CONTRA COSTA COLLEGE

DESIGN GUIDELINES 2024

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OVERVIEW

Design guidelines are recommendations that provide colleges with a structured approach for developing their physical spaces. By offering a framework for cohesive and functional environments, these guidelines contribute to the creation of aesthetically pleasing campuses that align with the Contra Costa College identity.

Design guidelines facilitate efficient land use, support functionality, and enhance the overall experience for students, faculty, and visitors, ultimately fostering a distinct sense of place and contributing to a conducive and inspiring learning and working atmosphere.

Every project on campus will utilize the guidelines presented in this section. In addition, the guidelines set forth in this document should therefore be checked periodically to ensure they remain relevant. These guidelines are not exhaustive, but intended to work in conjunction with applicable building codes and regulations. It is expected that standards of care and best practices be applied to each particular discipline..

PURPOSE

The purpose of this document is to establish a framework for CCC college by identifying a clear direction for its physical evolution and establishing a road map to the future. This document seeks to both provide boundaries ensuring a cohesive campus identity while supporting creative expression and innovative design solutions unique to individual project programmatic and site characteristics. This document will serve as a reference for architects, engineers, consultants, graphic designers, college representatives and others to inform decisions and design directions taken during the duration of the Facilities Plan's implementation.

GUIDELINES FRAMEWORK

The guidelines will provide a clear and integrated framework for future campus development decisions, while also highlighting performance criteria that promote a healthy and pleasant environment to support the College's academic mission.

In the Building System Guidelines, specific prescriptive guidelines have been established regarding product, system, and/or manufacturer criteria unique to each College.

RESPONSIBILITIES OF DESIGN AND ENGINEERING TEAM

Design and engineering firms, consultants, or contractors are responsible for the review and compliance with the District's Guidelines and Standards within (or referenced within) this document. It is however acknowledged that project specifics may require that there be exceptions to elements that are defined within the guidelines. As such, it is the responsibility of the Design or Engineering firm(s) to present the District with compliance and/or requested exception(s) to these guidelines. It is also expected that District Design and Engineering Firms reference and comply with all regulatory requirements that are applicable to the contracted work(s) and will seek approval of all Authorities Having Jurisdiction (AHJ) over the project.

CAMPUS GUIDELINES

The Campus Guidelines presented in this section provide a framework for the future design of the site, campus, and facilities.

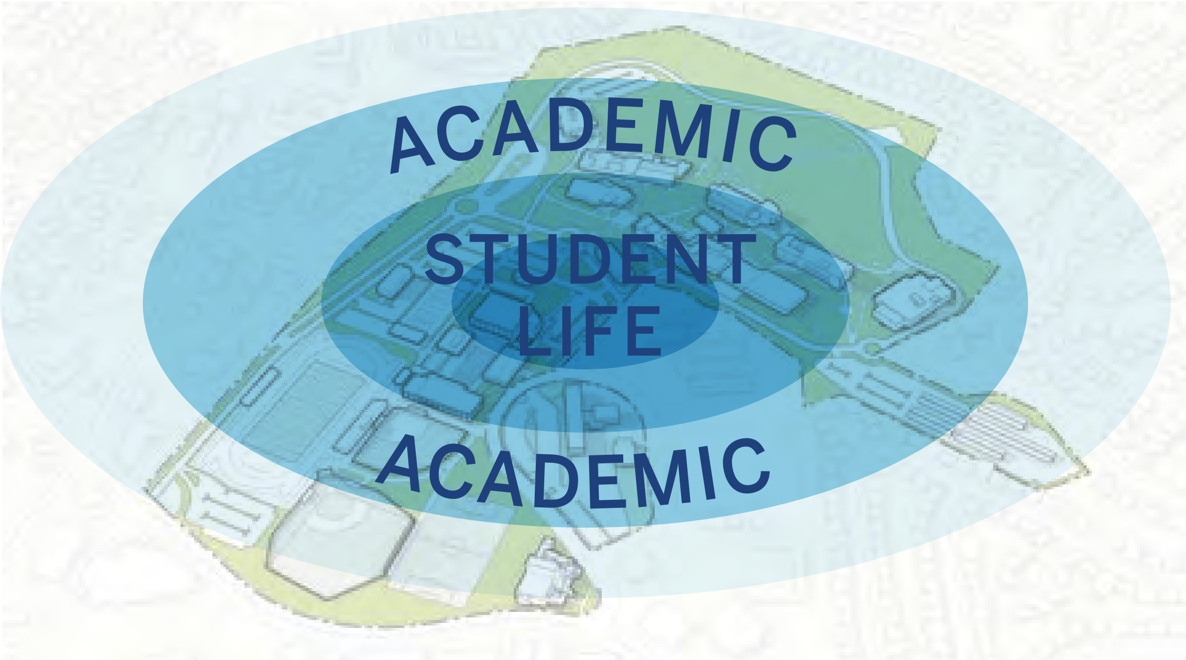
The guidelines are sequentially organized from general to specific elements and are meant to be complementary and cumulative.

