for processing radioactive packages in buildings where radioactive materials are used facilitates quick delivery.
2. Chemicals:
 - a. Chemicals that are no longer needed by the labs must be disposed of according to federal and state guidelines. To collect hazardous chemicals efficiently, space must be available to consolidate loads for movement to the EHS processing facility.
 - b. Building with particularly active waste generation must have surfaces that are durable, chemically resistant and easily decontaminated.
 - c. Buildings that generate significant quantities of flammable or combustible waste (the majority of the waste generated in research) must have appropriate cabinets for storage of flammables in the staging area to accommodate efficient transport. In those buildings, empty chemical containers will be rinsed and placed in the solid waste without transport. Adequate ventilation and facilities for that activity must be provided.
 - d. Safety showers and eyewashes are required in any areas where corrosive materials are handled.
3. Biological Materials and Infections Waste:
 - a. Biological materials that are no longer needed by the labs must be disposed of according to federal and state guidelines. Waste is collected from the labs by UC Denver **Health Safety Department**. Infectious waste is collected and

disposed of under contract. The pickups will generally not be more than once per day, so the storage space for the waste must accommodate one-day's waste with a comfortable buffer for days of greater waste generation. A hand-washing sink must be available to encourage hand washing after handling waste containers.

4. Flammable Materials and Specialized Storage:
 - a. The use of flammable liquids in buildings has important implications and limitations under fire codes that must be considered in design.
 - b. Buildings that generate significant quantities of flammable or combustible waste (the majority of the waste generated in research) must have appropriate cabinets for storage of flammables in the staging area to accommodate efficient transport. In those buildings, empty chemical containers will be rinsed and placed in the solid waste without transport. Adequate ventilation and facilities for that activity must be provided.
5. Emergency Response Room:
 - a. UC Denver benefits greatly from the ability of Health Safety Department to evaluate spills and respond to minor spills of hazardous materials. In buildings where significant quantities of hazardous materials are used, Health Safety Department needs space to accommodate spill control equipment on site to facilitate quick and effective response.

G. Mailing Services:

1. Each individual building will have a mail station with mail stops for the occupants of that buildings, and receptacles for outbound internal and external mail. These mail stations will not be staffed and will be serviced for mail delivery and pickup once per day.
2. United States Postal Service (USPS) drop boxes for letter and Priority Express mail will be provided in individual buildings if the volume is sufficient to meet USPS requirements.
3. See Part 4, Section 11000 for specific mail center needs at buildings.

H. Materials Handling Matrix:

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Dock Lift	48" height docks with levelers having an operating range of 12" (to 58" max height from ground); one per 100,000 sq. ft of building. One scissors lift with a lifting capacity of a minimum 10,000 lbs. if more than one dock door is built.	48" height docks with ground to dock scissors lift, lifting capacity of a minimum of 8000 lbs. *An alternate option of using a grade to 54" above grad scissor lift dock in lieu of a 48" dock. This alternate must be reviewed and approved by materials management prior to its use and will require adjustments to the dock door and dock circulation requirements below. Materials management will need to work closely with the design team if the alternate is used.	48" height docks with ground to dock scissors lift, lifting capacity of a minimum of 8000 lbs. *An alternate option of using a grade to 54" above grad scissor lift dock in lieu of a 48" dock. This alternate must be reviewed and approved by materials management prior to its use and will require adjustments to the dock door and dock circulation requirements below. Materials management will need to work closely with the design team if the alternate is used.	Specialized buildings are building that serve one specific purpose, and have unique characteristics based on their use. Examples of such buildings are warehouse, hazardous materials handling facilities, motor pool, garages, Facilities Operations warehousing, and power plant. These facilities should be handled on a case by case basis for materials handling.
Dock Doors	Power operated overhead doors with manual override. Minimum height: 10'. Minimum width 8' Dock door covered for weather protection.	Power operated overhead doors with manual override. Minimum height: 10'. Minimum width 8' Dock door covered for weather protection.	Power operated overhead doors with manual override. Minimum height: 10'. Minimum width 8' Dock door covered for weather protection.	

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Dock Circulation Area/Clearance Space	Minimum 20' depth of clear area from dock edge into building. Minimum 10' clearance on either side of dock door both internal and external of building.	Minimum 20' depth of clear area from dock edge into building. Minimum 10' clearance on either side of dock door both internal and external of building.	Minimum 20' depth of clear area from dock edge into building. Minimum 10' clearance on either side of dock door both internal and external of building.	
Dock Security and Access	Door unlocked from 7AM-4:30 PM Monday-Friday for vendor access. Doors locked after these hours with card-controlled access for building occupants.	Door unlocked from 7AM- 4:30 PM Monday-Friday for vendor access. Doors locked after these hours with card-controlled access for building occupants.	Door unlocked from 7AM- 4:30 PM Monday-Friday for vendor access. Doors locked after these hours with card-controlled access for building occupants.	
Dock Lighting	Flexible arm for viewing into truck: adequate internal lighting; external security lighting	Flexible arm for viewing into truck: adequate internal lighting; external security lighting	Flexible arm for viewing into truck: adequate internal lighting; external security lighting	
Delivery and Courier Parking	Minimum of two spaces, 14' width, per building. For building over 100,000 sq. ft., add one additional parking space per 100,000 sq. ft.	Minimum of two spaces, 14' width, per building. For building over 100,000 sq. ft., add one additional parking space per 100,000 sq. ft.	Minimum of two spaces, 14' width, per building. For building over 100,000 sq. ft., add one additional parking space per 100,000 sq. ft.	
Parking for delivery vehicles	Deliveries will not be permitted in any locations other than the service docks or assigned delivery areas of the buildings. Signs will be installed that indicate where deliveries are permitted.	Deliveries will not be permitted in any locations other than the service docks or assigned delivery areas of the buildings. Signs will be installed that indicate where deliveries are permitted.	Deliveries will not be permitted in any locations other than the service docks or assigned delivery areas of the buildings. Signs will be installed that indicate where deliveries are permitted.	Deliveries will not be permitted in any locations other than the service docks or assigned delivery areas of the buildings. Signs will be installed that indicate where deliveries are permitted.

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Ramps	Ramps to the dock area from an area adjacent to the delivery parking area. Width of 8'. Ramp should be ADA compliant.	Ramps to the dock area from an area adjacent to the delivery parking area. Width of 8'. Ramp should be ADA compliant.	Ramps to the dock area from an area adjacent to the delivery parking area. Width of 8'. Ramp should be ADA compliant.	
Service Elevators	Minimum: Door Width: 6' Door Height: 7' Cab depth: 10' Cab width: 6'9" Cab height: 10' Load Capacity: 8000 lbs. (5000 lbs will be considered upon analysis of expected loads)	Minimum: Door Width: 6' Door Height: 7' Cab depth: 10' Cab width: 6'9" Cab height: 10' Load Capacity: 8000 lbs. (5000 lbs will be considered upon analysis of expected loads)	Minimum: Door Width: 6' Door Height: 7' Cab depth: 10' Cab width: 6'9" Cab height: 10' Load Capacity: 8000 lbs. (5000 lbs will be considered upon analysis of expected loads)	
Turning Radius inside of Buildings	Adequate turning radius outside of service elevators to accommodate an 8 ft piece of equipment. Consideration must also be given to accessibility to rooms containing large scale equipment.	Adequate turning radius outside of service elevators to accommodate an 8 ft piece of equipment. Consideration must also be given to accessibility to rooms containing large scale equipment.	Adequate turning radius outside of service elevators to accommodate an 8 ft piece of equipment. Consideration must also be given to accessibility to rooms containing large scale equipment.	
Internal Storage and Staging Area	Dock: Minimum of 250 sq. ft. per building for buildings under 100,000 gsf; 500 sq. ft. per 100,000 gsf of building space. Secured cage area to hold materials until delivery to room is accomplished. Secured area for dock equipment.	Dock: Minimum of 250 sq. ft. per building for buildings under 100,000 gsf; 500 sq. ft. per 100,000 gsf of building space. Secured cage area to hold materials until delivery to room is accomplished. Secured area for dock equipment.	Dock: Minimum of 250 sq. ft. per building for buildings under 100,000 gsf; 500 sq. ft. per 100,000 gsf of building space. Secured cage area to hold materials until delivery to room is accomplished. Secured area for dock equipment.	