- Organization & Identity
- Mobility
- Site Design
- Landscape & Hardscape
- Lighting
- Signage & Wayfinding
- Site Excavation & Infrastructure Development
- Security

ORGANIZATION & IDENTITY

CAMPUS ORGANIZATION

The current campus organization is aligned with the recommendations outlined in this plan for future development. The academic ring surrounding the campus includes areas dedicated to arts, general education, performing arts, and athletics. While, the heart of the campus, is characterized by student life functions, and will be further enhanced by the construction of the new Student Commons and Community Building.



CAMPUS IDENTITY

Developing the entire campus to create a strong sense of place for all students, faculty, staff, and community is fundamental for the future and growth of the college.

CCC campus is characterized by “zones” of various functions, including a student life-oriented core of campus and academic uses situated around the core.. The goal is to create a welcoming experience on our campus and an interactive connections among different programs to foster a sense of belonging and community among our students.

MOBILITY

MULTI-MODAL ACCESS AND PARKING

These guidelines relate to the design of the transportation infrastructure to allow the public to access the campus, as well as the long-term and short-term storage of personal and shared transportation (i.e. parking).

The guidelines support the safe and convenient access for all modes, but there will be a clear priority towards active transportation modes - walking, bicycling, and public transit - as they provide more equitable access to everyone, are more environmentally friendly, and have a smaller infrastructure footprint that better preserves the natural character of the site.

- Active transportation modes (walking, bicycling, and transit) shall receive priority over vehicles: consider development of physical infrastructure and convenience of access to the campus, amongst others.
- Wherever access for vehicles is provided, there shall be protected spaces for active transportation modes.
- Bicycle parking, including bike lockers, should be located in the most convenient location for accessing campus buildings, as well as bicycle and pedestrian circulation routes.
- A variety of landscape strategies should be considered in parking areas: landscaped bioswales and walking paths, as an example.
- Install and maintain a sufficient number of electric vehicle charging stations across the campus, strategically located near parking areas and key facilities.
- Reserve specific parking spaces for electric vehicles, clearly marked and located close to charging stations.
- Consider bikeshare infrastructure easily accessible and strategically placed for maximum usability,

SITE DESIGN

Providing development guidelines for outdoor spaces is essential to creating the look and feel for the CCC Campus. A unified appearance can be attained by following the general guidelines which include the following:

- Major Spines and Walkways
- Open Spaces and Plazas
- Natural Areas
- Outdoor Gathering and Learning Space
- Pedestrian Circulation

Major Spines and Walkways

Create well-defined walking paths radiating from the heart of the campus to the boundaries of campus. These paths should be wide, well-maintained, and lined with pedestrian-friendly features such as benches, lighting, and wayfinding signage. The pedestrian connectivity throughout the campus should be seamless and pleasant.

Open Spaces and Plazas

Open spaces are important features in a campus setting, and add to the campus experience. Open spaces, including plazas, landscaped areas, and natural areas, provide a unique campus identity to the College.

Plazas are a central component of CCC's open space program. Plazas combine hardscaped and landscaped elements and also function as great locations for events such as graduation, performances, and festivals. Plazas should incorporate shade structures, seating, and elements of visual interest such as artwork or water elements.

Natural Areas

Trails and open spaces along the creeks provide opportunities for students to reflect, connect with nature, and learn about the natural systems of the campus. Developing and defining these exterior places will celebrate the site and offer respite, meditation, and collaboration.

Outdoor Gathering and Learning Space

Flexible outdoor gathering and learning spaces are important to the campus setting to provide a diverse interaction opportunities for all students. Natural elements, materials, and landscaping all enhance the experience of outdoor gathering and learning.

Designing an outdoor gathering space on campus requires thoughtful consideration of its location and functionality to cater to various activities and group sizes. Placing the space where pedestrian paths merge, near dining areas, and where student interactions are frequent ensures accessibility and encourages spontaneous gatherings. The size of the space should be versatile, accommodating both small group conversations and larger events seamlessly. Incorporating natural landscaping such as trees, shrubs, and greenery around the space not only enhances its aesthetic appeal but also provides much-needed shade, creating a comfortable environment for extended stays and outdoor activities, regardless of the weather conditions.

Outdoor learning spaces are to be strategically placed on campus adjacent to academic building with classrooms or labs. Typically, they're located adjacent to corridors or quads, but should not be adjacent to loud gathering spaces. Spaces should be flexible in nature and designed with work areas and seating to accommodate small groups or a full size class. Seating can either be movable tables/chairs or large permanent features with ample space. Large over-story trees can provide shade, while creating a "room" feeling. Surrounding the learning space with medium-height plants creates an enclosed feeling, but views should be kept open to surrounding walkways for safety.




Pedestrian Circulation

Circulation refers to how people move about the campus. It considers a range of users from those attending a single event or class to those who may spend the whole day on campus.

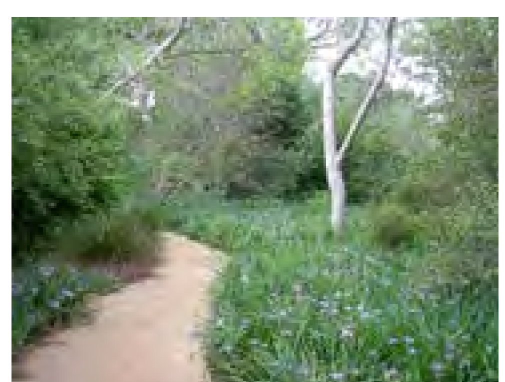
The proposed circulation plan establishes a framework for improved access, circulation, and safety throughout the campus.

- Campus shall strive for universal accessibility and landscape integration.
- Define clear and separated pedestrian and vehicular circulation.
- Shared streets on campus should be designed primarily for pedestrian use while accommodating vehicles as secondary users. This approach prioritizes safety and walkability, fostering a pedestrian-friendly environment.
- Where there is not passenger vehicle access, emergency and service access, made with permeable materials, shall be combined with pedestrian pathways, rather than separate infrastructure.
- All areas accessed by vehicles shall consider permeable, sustainable materials and shall employ NACTO traffic calming standards - to limit comfortable driving speeds to be 20 mph or below.
- Pick-up/Drop-off locations should be accessible.

LANDSCAPE & HARDSCAPE

Creating sustainable and environmentally friendly landscapes and hardscapes is essential for modern campuses seeking to minimize their ecological footprint and promote a healthier, more resilient environment. By incorporating principles of sustainability into landscape design and hardscape construction, 4CD can not only enhance the beauty and functionality of their campuses but also contribute to the well-being of the campus community and surrounding ecosystems by emphasizing practices that conserve resources, support biodiversity, mitigate environmental impacts, and foster a sense of stewardship among campus stakeholders.

- Local Climate: Select plants that thrive in Contra Costa County, they should thrive in the region’s cool, wet winters and hot, dry summers.
- Native Plant Selection: Choose native plant species for landscaping projects whenever possible. Native plants are adapted to the local climate and require less water, fertilizer, and pesticides compared to non-native species. They also support local ecosystems by providing habitat and food for native wildlife.
- Drought-Resistant Landscaping: Incorporate drought-resistant plants and xeriscaping principles to minimize water usage and promote water conservation. Use techniques such as mulching and drip irrigation to retain soil moisture and reduce water evaporation.
- Green Infrastructure: Integrate green infrastructure elements, such as rain gardens, bioswales, and permeable pavement, to manage stormwater runoff and improve water quality. These features help recharge groundwater, reduce flooding, and filter pollutants from runoff.
- Education and Training: Basic education and training should be provided to college maintenance and operation staff to ensure proper maintenance and care of plants.



SIGNAGE & WAYFINDING

PRE-JOURNEY ORIENTATION

Creating an intuitive, accessible, and cohesive wayfinding system is fundamental to the campus experience. This section details guidelines aimed at facilitating seamless navigation for all campus users, from first-time visitors to long-term students and staff, through well-designed signage and strategic placement.

Key Destinations for New Comers

- Visitors & Prospective Students: Highlight direct routes to the Welcome Services Center, the Book Center, and the Student Union.
- One-Time Visitors: Ensure visibility for cultural and athletic facilities, including the Athletic Facilities, the Performing Arts Center, Music Building and the Community Conference Center.
- First-Time Students: Prioritize signage for essential student services like Welcome Services Center, the Book Center, Student Union, the Learning Center and Communities Annex Buildings.
- Primary Student Destinations: Emphasize access to the popular destinations like the Library and the Diablo room for student activities such as extracurricular or personal/career guidance.

Vehicular Experience

The guidelines aim to optimize the vehicular experience on campus, ensuring clear navigation, safety, and a welcoming atmosphere from the moment of arrival. By integrating strategic signage, effective traffic flow, and digital aids, we facilitate access for all campus visitors, students, and staff.

Signage Design and Placement

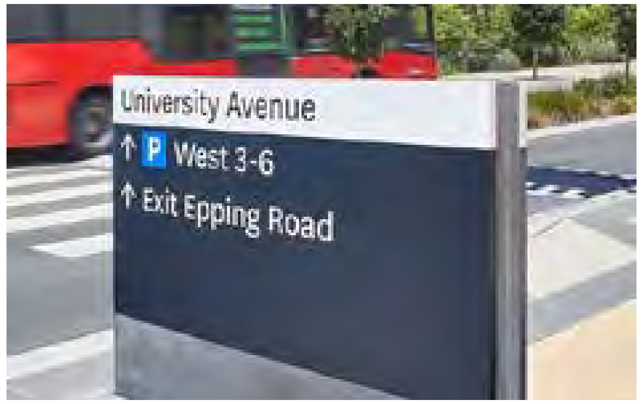
- Gateway Monuments: Create distinctive, memorable entrance features that signal main access points and integrate with the campus's overall design theme.
- Comprehensive Signage System: Deploy a system of lot identification, directional guidance, and parking information signs that are durable, visible at night, easy to maintain, up to date with destinations listed in proximity to the lot.
- Establish a clear hierarchy in signage: Prioritize large and legible numerical icons for directing to parking lots, ensuring visibility and ease of navigation for all visitors. Consider sizing supporting destination signs slightly smaller, suitable for repeat visitors.

Traffic Management and Digital Integration

- Efficient Traffic Circulation: Develop traffic management plans to minimize congestion and enhance vehicular safety across campus.
- Digital Navigation Aids: Integrate digital signage and online tools to offer real-time traffic and parking updates, complementing physical signage with mobile and web-based resources.