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Gas Cylinder Storage	Dock: Temporary secured (caged) storage for delivered tanks and holding empty tanks for vendor pickup. Internal to floors: Must meet NFPA standards for gas storage			
Specialized Storage	Any specialized storage must be addressed in the design stage of the building.	Any specialized storage must be addressed in the design stage of the building.	Any specialized storage must be addressed in the design stage of the building.	
Materials Handling Equipment used in Building	Manual pallet jack, flat bed cart, 2 wheel dollies, delivery carts, compressed gas dolly, drum dolly. Power pallet jack for buildings in which excessively heavy equipment is used (i.e., large ultracold freezers).	Manual pallet jack, 2 wheel dollies, delivery carts.	Manual pallet jack, 2 wheel dollies, delivery carts.	
Floor Covering	No carpet or ceramic tile in major distribution paths.	No carpet or ceramic tile in major distribution paths	No carpet or ceramic tile in major distribution paths	
Door Width	Minimum door width of 36" in rooms and access corridors where large equipment is installed (i.e. ultracold freezers, ventilation hoods)			

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Hall Width	Minimum width of 8 feet along major corridors to accommodate pallet jacks for large equipment. Chemical showers need to be recessed so as to not interfere with materials flow.			
Trash Removal	Storage for trash collection cart: 48"Lx30"Wx 40"H Recycle receptacle per material on each floor.	Storage for trash collection cart: 48"Lx30"Wx 40"H Recycle receptacle per material on each floor.	Storage for trash collection cart: 48"Lx30"Wx 40"H Recycle receptacle per material on each floor.	
Biohazard Area	Adequate storage for infectious waste generated in bldg., 100 sq. ft. will usually be enough. Overhead coiling door, 80 foot candle lighting, door locked by combination key punch, walls epoxy painted, floor sheet vinyl with integral base, temperature control to room temp, Proximate hand washing sink.		Adequate storage for infectious waste generated in bldg., Proximate hand washing sink. 100 sq. ft. will usually be enough. Not needed if no infectious waste generated.	Adequate storage for infectious waste generated in HSD processing bldg., 100 sq. ft. Proximate hand washing sink.
Flammable Materials and Specialized Storage	Adequate storage for hazardous materials used in building.			

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Hazardous Waste Storage Area	vinyl tile with coving, no floor drain, open shelves on one wall, accommodate 2-60 gallon flammable storage cabinets (30 gal.) stacked 2 high, 1 vented undercounter flammable storage cabinet, 2 carts (3 ft.x4 ft.) staged in room. 3 ft.x2 ft. uneven leaf double door. Stainless steel counter with large single basin sink 30"x18"x16" deep, back draft exhaust the length of the counter louvered to 12" above counter. Proximate safety shower and eyewash.			
Radioactive materials processing room	Space to process radioactive packages (100 sq. ft.)			
Emergency Response Room	Approx. 200 sq. ft., lockers, bench, 2 response carts, metal cabinets with supplies, one undercounter refrigerator, phone. At least one shower facility in building.			

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
Feature:				
Driving Routes	Delivery and circulation corridors will be established for new and existing building as they are occupied.	Deliveries to Building 500 from the east, entering through the East Gate on Potomac Street. Delivery and circulation corridors will be established for new and existing building as they are occupied.	Delivery and circulation corridors will be established for new and existing as they are occupied.	
Internal Delivery Routes	Delivery routes must be planned into buildings in order to allow for minimal disruption of daily activities. Routes must be logical and include direct access to service elevators.	Delivery routes must be planned into buildings in order to allow for minimal disruption of daily activities. Routes must be logical and include direct access to service elevators.	Delivery routes must be planned into buildings in order to allow for minimal disruption of daily activities. Routes must be logical and include direct access to service elevators.	
Delivery Vehicles (used by UC Denver)	Straight truck with 24' box, 36' overall, 48" floor height, lift gate; Package van 24' overall, 36" floor height. Electric delivery van (Mail, Hazardous Materials, Facilities).	Straight truck with 24' box, 36' overall, 48" floor height, lift gate; Package van 24' overall, 36" floor height. Electric delivery van (Mail, Hazardous Materials, Facilities).	Straight truck with 24' box, 36' overall, 48" floor height, lift gate; Package van 24' overall, 36" floor height. Electric delivery van (Mail, Facilities).	

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
<p>Feature:</p> <p>Access to buildings by over the road vehicles</p>	<p>Provide access to building by over the road carriers (55' van plus 20' cab, 75' overall length); requires a minimum apron space of 155', based on counterclockwise travel. If approach is clockwise increase apron length by 20'. Concrete landing strips must be provided to handle the weight of the trailers at the driving wheels and/or landing gear.</p>	<p>Provide access to building by straight trucks, 36' overall length.</p>	<p>Provide access to building by straight trucks, 36' overall length.</p>	
<p>Snow removal/ Drains</p>	<p>Need to be present.</p>	<p>Need to be present.</p>	<p>Need to be present.</p>	
<p>Animal Related Issues</p>	<p>All issues related to animals will be under the direction of the Animal Resources Center.</p>			

Building Type	Lab	Administrative - Office	Educational	Special Use Buildings
<p>Feature:</p> <p>Mail Stations and Mail Handling</p>	<p>A Mail Station will be established in each building to provide a central location for the mail collection. The room will have adequate space for department mail stops, drop boxes for intercampus mail, a sorting table for staff use, and adequate circulation space for filling mail stations and picking up mail.</p>	<p>A Mail Station will be established in each building to provide a central location for the mail collection. The room will have adequate space for department mail stops, drop boxes for intercampus mail, a sorting table for staff use, and adequate circulation space for filling mail stations and picking up mail.</p>	<p>A Mail Station will be established in each building to provide a central location for the mail collection. The room will have adequate space for department mail stops, drop boxes for intercampus mail, a sorting table for staff use, and adequate circulation space for filling mail stations and picking up mail.</p>	
<p>Carrier Pickup UPS/ FedEx/ USPS</p>	<p>Letter drop boxes to be provided for ease of use by department for FedEx, UPS; etc. Staffing in building to receive packages for shipment that cannot be left at drop boxes.</p>	<p>Letter drop boxes to be provided for ease of use by department for FedEx, UPS; etc. Staffing in building to receive packages for shipment that cannot be left at drop boxes.</p>	<p>Letter drop boxes to be provided for ease of use by department for FedEx, UPS; etc. Staffing in building to receive packages for shipment that cannot be left at drop boxes.</p>	

3.3 UC Denver Information Systems G/C:**A. Reference:**

1. Note all design criteria and specification criteria for information systems can be found in Specification Section 16740. It includes information about room sizing and location, environmental conditions, plywood on walls in telecom rooms and raceway information. In general the design team is required to provide the physical space and raceway for telecom systems. The design team is not required to design data equipment or wiring systems. These are designed and bid out separately.

3.4 UC Denver Utilities Mechanical Infrastructure G/C:

A. INTRODUCTION

This document addresses mechanical requirements of UC Denver utilities infrastructure design at the Anschutz Medical Campus. The design criterion outlined in this document is intended to provide guidance in developing building system connection designs, cost estimates, equipment selection, and operational sequences. It is not intended that this document be used in lieu of performing the proper engineering and evaluation of the existing systems. Rather, its purpose is to document the interface requirements between the individual buildings and the campus distribution system for steam and chilled water. Design engineers are to verify the intended operating conditions for their projects with UC Denver for each specific building.

B. SUMMARY

The following is a summary of the design conditions relative to the campus mechanical systems. The background and assumptions inherent in these design conditions are discussed in the remainder of this document.

Mechanical Utilities – General:

- 1) Mechanical utilities, specifically steam and chilled water, will be generated at the UC Denver Central Utility Plant located on the east side of the Anschutz Medical Campus.
- 2) Mechanical utilities are distributed throughout the site by means of underground piping systems located in designated utility corridors. Portions of the distribution system are in place and other portions remain to be constructed in the future.
- 3) All buildings located on the Anschutz Medical Campus will be connected to the central steam and chilled water distribution systems. Exception: Buildings that were constructed and operational prior to the campus chilled water system completion, have their own chilled water plants, but may connect to the central system in the future.
- 4) Buildings may have their own local steam and chilled water generation systems for critical services and/or emergency standby operation, as dictated by the planned use and occupancy of the buildings. These systems shall be so designed that their operation does not alter or impact the operation of the campus distribution systems.
- 5) Building connections to the campus mechanical distribution systems will be made in designated mechanical utility vaults.
- 6) Each building project and building mechanical designer is responsible for designing the connections and proper isolation for the connections to the mechanical distribution systems within the mechanical vaults as described in this document.