Implementation and Improvement

- Guideline Compliance: Ensure all developments and updates within the campus adhere to the established signage guidelines, maintaining consistency and coherence in design and functionality.
- Regular Review and Updates: Conduct ongoing assessments of traffic patterns, signage effectiveness, and technological advancements to continuously improve the vehicular experience.



PEDESTRIAN NAVIGATION

The guidelines are designed to enhance the pedestrian experience on campus, focusing on safety, accessibility, and ease of navigation. By incorporating comprehensive wayfinding signage, thoughtful pathway design, and digital resources, we aim to create an environment that supports and enriches the journey of every pedestrian, whether they are students, staff, or visitors. Potential wayfinding strategies are highlighted below.

Pedestrian Plan and Wayfinding

- Enhance Directional Signage: Address the current sparsity and lack of identifiability in pedestrian directional signage by deploying more signs at strategic locations, especially at intersecting pathways, to clarify navigation.
- Campus Maps and Directories: Increase the number and visibility of campus maps and directories at key entry points and popular destinations. Ensure that these resources are consistent with the digital wayfinding maps available on the campus website, improving readability and orientation for visitors and campus community members alike.

Standardization and Accessibility of Pedestrian Directionals

- Consistent Message Strategy: Standardize the message strategy across all pedestrian directional signage to avoid confusion and ensure information is up-to-date, legible, and easy to understand.
- Design Flexibility: Adopt new pedestrian directional signage with design options that cater to diverse needs, ensuring signs are recognizable, legible, and capable of accommodating changes in information or direction.
- Accessible Signage: Implement accessible signage that accounts for the campus's topography and architectural barriers. Include clear directions to ramps, elevators, and accessible routes, particularly at key transit points such as the north entry to the Commons.

Building Identification and Maintenance

- Diverse Identification Strategies: Standardize building identification strategies to enhance contrast and legibility across different materials and environmental conditions. Address issues of wear and visibility to ensure long-term recognition and maintenance ease.
- New Sign Standards for Building ID: Develop new building identification standards (BID) that are easily distinguishable from a distance and maintain clarity over time. Consider materials and designs that stand up to weather and wear while supporting easy updates or changes.
- Maintenance and Changeability: Ensure the new signage system, including building IDs and wayfinding panels, is designed for durability and ease of maintenance. Explore options such as replaceable panels instead of permanent vinyl to facilitate updates and repairs.

Implementation and Improvement

- Comprehensive Review and Update: Regularly assess the effectiveness of installed signage and wayfinding tools, making necessary adjustments based on campus development, user feedback, and emerging best practices.
- Collaboration and Compliance: Work closely with campus planning, facilities, and accessibility departments to ensure that all new signage adheres to these guidelines and supports the overall vision for an inclusive and navigable campus environment.

SITE EXCAVATION & INFRASTRUCTURE DEVELOPMENT

The future development of CCC will strengthen the established character and infrastructure. New buildings will be developed on a range of existing site conditions, from landscape to previously developed sites such as parking lots. New and updated infrastructure will similarly range in these development settings.

New infrastructure and buildings should take into consideration of their context with nature - developing a design that fits into, and enhances, the existing natural conditions of the site. This begins at a project's foundation: leverage existing topography and developed area to enhance its design, as well as rethink the purpose, impact, and synergies of the site infrastructure.

- Where feasible siting of new buildings and routing of infrastructure shall prioritize previously developed sites.
- Building and site design shall prioritize preserving existing topographic conditions in order to avoid excavation and regrading; regrading shall enhance natural ecosystems, plant, and animal habitats.
- As afforded green infrastructure strategies shall be prioritized over gray infrastructure.
- Infrastructure should provide multiple functional uses. For example, instead of simply channeling rainwater into underground pipes, the college could design streets with permeable pavements that allow water to infiltrate the ground. Additionally, incorporating rain gardens and bioswales can capture runoff, enhancing sustainability and supporting the natural ecosystem.
- On-site, closed, cradle-to-cradle infrastructure systems (e.g. treated water used for non-potable purposes) shall be prioritized over expanding existing infrastructure systems.
- Where excavation or fill is needed to create buildable areas, all earth excavated should remain on the property whenever possible, and all earth used for fill shall come from the property (excluding contaminated soil).
- The building and campus shall seek to be net-positive energy through on-site generation; development should use environmental design and strategic sustainable mechanical strategies to first reduce overall energy use.
- Building placement should account for path of travel between varying elevations to minimize additional site work, ramps, walls, etc.

SECURITY

Security encompasses physical, technology, and policy strategies to ensure a safe environment for everyone. In every sense, security strategies need to be inclusive to the experiences and perceptions of all groups across age, gender, and race/ethnicity.

Security and students safety is one of the District's primary concerns and should be addressed as such during the design and construction phases of each building and site improvement project.

- Overall approach to security should embody community and placemaking centered strategies, not "broken windows" theory approaches.
- Promote a common ownership to surveillance by everyone in the CC community by designing for diverse pedestrian activity while the campus is open.
- Prioritize planting and landscape strategies rather than built structures or surveillance technology.
- Ensuring landscaping strategies to provide clear sight lines.
- Use landscaping and clear entries to provide natural access control, indicate public routes, and prohibit unauthorized vehicles.
- When fencing is needed, it should be of aesthetic quality by using local, unique patterns and materials.
- Fencing and other security elements shall not disrupt or create any hardship for natural wildlife behavior and habitat.