C. STEAM AND CONDENSATE:

- 1) Steam generation and delivery to the campus from the Central Utility Plant will be at 125 psig saturated. Steam available for building use, at the building point of connection is assumed to be between 110-125 psig saturated.
- 2) The campus steam and condensate return systems, once completed at full build-out, will consist of looped feeds as shown in the diagram below. Only steam mains are shown for clarity. Steam mains are 20”, condensate return mains are 8”.

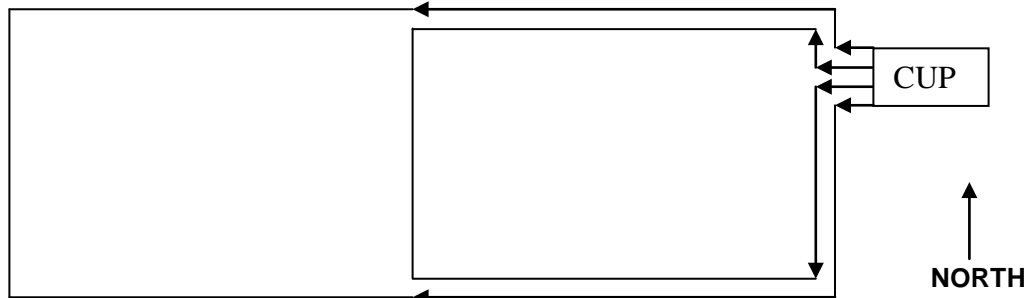


D. CHILLED WATER:

- 1) Chilled water generation and delivery to the campus distribution system from the Central Utility Plant will be at set-point temperatures of 40 °F supply with 56 °F return (16 °F delta). This maximizes

chiller operating efficiency. Chilled water supply temperature available for building use associated with peak load, at the building point of connection should be 41 °F.

- 2) The campus chilled water system, once completed at full build-out, will consist of two separate looped feeds as shown in the diagram below. Only chilled water supply headers are shown for clarity. Both supply and return chilled water headers are 20”.



E. UTILITY VAULTS

Steam, steam condensate, and chilled water are distributed and returned through main piping connections that are located inside large underground utility vaults. These are primarily located along East 19th Ave. and the future 17th Avenue. The utility vaults are designed to house all of the main distribution piping, isolation valves, and allow accessible connection locations for all future buildings. In addition, the utility vaults house the expansion joints and condensate trapping stations for the steam service. Inside the vaults there are distribution headers for steam, condensate, and chilled water supply and chilled water return. These preinstalled headers allow for future connections to be made to the main distribution systems with a minimum downtime imposed on other buildings. The UC Denver guidelines for connecting to the headers should be followed in order to alleviate any potential future conflicts in the connections. All penetrations into the utility vaults shall be constructed such that the watertight seal at the wall is maintained. These penetrations and connections will be provided by individual building projects and funds for such penetrations and connections should be allocated accordingly. Please refer to appropriate UC Denver guidelines for piping requirements interior to the mechanical utility vaults. Actual piping layout and configuration of each vault varies greatly. Contact UC Denver facilities engineering staff for appropriate piping configuration and backgrounds for the particular vault. Also, refer to the standard specifications for pre-insulated piping systems for buried steam, steam condensate, and chilled water piping.

F. STEAM

The connection to the campus steam system is done by means of connecting to the steam headers located inside the mechanical utility vault designated by UC Denver. These header connections are typically 12” Sch 40. Saturated steam at 110-125 psig will be provided for the building at the steam header.

An isolation valve shall be located in the utility vault downstream of the connection to the steam header. The service pipe from the vault to the building shall be anchored in un-excavated soil within 5 feet outside of the vault wall and from the building wall in order to minimize the expansion directed into the vault and building. Thermal expansion of the service line must be provided for outside of the utility vault. Additional expansion loops and anchors may be required depending on the distance and routing. Extreme care should be taken in the design of the high temperature piping systems to avoid excessive stress on the pipe, anchors, vault and building. The slope of the steam connection piping must lie so that the condensate is effectively drained to either the steam header located in the utility vault or to the building (see CONDENSATE section).

After the building penetration, isolation flanges and gaskets shall be provided to electrically isolate the distribution system from the building in order to prevent electrolytic corrosion on both systems (see **REF DWG 1**). Provisions to trap the condensate shall be made directly after the isolation flanges and gaskets in the building. Downstream of the trapping station an isolation valve shall be located inside the building.

Directly downstream of the isolation valve and upstream of the building pressure reducing station, a vortex type flow meter, pressure and temperature compensating, will be installed. This meter will be installed in a length of straight pipe dictated by the particular piping configuration and model of steam meter in order to have accurate measurement. The meter shall be sized to accommodate both the maximum and the minimum flow rates anticipated. If the metering accuracy cannot be maintained at both the maximum and minimum flow values of the meter, a parallel dual meter installation will be needed.

G. STEAM CONDENSATE

The connection to the campus condensate return system is done by means of connecting to the condensate return headers located inside the mechanical utility vault designated by UC Denver. These header connections are typically 4" Sch 80.

An isolation valve shall be located in the utility vault upstream of the condensate header and header isolation valve. The service pipe from the utility vault to the building shall be according to the standard specification for preinsulated piping systems. The service pipe shall be anchored in un-excavated soil within 5 feet of the vault wall and the building wall in order to keep a very small amount of expansion directed into the vault and building. Thermal expansion of the service line must be provided for outside of the utility vault, between the anchors.

If it is necessary to trap and drain the connection line in-between the utility vault and the building, and no practical steam main drainage scheme using only slope exists (either to the building or to the utility vault), then these traps may be connected directly to the pumped condensate return line. Care must be taken in sizing the steam main from the vault to the building because if the building penetration is located higher than the utility vault connection, and it is desired to drain the condensate into the utility vault, over-sizing the steam main to accommodate counter flow conditions may be necessary.

Upstream of the building penetration, isolation flanges and gaskets shall be provided to electrically isolate the distribution system from the building in order to prevent electrolytic corrosion on both systems. Upstream of the isolation flanges there is located a single trap discharge connection from the steam trap located upstream from the steam isolation valve located inside the building. A steam condensate isolation valve shall be located inside the building upstream of the trap discharge connection. Upstream of the steam condensate isolation valve, an ultrasonic type flow meter and temperature sensor integrated into a BTU meter may be required for measuring energy usage. The meter manufacturer's recommendations for the piping configuration around the meter must be adhered to for the accuracy of this meter to remain high. All steam condensate produced in the building must be collected at the receiver such that it is metered when discharged back to the distribution system.

The steam condensate return system is intended to operate in the future under pressure and have no working atmospheric vents after leaving the buildings. All condensate trapped inside the building must be collected in a non-vented receiver and pumped into the UC Denver condensate return system using a steam motivated steam condensate pump (see **REF DWG 1**). Please note that the pressure reducing valves serving the steam condensate pumps are fed with the pressure of the main steam line (110-125 psig) upstream of any pressure reducing stations. This allows the motivation pressure of the steam-powered pumps to be adjusted over time to meet the changing system demands without concern regarding the pressure of the steam for use by the building loads. It is anticipated that the condensate return line back-pressure will increase as more buildings are constructed and come on line. Building condensate return design should be based on the worst case of 35 psig back pressure, yet be adjustable for the low backpressure that will be seen during the first several years.

Minimum steam condensate return temperature from the building is assumed to be 180°F. Maximum steam condensate return temperature from the building is assumed to be 200°F. Under no circumstance is live steam (other than flash steam) to be introduced into the steam condensate return lines. Damage may occur to the insulation and waterproof protective jacketing if excessive pipe surface temperatures are reached. This damage will lower the long-term efficiency and will shorten the service life of the piping system.

H. CHILLED WATER

The connection to the chilled water system is done by means of connecting to the chilled water headers located inside the utility vault designated by UC Denver. These header connections are typically 12"-14" Sch 40. Chilled water at 41°F will be provided for the building.

An isolation valve shall be located in the utility vault on both the chilled water supply and chilled water return piping connections to the header. The service piping from the vault to the building shall be routed in such a way as to avoid high points and air pockets in the piping. Automatic air vents may be required where a high point is unavoidable. Anchors (for thermal expansion) are typically not required on the chilled water lines.

After the building penetrations, isolation flanges and gaskets shall be provided to electrically isolate the distribution system from the building in order to prevent electrolytic corrosion on both systems (see **REF DWG 2**). Isolation valves shall be located inside the building after the isolation flanges. Downstream of the supply isolation valve inside the building, a transit time ultrasonic flow meter shall be installed in a length of straight pipe in order to achieve accurate readings as per manufacturer's recommendations. Temperature sensors (thermowells) on both the supply and return lines are necessary to monitor the thermal energy absorbed by the system. Pressure transducers on the supply and return lines (between the building wall and the main building isolation valves) may be required by UC Denver facilities to monitor the chilled water system operation and provide more efficient operation of the central plant and the distribution system.

The campus chilled water distribution system will operate in a de-coupled manner with the building. Three options are available to the building design engineer.

Option 1: Primary-secondary bridle

A primary-secondary bridle connection and building circulation pump(s) may be used. (see **REF DWG 2**). Design parameters for the use of a primary-secondary bridle shall include:

- The highest point of the building chilled water piping system (including all connected equipment and piping) shall not be higher than an elevation of 5,475' A.S.L. because of the static pressure induced on the campus system by the building piping system.
- No makeup water or chemicals shall be introduced into the chilled water system at the building. All chemical treatment will occur at the Central Utility Plant.
- Piping system expansion capacity for each building project shall be provided for at the Central Utility Plant. The building mechanical systems designer shall provide the campus facilities engineering staff with the calculated amount of expansion required for the building from the point of connection with the campus system.
- Pumps are to be located after the bridle connection (suction side of the pump towards the bridle connection). Pumps located before the bridle connection have the potential to pressurize the primary side of the connections and shall not be permitted.
- All equipment and connections shall be specified for 150 psig ratings (flanges, gaskets, Victaulic connections, etc.). This is the rating of the campus distribution system chilled water piping.
- The building chilled water system should be designed to utilize 41 °F supply water with a return to the campus system at 56 °F (15 °F delta). See **REF DWG 2**.

Option 2: Flat Plate Heat Exchanger

A flat plate heat exchanger(s) and building circulation pump(s) may be used to isolate the building and campus chilled water systems (see **REF DWG 3**). Design parameters for the use of a flat plate heat exchanger shall include:

- The highest point of the building chilled water piping system (including all connected equipment and piping) exceeds an elevation of 5,475' A.S.L.
- The building will be required to manage its own makeup water and chemical treatment.
- Piping system expansion capacity will be provided for at each individual building.

- Pumps are to be located after the flat plate (suction side of the pump towards the flat plate connection). Pumps located before the flat plate have the potential to pressurize the primary side of the connections and shall not be permitted.
- All equipment and connections shall be specified for 150 psig ratings (flanges, gaskets, Victaulic connections, etc.). This is the rating of the campus distribution system chilled water piping.
- The building chilled water system should be designed to utilize 44 °F supply water (based on a 3 °F approach) with a return to the campus system at 56 °F.
- The flat plate heat exchanger should be sized for a differential pressure of no more than 9 psid at the maximum flow (source side).
- Building system designers must consider the impact of the loss in temperature (approach) across the flat plate heat exchanger.

Option 3: Hybrid System

If required by the building design and intended use, a building may utilize both types of de-coupled systems in a single building installation. Design parameters for the use of a hybrid system shall include:

- Each system shall be independent of the other.
- The maximum static head limitation of 5,475' A.S.L. is not exceeded.

Design of the building connections, pumping system and flat plate and/or bridle connection is the responsibility of the building design engineer.

With either the direct bridle or the heat exchanger approach, temperature control of the supply temperature to the building shall be maintained through a direct acting temperature control loop as shown in **REF DWG 2**. The control valves will need to be able to close against the 100 psi (230' W.C.) differential pressure from the central plant pumps and have 3-5 psid across the valve at full (100%) flow. Pipes should be sized for a full flow pressure loss of around 1.5 psi per 100 feet. The buildings with shorter distances (<300 feet) may be designed with slightly higher pressure losses per unit length, while buildings with longer distances (>300 feet) to the distribution vaults should be designed with slightly lower pressure losses per unit length.

In all cases, chilled water at peak load will be provided to the building through the chilled water distribution system prior to the bridle connection or heat exchanger at 41°F and should be returned to the distribution system at 56°F based on the building design loads. The building design engineer shall be responsible for a system design which not only accomplishes building temperature control, but which returns chilled water to the Central Utility Plant as near to the design return water condition of 56 °F as possible. The building design engineer is encouraged to make use of chilled water reset, and variable speed pumping as a means to insure that the return water temperature is kept high.

If the building design requirements cannot be met by the campus chilled water system and temperature limitations as described above, then an auxiliary means of cooling and/or chilled water may be required.

I. BILLING PHILOSOPHY

The CUP (Central Utility Plant) enterprise is self-supporting – all costs of operation (capital, energy, labor) are collected through payment of a unit rate for consumption as measured by the building meter.

- 1) **Metered Steam:** Daily steam consumption is measured and totalized monthly. The utility is billed at a unit rate per 1,000 pounds of steam consumed. Vortex metering technology has a limited low flow capability, which may require a dual meter station to capture low flow measurement. In order to encourage appropriate investment in building metering equipment, low flow penalties will be used. For any day that the total steam consumed is less than the daily minimum that the installed meter is capable of capturing, a surcharge of 90% of the specified daily minimum will be used for that day.
- 2) **Metered Chilled Water:** Cooling energy (chilled water) is based on the total BTU (British Thermal Units) of cooling delivered to the building. Determination of BTU energy requires a minimum of two temperature sensors (one on the supply line, one on the return line), and GPM flow. Billing of cooling energy is done on the basis of ton-hours of cooling and is determined by converting the BTU cooling units through calculation using the Building Automation System (BAS) computer. The building

- connection to the CUP chilled water distribution system is accomplished in a traditional primary/secondary decoupled manner. Using a building-side 2-way modulating control valve, chilled water return temperature is set at 56 degree F for return back to the CUP. Low delta T across the CUP chillers results in poor energy efficiency and consequently all CUP users are hurt. In order to minimize this delta T problem, buildings returning less than 56 degree F will be penalized (UC Denver staff may request evidence indicated that the BAS is using the specified control set- point). The monthly average return temperature will determine if there will be a surcharge applied for improperly returning the chilled water at the correct temperature. This surcharge will be based upon the reduced efficiency of producing the chilled water at the CUP Facility.
- 3) **Metered Electrical Power:** Utility company custody transfer meters are used at the main campus switchgear. These utility costs are appropriated to the buildings based on sub-meter readings, plus distribution losses.
 - 4) **Potential Optimization Strategies:** The provision of both steam and chilled water utilities from the CUP to the individual buildings is based on thermal energy needs for supporting building operation. The Design Criteria document describes initial design expectations, though long term operating strategies should also be considered. A/E design consultants should discuss operating plans with UC Denver engineering staff. Energy saving opportunities exist that will benefit all parties associated with CUP services. These strategies are not fully formulated at this time, but should be considered in the future, and may include: steam pressure reset and chilled water supply reset.

Steam Pressure Reset - There may be an opportunity during the low load off-season to reduce steam pressure from 125 PSI down to about 90 PSI based on a set schedule. All parties would benefit by energy savings. Minimum building operating requirements will always remain as a primary concern, with energy conservation measures subordinated.

Chilled Water Supply Temperature Reset - There may be an opportunity during low load conditions to gradually increase CHWS based on a set routine that may include the following:

- Outside Air Temperature – outside weather may serve as a proxy for load, but would not be an independent variable (building needs would take precedent over a generalized schedule)
- CUP Pump Flow Demand – if flow to a particular building is pinched down, this is an indication of low demand (differential pressure at supply/return building connection)
- CHWR Temperature Pattern – if chilled water is returning to the CUP unspent, this is an indication that building demand is being met
- Other Undefined Strategies – the freedom to take advantage of advances in operating technology should always remain as an option - possible use of the campus-wide BAS may allow for other control inputs

Chilled water supply set-point may rise from 41 degree to some undefined value (maybe 48 degree?), only when cold chilled water is not necessary. All parties would benefit by energy savings. Minimum building operating requirements will always remain as a primary concern, with energy conservation measures subordinated.