BUILDING GUIDELINES

The Building Guidelines outlined in this section offer a framework for harmonizing architectural design elements such as building features, materials, massing, and height to create a cohesive campus environment.

By adhering to these guidelines, new construction and renovations can align with the overall aesthetic and character of the campus, promoting visual unity and a sense of continuity.

- Expression of Content
- Building Features
- Height and Massing
- Other Considerations

EXPRESSION OF CONTENT

This contextual sensitivity aims to provide an unique identity for the institution. Architectural concepts are conceived not just as structures but as expressions that reveal the essence of the building's contents.

A key strategy involves literal transparency, allowing glimpses into the engaging and intellectually stimulating activities associated with instructional programs. However, the challenge lies in balancing transparency with the practical considerations of audiovisual projection systems, which may be sensitive to daylight, and the need for wall space for equipment and displays. While strategic location of program elements can overcome this, a comprehensive solution is to approach all materials as contributors to this effort.

BUILDING FEATURES

The use of a **Large Glass Window Wall** promotes a seamless indoor-outdoor connection, allowing occupants to enjoy natural light and views of the surrounding landscape while fostering a sense of openness within the building, while the large glass wall should be situated in lobbies, lounge or entries, where it can either create an inviting atmosphere or visually represent the active programs taking place behind it. Highly efficient glazing shall be used to minimize heat gain/loss through the glass. Design for new projects shall Optimize the balance between glass and solid wall, and use shading elements to significantly reduce energy consumption, annual costs, and optimize thermal comfort.

The **Horizontal Overhang** not only serves a practical purpose by providing sunshade and protection but also becomes a distinctive feature expressing the entry wall. This design element adds a dynamic touch to the building's facade while contributing to energy efficiency by mitigating direct sunlight and reducing heat gain.

The choice of **Brick Veneer** establishes a tactile and visual connection with the landscape and hardscape, creating a harmonious blend with the natural surroundings. The combination of large glass window wall and brick veneer creates a captivating interplay between transparency and solidity, contributing to the overall aesthetic appeal of the building.

HEIGHT AND MASSING

The roof form should be kept consistent with concealed mechanical and electrical systems, which is a pragmatic and aesthetically conscious design approach to ensures a clean, cohesive appearance while maintaining functionality and ease of maintenance.

Consistent floor heights are desirable campus buildings. Variation in the level of the building floor pads is accepted however, in order to utilize the natural topography of the site and to effectively reduce the need to import engineered fill and associated construction costs.

By stepping and offsetting building planes, the design harnesses natural elements to provide shading, helping to regulate internal temperatures and minimize the reliance on active cooling systems. This sustainable approach aligns with environmental considerations and promotes energy efficiency.

Buildings are sited and configured to create pedestrian plazas / courts and to define the edges of the central plaza area.

The CCC campus is exempt from local building height ordinances, and the Plan sets no strict height limits. However, it is the intent to generally comply with the underlying zoning and regulatory constraints that would exist in the site were it being reviewed by the local jurisdiction.

Current buildings on the campus do not exceed 3 stories in height, excluding mechanical roof screens. Future buildings should respect this context and maintain harmony in overall height. If any proposed building exceeds 3 stories, it must undergo a thorough review process by the campus and district to ensure it aligns with the existing architectural framework and community standards.

Variation in height and massing is encouraged. Extending building elements such as stair or elevator towers to serve as landmark features is encouraged.

OTHER CONSIDERATIONS

SOCIAL SPACE

Incorporating student-centric spaces within buildings and outdoor environments is essential for fostering a supportive and engaging campus atmosphere and promoting student success. Every project should prioritize creating versatile and inviting areas that encourage collaboration, engagement, and a sense of belonging.

These spaces should be conveniently located for easy student access and feature movable furniture to adapt to various activities and purposes. Additionally, considering accessibility, safety, and sustainability ensures these areas meet the diverse needs of the student body. The use of hardscape, landscape, trees, and shrubs can effectively define seating areas, creating aesthetically pleasing and functional spaces that blend seamlessly with the natural environment.

RESTROOMS

The provision of restrooms must meet code requirements, at a minimum. A careful assessment of the uses and occupant loads must be done to ensure adequate facilities are provided. Access to restrooms shall be provided throughout the facility, including areas of the building that may be operated separately. At least one gender-neutral restroom per facility shall be provided at the minimum. The effort should be made for the transition towards having at least one gender-neutral multi-stall restroom in each new facility, depending on size and occupant load requirements.

LACTATION ROOM

Lactation rooms(s) should be distinct room(s) designed for their intended purpose (should not be in or accessed through bathrooms, locker rooms, or similar facilities). Lactation room(s) may be located near lobbies or main corridors, in proximity to breakrooms, bathrooms, and other core building functions. The room(s) shall be a private space with proper signage and adequate doors to ensure privacy. Each room shall be equipped with a lockable door, table(s) or counter, standard ergonomic chair(s), trash can, adequate lighting, and multiple electrical outlets. At least one Lactation room per building shall be provided. Location and design of room shall be considered and reviewed during the design phase of each project.

DISTRICTWIDE SUSTAINABILITY GUIDELINES

New buildings and major renovations shall be designed to outperform the requirements of Title 24 and meet the minimum requirements to participate in the California Energy Design Assistance (CEDA), or equivalent program. CEDA promotes the electrification and decarbonization of new building construction or major renovation. and provides utility incentives to owners who participate in this incentive program. CEDA works in collaboration with project teams to reduce energy demand, consumption, and carbon emissions. For projects that comply with Title 24 using the Performance Approach pathway, each of the three building components (envelope, indoor lighting, and mechanical/domestic hot water) shall meet or exceed the performance of the Standard design for that component alone.

2022 4CD DISTRICT-WIDE ENERGY & SUSTAINABILITY GOALS

The Districtwide Sustainability Guidelines aim at supporting the District's nine (9) Sustainability Goals. Design guidelines/standards include architectural, structural, mechanical, electrical, and plumbing sections that are all geared to help achieve the 4CD Sustainability Goals. Buildings being designed and built now, impact 4CD's 2025, 2030 and 2035 sustainability goals. New construction and major renovations should be designed to meet these goals, since old building stock without upgrade projects will have a harder time meeting these goals and because making these investments during a project/building update makes the most financial sense.

On November 9th, 2022, the Contra Costa Community College Governing Board adopted Board Resolution 20B in support of Sustainability and Climate Action. This resolution adopted nine sustainability goals, which are in support of the 2019 California Community Colleges Board of Governors (BOG) Climate Change and Sustainability Policy and in support of the 2021 California Community Colleges Board of Governors (BOG) Climate Action and Sustainability Framework. The Framework refined the 2019 policy to reach further as well as extended the end target year by five years, putting it out to 2035. This framework aligns with current state policies and includes comprehensive goals for establishing benchmarks and meeting targets for reductions in greenhouse gas emissions, energy efficiency, water usage reduction, waste, transportation, food systems, and sustainable purchasing.

The 4CD resolution forms the basis for future planning of necessary infrastructure upgrades and building retrofits. It was utilized in the Facilities Plans and serves as a guidepost for fine-tuning campus operations.

All new major construction projects shall be designed and constructed to be Zero Net Energy, meeting the below goals and meeting building codes. 4CD has already designed several buildings to be all electric and ZNE ready and are certifying some to be ZNE, using existing onsite PV. Combining this precedence with the shift in building codes to ZNE, all construction projects should be designed for electric heating/cooling and all electric heating hot water systems, combined with ZNE.

4CD has continued to improve all facilities through such sustainable projects as LED lighting upgrades, building automation/climate control systems, water conservation projects throughout all campuses and reducing utility costs and reliance on fossil fuels by investing in renewable energy sources across 4CD. Project teams should be innovative at combining projects and technology that may result in lower total cost of ownership, or balanced total costs (e.g. updating to LED lighting when replacing an HVAC system can result in smaller size/right sizing HVAC equipment), or replacing Building Automation Systems when doing major HVAC upgrades, even when only parts of a building are being touched.

The table below shows 4CD sustainability goals in more detail, with key intermediate goals, and some of the steps required to achieve the 2035 goals.

Categories	Categories	Intermediate Goals by 2030	Goals by 2035
#1: Greenhouse Gas (GHG)	Establish baseline/benchmark greenhouse gas emissions Conduct emissions inventory and create a Climate Action Plan	Reduce GHG by 75% below the baseline.	Reduce GHG by 100% below the baseline.
#2: Renewable Energy	Establish Campus-wide EUI score Conduct Effective Useful Life (EUL) analysis of all gas-using appliances and systems Plan for electrification of systems with EUL of less than 10 years	Decrease EUI by 25% Produce or procure 75% of electrical consumption using renewable energy	Decrease EUI by 40% ZNE Campus
#3: Green Building and ZNE	Benchmark EUI for each building Develop ZNE and campus electrification strategy Optionally conduct LEED or WELL assessments of existing buildings	All new buildings LEED or WELL Gold Reduce natural gas usage by 30%.	All new buildings ZNE and Zero Carbon All existing buildings LEED O&M Gold or WELL Gold equivalent Reduce natural gas usage by 75%.
#4: Transportation	Conduct accounting and conditions assessment of fleet vehicles; assess remainder rolling stock for electrification Develop EV charging infrastructure to encourage faculty, staff and students to use EVs Promote accessible shared transport methods Make pedestrian and bicycle assess improvements by 2025	50% of new fleet vehicles must be ZE vehicles 50% of rolling stock must be ZE Implement green parking permits by 2030	100% of new fleet vehicles must be ZE vehicles 100% of rolling stock must be ZE Achieve 50% reduction in Single Occupant Vehicle (SOV) transportation