Electrical Demand Load Shedding - This is unrelated to CUP operation, but there may be an opportunity to use the campus-wide BAS (Building Automation System) in conjunction with the individual building electrical meters to implement load shedding as electrical demand increases toward annual peak values. Minimum building operating requirements will always remain as a primary concern, with energy conservation measures subordinated.

J. UC Denver Evaporative Cooling G/C:

INTRODUCTION

UC Denver **requires** direct-evaporative cooling **for all** new projects **and AHU replacements**. Indirect evaporative cooling, through CUP (Central Utility Plant) outside-air free cooling is already being implemented and is not relevant to building direct-evaporative cooling (the CUP uses a plate and frame heat exchanger with cooling towers to condition the chilled water). Evaporative cooling will be

accomplished in conjunction with a full capacity chilled water coil sized for peak cooling demand. Evaporative cooling will augment traditional chilled water cooling. In some cases, depending on outside air psychometrics, cooling delivery (ton-hr consumption) will be fully provided by the evaporative cooling system, in other cases a combination of evaporative cooling and chilled water coil may be used to maintain RH set point (relative humidity). The two cooling systems will work together, with the evaporative cooling system being the primary device (called on first), to provide the desired discharge air temperature of 55 degree F (or as otherwise specified). During evaporative cooling mode, mixed-air units should not recirculate and should operate with full outside-air.

Construction standards are based on the design guidelines issued by the Munters Corporation and the final installation must conform to this detail.

Please see Part 4 Construction Standards – Division 15 (Mechanical) for more information. Specifically, see Section 15856 Direct Evaporative Cooling.

GENERAL DESIGN CONSIDERATIONS

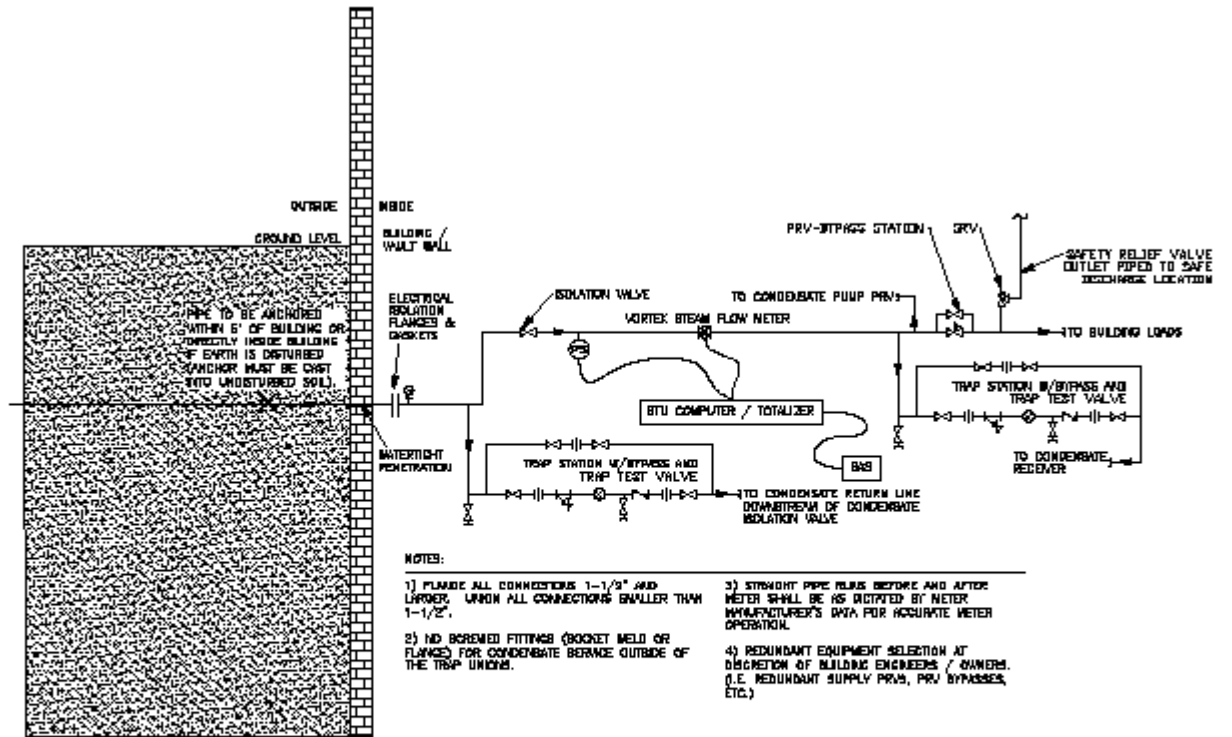
Air-handling-units need additional physical space to house the evaporative cooling section, including additional machine room space for the longer AHU. In all cases, the machine room floor must be sealed water-tight with an epoxy sealant. Also provide curbs, caulking of seams/joints, or any other mechanism necessary to provide a water-tight machine room floor.

- 1) Evaporative cooling section must have stainless steel sumps and housing, with stainless steel fasteners/dielectric gaskets between the housing and the rest of the AHU. The upper portion of the housing should include a shield surrounding the top of the distribution header. The sump must be a minimum of 12-inches deep and extend at least 6-inches upstream of the media and 12-inches downstream of the media (accommodate submersed pump on the downstream side). The sump should include a factory installed “air baffle plate” with a 1 inch gap on the bottom of the sump.
- 2) The sump must be provided with metered water bleed-off and automated sump drain down (all control valves must be located in warm environment not subject to freezing). Include sump low-water pump cut-off switch (pump motor must also be thermally protected and capable of being operated dry for up to 12 hours without damage). Use P-traps with sump drain routed to indoor floor sink. Include full size manual bypass drain line. Sump must be sloped for complete positive drainage (during drying cycle, no standing water will be allowed).
- 3) Domestic cold water make-up line must be piped at a level higher than the sump overflow drain. Provide automatically control of the water fill line with adequately sized brass float valve assembly for make-up water control. Include full size quick fill bypass line.
- 4) Evaporative cooling section must be installed upstream of the supply-air fan.
- 5) In order to eliminate problems with odor and scaling, specify routine for daily drying-out cycle for the evaporative media and weekly sump draining.
- 6) Chilled water coil will be downstream of the evaporative cooling section.
- 7) Media specification (subject to approval): Use 12-inch thick fiberglass media type, providing a saturation efficiency of approximately 90 percent at 500 fpm face velocity without water carryover. Similar to Munters Glasdek product (UL Class 2 rating).
- 8) Chemical water treatment due to raw water hardness may be required (subject to approval). Water treatment requirements should be proposed on a project-specific basis.
- 9) Components requiring periodic inspection and/or service must be easily accessible.

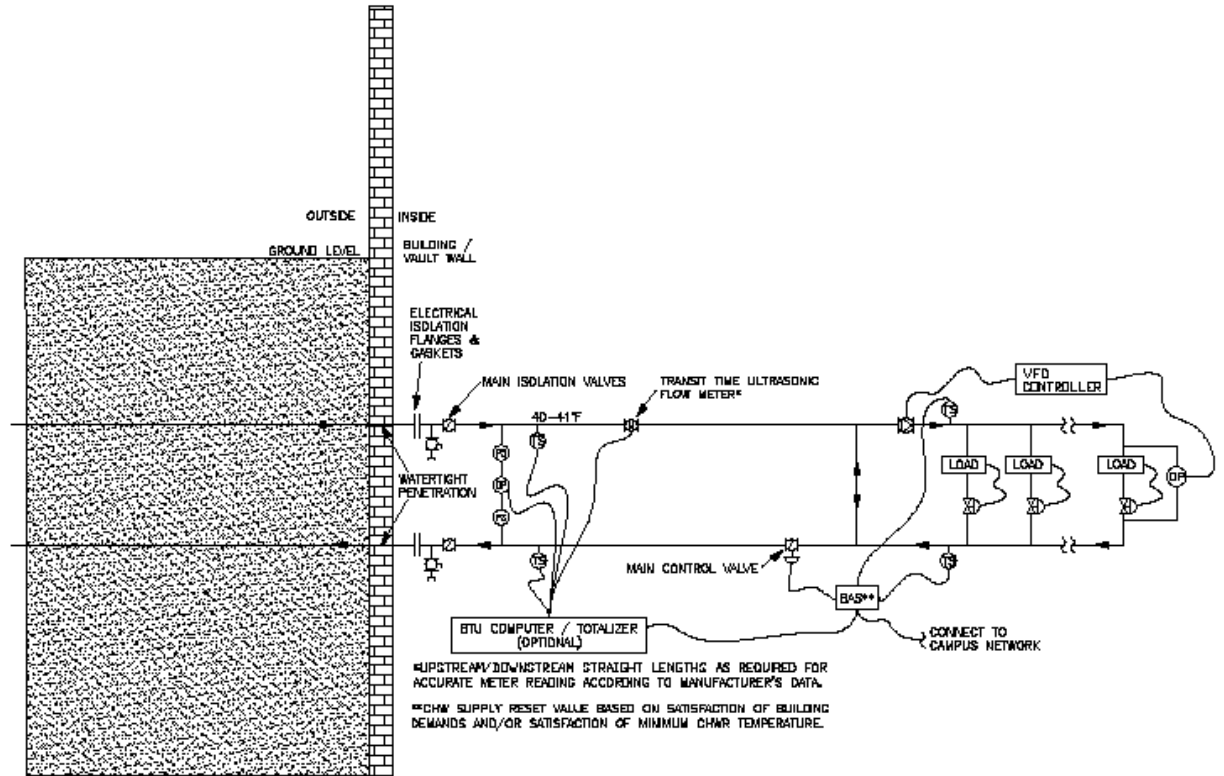
K. REFERENCE DRAWINGS

The following diagrams are referenced in the above text and are for general use and design discussions. Valves are shown as a generic valve symbol and are not meant to depict a particular type of valve. It is important to emphasize again, that each particular installation is unique and may require a different approach to the installation.

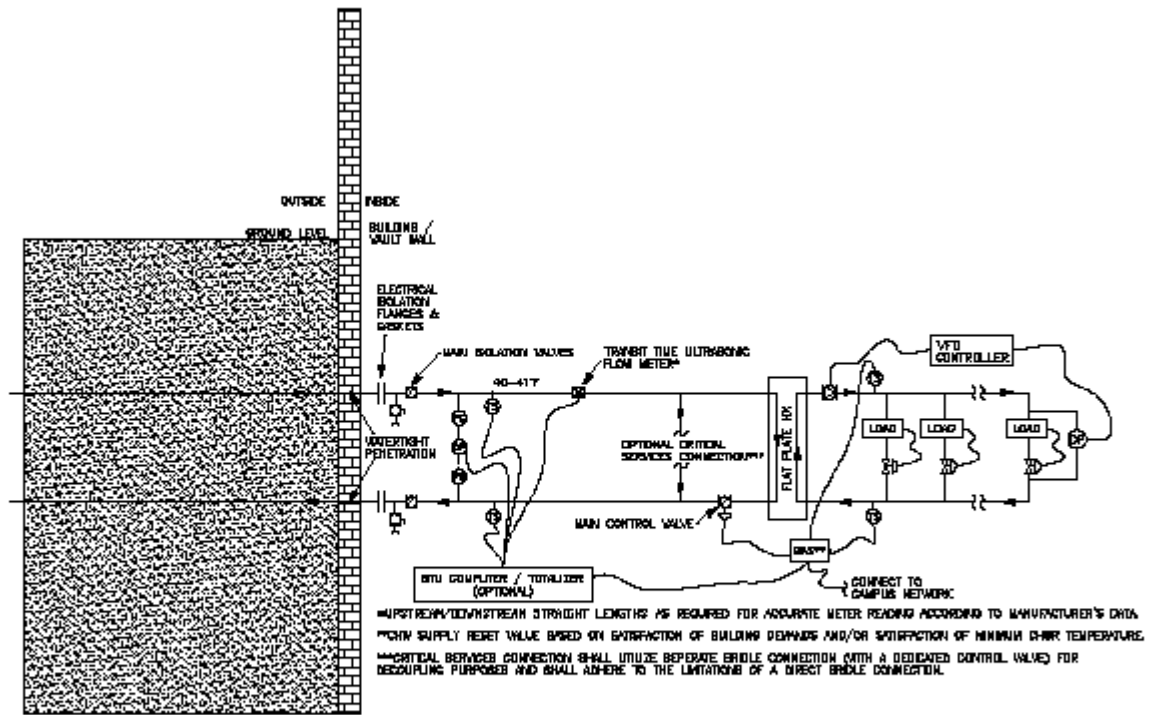
- REF DWG 1:** Steam Connections Inside Buildings
REF DWG 2: Chilled Water Connections Inside Buildings W/ Bridle
REF DWG 3: Chilled Water Connections Inside Buildings W/ Heat Exchanger



REF DWG 1: STEAM CONNECTIONS INSIDE BUILDINGS



REF DWG 2: CHILLED WATER CONNECTIONS
INSIDE BUILDINGS WITH BRIDGE



REF. DWG 3) CHILLED WATER CONNECTIONS
INSIDE BUILDINGS WITH HEAT EXCHANGER.

3.5 UC DenverC BL3 Construction Standards:

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I. Introduction

A. General Design of UC Denver Biomedical Laboratories

The University of Colorado **Denver** is an educational, clinical and medical research facility which houses laboratories for the purpose of performing medical research. Biomedical laboratories should be designed to address the hazards that are inherent or anticipated in such facilities. The planning and design group must address the major hazards which would be encountered in such laboratories, including biological, chemical, and radioactive hazards. Therefore, proper facilities for storage, handling and disposal of hazardous materials must be addressed in the design process. Regulations and guidelines are referenced in this document.

B. BL3 Planning

During the design and planning phase of a BL3 laboratory it is essential that the construction standards in this document be addressed. The standards are based upon the performance specification as published by the CDC/NIH Biosafety in Biomedical and Microbiological Laboratories Guidelines. They are written to specify what UC Denver BL3 Construction Standards Committee feels should be included in a BL3 facility and are not intended to supersede, but to enhance the CDC/NIH guidelines.

The Standards are not to limit a planner or engineer to the materials as stated here, but are a minimal requirement. Where possible, options of materials or equipment have been listed. If a new and different product meets the performance criteria and receives the approval of that material by the Health and Safety Division of the UC Denver Facilities Department, then it is appropriate to use the alternate material or equipment in the construction of the facility.

C. Feasibility Study

During the initial planning phase for a new or remodel of an existing lab to a BL3 facility, it is imperative that a feasibility study be conducted to determine and assure that the anticipated location and building infrastructure can support a BL3 facility. The BL3 Construction group has determined that there are some options in determining location of a laboratory. The location should be considered in the following order of preference.

1. Can the proposed BL3 facilities be established adjacent to existing BL3 facilities?
2. Can the BL3 facility be provided with a stand alone HVAC system?
3. Can the BL3 facility be adequately isolated within an existing building?
4. Can alternate off campus space be explored for additional BL3 facilities?

The feasibility study should address existing conditions including infrastructure and what services and utilities are available and where. Some of the issues to be considered are listed below:

1. Mechanical shafts must be of adequate size to accommodate additional ducting
2. For a stand-alone system, there must be adequate space on the roof to place supply and exhaust units
3. Location, proximity, availability and adequacy of services
 - a. steam; adequate pressure for all needs including autoclave
 - b. vacuum; capacity sufficient for additional ports
 - c. electrical power; sufficient for HVAC and all lab equipment
 - d. **Building Automation System BAS (Siemens)** points availability
 - e. building HVAC system adequate
 - f. fire alarm system/monitoring/suppression
 - g. telecommunications
 - h. maintenance accessibility
 - i. natural gas
 - j. DI water

- k. compressed air
- l. chilled water
- m. hot water
- 4. Relative maintenance cost

Discussions have indicated that there is some concern whether existing building systems can support future BL3 labs. Until this question is answered, current thinking suggests that future BL3 labs be located at upper floors with stand alone systems. However, as already noted stand alone systems require roof space which may be limited..