Categories	Categories	Intermediate Goals by 2030	Goals by 2035
#5: Zero Waste	Conduct waste categorization assessment Benchmark and comply with T14, Division 2, Chapter 5 Benchmark and comply with Title 14, CCR Division 7 Develop a total material consumption benchmark Conduct an AB341 compliance assessment Centralize reporting for waste and resource recovery	Achieve zero waste to landfill Conduct a circularity analysis Reduce material consumption by 10%	Maintain zero waste to landfill. Increase material circularity by 25% Decrease consumption of materials by 25% by 2035
#6: Procurement	Benchmark sustainability of existing products and services Adopt sustainable procurement policy and administrative procedure Purchase environmentally preferable electronics products	Increase procurement of sustainable products and services by 25%	Increase procurement of sustainable products and services by 50%
#7: Water	Develop local benchmarks for potable water usage Identify non-potable water resources Create landscape zoning map and irrigation metering strategy Adopt CCC Model Stormwater Management Program practices	Reduce potable water usage by 25% Install meters on all landscape irrigation systems of 2500 SF or more (unless using local or municipal reclaimed water) Landscape plantings are 90% native Irrigated turf cannot exceed 50% of landscaped areas on campus Follow Municipal Separate Storm Sewer Systems (MS4) requirements	Reduce potable water usage by 50% Limit stormwater runoff and discharge to predevelopment levels for temperature, rate, volume and duration of flow through the use of green infrastructure and low impact development for the campus AND for new buildings and major modifications

Note: Goal #8 and 9 are irrelevant to the design guidelines, so they have been removed from the table above.

Designers should plan to attain the building design to comply with 4CD 2035 goals, as much as possible. For more details on how to achieve the desired goals, below are some more specific technical paths to implement into the buildings/projects design and construction.

GOAL 1: GREENHOUSE GAS (GHG) EMISSIONS

Technical Path

- Incorporate emissions data and analysis into the design decision making process, using actual utility emissions factors based on 4CD purchased electricity and gas and/or onsite renewable energy.
- Utilize the Facilities Plans and Electrification Study as a reference for electrification projects, including HVAC upgrades to reach this goal. Use emissions data, rate data, escalation data, EUL data, and other data/materials as appropriate, as they lay out options and viable plans to get to zero GHG emissions by 2035. Confirm all data with 4CD.
- Identify design strategies and technologies early in design to minimize emissions during both the construction and operation of the facility.

GOAL 2: RENEWABLE ENERGY

Technical Path

- Review the existing and proposed EUIs in the Electrification Study, to understand the baseline and target EUIs for the building/project. Design building/project to meet or beat the target EUIs.
- Identify and implement design strategies and technologies that prioritize enhancing energy efficiency across existing infrastructures, focusing on reducing EUI through targeted retrofits and upgrades.
- Convert natural gas-fired equipment to electric heat pump technology as much as possible. Doing this allows us to buy clean, green electricity, or produce it for free on our campuses, thus reducing our annual utility costs and achieving zero GHG emissions. Reference the Electrification Study.
- New buildings shall be fully electric, using heat pump technology for heating/cooling and domestic hot water. Incorporate the analysis of benefits of designing around adding thermal energy storage on the heating side, to reduce heat pump size and first costs and optimize GHG reductions, as well as optimizing controls for grid response for demand based savings.
- Incorporate requirements for 4CD to be able to capture funding from the Inflation Reduction Act (IRA). Funding for 4CD may primarily come from projects related to solar PV, BESS and thermal energy storage technologies. Utilize utility incentive programs to gain incentives for 4CD to utilize to fund future energy efficiency upgrade. The current utility based incentive program that is required on 4CD projects is the California Energy Design Assistance (CEDA) program which promotes the electrification and decarbonization of new building construction or major renovation.
- Include energy efficiency measures such as LED lighting, converting building automation controls to our master controls spec using ASHRAE Guideline 36 to optimize building controls, comfort and efficiency, installing building electric and gas meters, and adding more onsite solar PV to offset GHG emissions from purchased electricity and to provide annual utility cost savings. Reference the Electrification Study.
- Integrate renewable energy solutions by expanding on-site solar power generation and adding BESS, as appropriate. 4CD prefers canopy/parking lot-based solar PV systems, rather than building systems.
- Embody innovation and suggest/find solutions for more gas-fired equipment that can be considered more difficult-to-convert such as Bunsen burners and art kilns.

GOAL 3: GREEN BUILDINGS

Technical Path

- Establish target Energy Use Intensity (EUI) for building/project. Reference the Electrification Study for baseline and target comparisons and review Goal #1.
- All new buildings shall achieve LEED (or WELL) Gold certification, focusing on sustainable design principles to minimize environmental impact, and provide healthy, comfortable and energy-efficient buildings. All buildings/projects shall include Enhanced Commissioning level of Cx scope for envelope and MEP systems, including meters and energy dashboard. All building projects shall also include LEED Educational signage to showcase sustainable features in the building as a learning opportunity for our students, faculty and staff.
- Implement targeted upgrades and retrofits to existing buildings to achieve LEED O&M Gold or WELL Gold equivalence, emphasizing the reduction of natural gas usage and the promotion of renewable energy sources.
- Advance the adoption of Zero Carbon standards for new constructions, ensuring that all future building projects not only achieve ZNE status but also contribute positively to the campus’s overall sustainability goals.

GOAL 4: TRANSPORTATION

Technical Path

- Integrate pedestrian and bicycle infrastructure into building/project to improve access to/from/on campus and to/from public transit stations.
- Integrate bike lockers into building/project to increase access to bicycle/scooter transportation.
- Expand electric vehicle (EV) charging infrastructure across campuses to support and encourage the adoption of electric vehicles by the 4CD community, including fleet vehicles.
- Provide for clean, green, parking spaces to promote and encourage clean, green zero-emission transportation.