D. Biosafety Level 3 Laboratory Design

Biosafety Level 3 (BL3) laboratories are those in which work is done with infectious microorganisms, indigenous or exotic, considered by NIH/CDC to be Class 3 pathogens. These agents are capable of causing serious or potentially fatal disease as a result of exposure, usually by the inhalation route.

The BL3 containment facility is designed with special engineering and facility features. Biological safety cabinets are an essential engineering control of BL3 laboratories and are required for all procedures involving manipulation of infectious materials. Since research with a Class 3 agent often involves the use of other major hazards, all aspects of safety must be considered and coordinated in the design of the laboratory.

The Construction standards follow.

II. Basic Laboratory Design Features

A. Physical Barrier

The laboratory shall be physically separated from areas that are open to unrestricted traffic within the building. Passage through two sets of doors is the basic requirement for entry into the BL3 laboratory from access corridors or other contiguous areas. A change room is recommended, with a shower (optional).

Guideline: CDC/NIH BMBL, BL3, Section III.D.1

Access

Access is restricted and authorized by the laboratory director or principal investigator only. Access should be designed to allow the fire department access in the event of a life threatening emergency.

Access for maintenance must be scheduled. Where feasible, control valves, filters, plumbing, electrical J-boxes, and other mechanical and electrical devices that may need maintenance should be accessible from outside the restricted area.

Doors should be equipped with an alarm or magnetic interlock, or the entry area so configured to prevent both sets of doors from being opened at the same time. Doors must also be self-closing and have crash bars for easy egress. The door shall be posted with entry requirements and procedures.

B. Interior surfaces

The interior wall, floor, and ceiling surfaces of the BL3 laboratory shall be water resistant, easily cleanable, and capable of being sealed for decontamination. Sealed penetrations are a necessary part of the facility to maintain negative air pressure and to facilitate decontamination.

Guideline: CDC/NIH BMBL, BL3, Section III.D.3.

- 1. **Ceilings**

Materials:

The ceiling must be gypsum board with a minimum of three coats of water-base epoxy finish. All joints must be fully sealed. Access panels, where necessary, must be fully sealed.

Sealants:

A long-life (≥ 15 year) silicone sealant or other approved sealant resistant to molds, fungi, etc. and not formaldehyde based must be used for sealing joints and penetrations. Silicone sealants are approved.

2. **Walls**

Materials, sealants, joints:

Walls must be gypsum board with at least three coats of water-base epoxy finish. All joints must be fully sealed, including door jams, power boxes, plug mould, wire mould, alarm or sensor boxes. Windows must be fully sealed. (CDC/NIH BMBL, BL3 Section III.D.6.)

All penetrations within the BL3 containment facility must be 12" or greater above the floor.

Sealants:

The ≥ 15 year silicone sealant is recommended. The sealant should also be fungus/mold resistant and maintain its flexibility over time.

3. **Wall /ceiling penetrations**

Electrical penetrations, including thermostats are to be minimized to one penetration. Electrical conduits are to be surface mounted with a weatherbox for plugs or switches. The conduit must be fully sealed off. This can be accomplished by using a product called seal-off or by placing a compound in the conduit around the wires and then backfilling the space with an approved silicone sealant. The conduit penetration is to be sealed minimally at the containment penetration. All screws are to be silicone sealed after seating.

Plumbing penetrations: Minimize penetrations so that only one penetration exists per utility. The penetrations must be completely sealed with an approved sealant and inspected before being covered. No floor drains are allowed in a BL3 laboratory.

C. **Electrical**

Lighting

The lighting panels shall be surface mounted. The conduit is to be sealed off where wires exit/enter conduit. If the lighting panels are not gasketed, then they must be sealed off with silicone. Lighting panels should be connected with surface-mounted hard- pipe electrical lines.

Every lab must have an emergency battery back-up light available to assist in the safe exiting of the laboratory in the event of a power outage.

Emergency power

Emergency power particularly for the School of Medicine has been discussed extensively. It is not currently feasible to provide the School of Medicine and other UC Denver buildings with uninterruptible power. Alternate sources of power and automatic switching make the risk of power outage on campus low. However, if a laboratory director feels that back-up power is needed for his/her laboratory, a UPS (uninterruptible power supply) might be considered to provide power for the critical equipment, i.e. biosafety cabinets.

D. Plumbing

Piping should be acid-resistant and should meet campus construction standards. There are to be no floor drains in the BL3 laboratories.

Sinks

A sink for handwashing is required close to the exit doorway with foot operated controls. It is also necessary to provide a face/eye wash station and a drench hose at a sink in the BL3 lab for emergency situations.

Gas Lines

Gas lines should be provided to the BSC when called for. There should be a shut-off valve located outside of the BL3 lab. An additional gas shut off valve with a handle should be located on the side of the BSC where gas is used.

Vacuum lines

House vacuum lines may be used in the BL3 facility. However, to assure that there is minimal opportunity for the house vacuum system to become contaminated, it is strongly recommended that an in-line HEPA filter be installed in the vacuum line at the perimeter of the BL3 facility. This recommendation is made to prevent the accidental contamination of the house vacuum system and potentially exposing physical plant workers to infectious agents. The vacuum line shall always be protected on the BL3 lab side by a liquid disinfectant trap, a dry disinfectant trap, and immediately before the vacuum attachment a HEPA filter. (CDC/NIH BMBL, BL3, Section III.D.11)

Disinfection/Sterilization

Following the use of the sink, the trap should be filled with 50-100 ml of bleach. This will protect the plumbing system from becoming contaminated.

Penetrations: All penetrations must be closed with an appropriate sealant. If sections of wall have been removed for plumbing to be installed, the opening must be closed up, finished, and sealed.

E. Flooring

The flooring material must be seamless and provide an easily cleanable surface. Two systems have been used successfully. The first is a monolithic epoxy flooring system and is available in variable textures to minimize slippage of personnel during daily operations. A second system is a welded or seamless vinyl covering. These systems must provide for an integral 4" coved base along walls and cabinetry.

F. Bench tops /Furniture

Bench tops shall be impervious to water and resistant to acids, alkalis, organic solvents and moderate heat. (CDC/NIH BMBL, BL3 Section III.D.4.)

BL3 research often involves the use of various hazards simultaneously. Therefore the materials used on bench surfaces should be able to withstand the chemical actions of these substances and disinfectants. It is recommended that the standard sink and bench top be composed of phenolic resin with integral sink. This material is less porous than slate or epoxy tops, but has the added benefit of minimal penetrations requiring to be sealed.

Laboratory furniture is sturdy, and spaces between benches, cabinets, and equipment are accessible for cleaning. (CDC/NIH BMBL, BL3 Section III.D.5.)

Laminated cabinetry is not recommended. Furniture should be metal. Wood is not recommended as it can chip and can absorb liquids.

G. Instrumentation

Biosafety cabinets

The choices for biosafety cabinets (BSC) are Class II Type A/B3 and Class II Type B2. The Class II, Type A is recommended, especially for work with low to moderate risk biological agents in the absence of volatile toxic chemicals and/or radionuclides.

A Class II, Type B2 biosafety cabinet is recommended for work with low to moderate risk biological agents in the presence of volatile toxic chemicals and/or radionuclides. The Class II, Type B2 biosafety cabinet must have a direct tie-in into the control system to monitor the exhaust flow. This flow information must be fed back to the pressurization control loop to ensure proper pressurization of the lab during normal and failure conditions.

It is important to remember that air supply grills be placed a minimum of 6' from the BSC and that the supply provide less than 20 fpm cross currents to these units. Placement of the units is also critical and they should be placed out of the flow of traffic and remote from any door. For proper operation of the BSC it must be assured that the ceiling height is adequate with sufficient clearance to provide for proper air circulation. Manufacturer's of BSCs have different specifications and must be reviewed thoroughly.

If a thimble connection to a Type A/B3 BSC is considered, it must be properly connected to an appropriate exhaust. The exhaust may not be via a common building or room exhaust, the preferred venting would be via a dedicated exhaust. The exhaust stack and fan must be labeled (see Ducting Section III.B. Ducting). The thimble connection, must not interfere with the air balance of the room.

The BSC should be set out from the facility wall to allow for easy cleaning, filter certification and replacement, and access to utility lines, i.e. vacuum and gas.

Centrifuges:

Centrifuges should be used only if they are equipped with safety cups or other secondary containment devices. Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharged into the laboratory. Non-CFC coolant centrifuges are recommended for new purchase. Some institutions have provided HEPA filtered shrouds over centrifuges where the effects of the agent may be uncertain or particularly hazardous. Such shrouds have been built by BSC manufacturers, further information may be obtained through the Biosafety Office.

Autoclaves

It is recommended that where feasible a pass through autoclave be engineered into the facility such that waste materials exiting the facility are autoclaved out. (CDC/NIH BMBL, BL3 Section III.D.7) The unit should have two sets of interlocking doors with control panels located in the containment suite. The unit shall also include a "Bioseal" which will seal the autoclave penetration within the wall. This "Bioseal" will provide for an air-tight seal. The autoclave coverplate must be attached to the wall and fully sealed.

As there is variation in autoclaves, it is necessary to verify before specification of the unit that steam requirements can be met and that steam pressure is available at the site of the new BL3 lab. Steam requirements may be in the range of 45-60 psi. The steam requirements must be approved by the Facilities Services group. It is also essential that proper drainage system for the autoclave is in place. The effluents shall be cooled, condensed, and directly drained into the floor drain.

Incubators

Incubators are available in various styles. The specification is up to the individual user, however, should a stackable incubator unit be considered, these should be anchored to the wall for improved stability. Electrical requirements and sufficient space must be addressed.

H. Alarms

The exhaust and supply fans and room pressure must be monitored by a visual and audible alarm and notify building maintenance and the BL3 facility. An audible fire alarm should be located within the laboratory. It may be advisable to include these alarms and any other monitoring devices in a control panel located within the laboratory or in the antechamber of the facility.

I. Access panels

It is advisable that access panels not be placed within the BL3 laboratory, if feasible. All access should be achieved from outside of the facility. Therefore, when designing the facility, maintenance access should be included in the design. As mentioned at the start, it would be advisable that a maintenance corridor or room be adjacent to the lab, where all necessary maintenance can be performed. Such an area would have all service shut offs, clean outs, HEPA filters, etc. located within it and allow for easy access and maintenance.

III. Ventilation System

A ducted exhaust air ventilation system must be provided to a BL3 laboratory. This system creates directional airflow that in addition to the lab's supply air, draws air from "clean" areas (e.g. corridors) into the laboratory toward "contaminated" areas (e.g. BL3 laboratory). Potentially biohazardous aerosols are contained within the laboratory due to laboratory air pressure is negative to adjacent areas. The exhaust air is not recirculated to any other areas of the buildings and is discharged to the outside away from occupied areas and air intakes.

Guideline: CDC/NIH BMBL, BL3, Section III.D.8

One of the key elements of the BL3 lab is the negative pressure of the facility. It is necessary that the mechanical system be able to provide this capability and maintain this environment continually

A. Supply Air

Supply air filters

The supply air handling unit should be fitted with 25/30% efficiency pre-filters and secondary air filters. The secondary air filter shall be rated at 90/95% efficiency.

Control of particulates into a BL3 area reduces the exhaust system maintenance and laboratory cleaning. It improves research quality by reducing the potential contamination of research products.

Supply air diffusers

Supply air diffusers such as perforated, circular, or quadrant sectional, shall be designed to provide no more than 20 fpm terminal throw velocity at 6 feet from any biological safety cabinet work zone and from the top of the cabinet, while maintaining uniform space temperature and not compromising the cabinet work zone efficacy.

Air Handling Unit - Supply Air

A dedicated HVAC system would be advantageous, thereby minimizing downtime due to non-BL3 HVAC maintenance or problems. A dedicated system would provide for greater reliability and control of the BL3 suite. In existing buildings, a separate air handler is desirable, although an existing air handling system can be modified, provided the modifications comply with section III.D (Interlock).

Separate air handling provides greater control of overpressurization of laboratory area if the exhaust should fail. Control of the supply air in an existing building via dampers that are normally open has been shown to work, but additional annual commissioning is required to verify the integrity of the damper controls. This is the responsibility of the laboratory and its managers in coordination with the Facilities group.

B. Exhaust Air

The exhaust air shall be HEPA filtered as it is exhausted from the facility. This can be accomplished either with exhaust air being controlled through a biosafety cabinet or the mechanical system being fitted with a HEPA filtration system.

Biosafety Cabinets

Vented, hard-connected biosafety cabinets may be used to discharge air from the BL3 laboratory. If Class II, type B(B1, B2, B3) cabinets are to be installed in the laboratory, air can be exhausted through the cabinets to provide HEPA filtration. When a biosafety cabinet is part of the room exhaust system, the unit must remain on continuously, except for scheduled maintenance, to maintain the negative room pressure.

The laboratory must be mechanically vented at all times, however supplemental room exhaust may be accomplished through a Class II Type B biosafety cabinet. When exhaust air is discharged through the biosafety cabinet, it must be assured that it can be tied into a hood exhaust system.

HEPA Exhaust Filtration

Exhaust air must be HEPA filtered before discharge to the outside. This is to protect maintenance staff and environment. It is recommended that the HEPA filters be located close to the facility perimeter and yet be accessible for easy maintenance. A system which is recommended is a bag-in/bag out system with 25/30 % rated pre-filters. The HEPA filters must be installed by a certification contractor and performance certified.

Ducting

Prior to installation of the ducting, the ducting should be cleaned of all visible dirt and particles and protected against further contamination with plastic. In some cases, it may be necessary that the duct undergo a static test to assure duct performance. Ductwork and associated equipment must be labeled with a purple stripe and tag indicating the potential biohazard if it is servicing a BL3 hood or lab.

Fan Redundancy

A redundant system is not required however, it is important that the scientific staff thoroughly evaluate and determine the risks involved should the exhaust system fail. IT should be noted that if manifolded Type B2 biosafety cabinets are used, a redundant fan should be provided.

C. Directional Air Flow

It is necessary for the research personnel to verify that the facility is operating properly before entering the facility. Therefore a visual display of pressure differential at the entry of the facility is necessary. A second display should be located in the lab with an audible alarm to indicate a non-containment room pressure situation. The display in the lab would indicate the negative pressure from the anteroom to the lab. (A digital photohelic, magnehelic, or analog gauge could be considered as an option.) The display should be part of an external control panel located outside the facility at the entrance of the laboratory in the corridor.

The negative pressure should be accomplished in a step progression from the corridor such that the BL3 containment lab is most negative. It is recommended that the negative pressure steps be by engineering the greatest negative step between the anteroom and the BL3 lab, thereby providing for the greatest margin of safety. The steps recommended are 0.07 " water column from anteroom

to lab and 0.03" water column from corridor to the anteroom, yielding a total difference from corridor to BL3 lab of 0.1" water column.

D. Interlock and Controls

It is recommended that an energy monitoring and control system (EMCS) with computer link be used for the BL3 HVAC system. It is suggested that the available control system be used for monitoring and control of the laboratory environment. Such a system would monitor the pressure differential across the HVAC HEPA filters, supply air flow, and exhaust air flow. The system shall also control comfort levels in the lab areas. If a Type B2 (100% exhaust) biosafety cabinet is used in the laboratory, it is necessary that the cabinet tie into the control system. The type of control system selected by Facilities Services for BL3 laboratories is a flow tracking system with direct pressure control cascade.

An interlock should be engineered such that the supply would be shut down if the exhaust fan failed. The control system would automatically notify laboratory personnel and maintenance by engaging an audio and visual alarm. Emergency procedures shall be posted at the alarm.

IV. Laboratory Commissioning

A commissioning table has been prepared to assist in the commissioning. A BL3 lab is to be visually inspected for sealing of all penetrations. Additionally the HVAC system must provide negative pressure. Alarms must also be available to notify occupants and maintenance of system malfunctions. Refer to the attached table for points to be verified.

3.6 UC Denver Security G/C:

- A. **Reference:** See Part 4, Section 16722 to complete electronic security requirements for building doors and camera.

3.7 High Performance Building Program

- A. Designs for new buildings and major renovations will adhere to latest high performance building program located on The State of Colorado Office of State Architect Website at:

3.8 Audio Visual

- A. **Reference:** See Part 4, Section 16780 for complete Audio Visual requirements and typical classroom and conference room layouts.