GOAL 5: ZERO WASTE

Technical Path

- Provide design of interior and exterior recycling, composting, and landfill bins as well as proper signage for each stream on projects/buildings to meet SB1383 requirements. Coordinate with 4CD for current standards.
- Try to reuse materials and reduce material consumption in building construction and building operation.

GOAL 6: PROCUREMENT

Technical Path

- Use 4CD's sustainable procurement policy that sets clear criteria for selecting environmentally friendly and socially responsible products and services in construction and building operations (anticipated release in 2025).
- Increase engagement with suppliers to encourage the provision of sustainable options, ensuring that procurement decisions are aligned with environmental stewardship and social responsibility goals. Provide guidance on building materials, construction methods and building operations/materials as well as building related furniture and fixtures.

GOAL 7: WATER

Technical Path

- Develop targets for potable water usage for building/project and identify alternative non-potable water sources for irrigation and other non-drinking purposes (toilet flushing, cooling tower make-up water, etc).
- Create a detailed landscape zoning map and implement an irrigation metering strategy to optimize water use across landscapes, adopting best practices for stormwater management.
- Integrate landscape irritation systems into Building Automation Systems.
- Provide water meters for all potable and reclaimed water usage and tie into BAS.
- Transition landscape to use native plant species to reduce the need for irrigation. In campuses where reclaimed water is supplied, provide a landscape that can grow and sustain the high minerals in the 4CD reclaimed water supply.
- Replace existing non-athletic irrigated turf with native, drought-tolerant plants and limit new irrigated turf to athletic fields.
- Implement green infrastructure and low-impact development strategies to manage stormwater runoff, ensuring that runoff and discharge levels are kept at or returned to predevelopment conditions.
- Develop landscape design that incorporates sustainable landscaping practices.

Through diligent planning, execution, and community engagement, these guidelines aim to transform 4CD campuses into examples of environmental stewardship and sustainability by 2035. Doing so, supports 4CD to achieve environmental justice, provide healthy, comfortable buildings, and reduce our annual operating costs for utilities and maintenance.

For a more detailed description of each goal, please reference 2022 4CD Sustainability Goals & Policy.pdf. Each year 4CD publishes an annual sustainability report (23-24 Annual Sustainability Report) showing their progress toward each of the nine goals.

REFERENCE DOCUMENTS

2022-2023 Annual Sustainability Report

2022 4CD Districtwide Energy & Sustainability Goals

INFRASTRUCTURE SYSTEMS GUIDELINES

SITEWORK AND WET UTILITIES

The proposed civil design guidelines below include considerations for grading, storm water management, and wet utilities.

Grading and Drainage

The finished grading should be designed to direct stormwater runoff away from the proposed building and towards stormwater treatment and storage facilities. Hardscape areas should be graded and coordinated with the building improvements, to meet ADA requirements and provide proper drainage. Softscape areas will be graded, as coordinated with the landscape architect, to utilize infiltration opportunities in order to reduce the amount of storm water runoff into the piping system. The onsite Storm drain system shall be designed to have a 25-yr storm event capacity.

- Grading requirements shall be consistent with the project Geotechnical report
- Cut and fill slopes should be 2:1 (horizontal to vertical) or flatter
- ADA path of travel improvements shall meet the most current version of the California Building Code (CBC), Part 2, Volume 1, Chapter 11B accessibility requirements

Stormwater Management

Development projects will be required to provide post construction stormwater treatment and storage facilities. The storage facilities shall be sized for the 100-yr storm event and to be of adequate size to detain and or infiltrate stormwater on the site to pre-developed levels. All Storm water runoff from impervious surfaces shall be directed to stormwater treatment and storage facilities. Utilize Best Management Practices (BMP's) and Low Impact Development (LID principles when designing the storm water runoff facilities. See Goal #7 in the "Sustainability Goals" Section.

- Develop a Stormwater Control Plan per Contra Costa County C3 requirements.
- Use LID practices such as BioRetention ponds, Vegetated swales, and planter boxes

Sanitary Sewer

Existing sanitary sewer that will be in conflict with proposed building footprints and site improvements will need to be rerouted and reconnected. Proposed routing shall maintain flows by gravity where possible to avoid the need for pump stations.

- Sewer pipes shall be PVC SDR 26 material
- Minimum slopes shall be 2% for 4", and 1% for 6" and 8" pipes. Flatter slopes if needed must be approved by district.
- Sewer mains shall have 10' minimum horizontal separation from domestic water lines
- Sewer laterals shall have 5' minimum horizontal separation from domestic water lines
- Sewer Manholes shall be spaced no more than 300'
- All sewer manholes shall have a permanently fixed tag or engraving with the manhole number and arrows indicating flow direction for each entering and exiting sewer line.

Storm Drainage

Proposed projects shall have storm drain inlets placed at all low points within pathways, and landscape areas. The building roof leaders shall be conveyed to Stormwater management areas for treatment and storage. Drains within landscape areas to be coordinated with the landscape architect. Drainage structures within pedestrian hardscape areas shall have ADA compliant Grates.

- Storm drain pipes shall be sized to accommodate a 25-yr storm event
- Minimum pipe size shall b 6"
- Storm drain pipe slopes shall be designed to maintain a minimum velocity of 2 ft/sec
- Storm drain lines 6" and smaller shall be SDR 35 PVC
- Storm drain lines 8" and larger shall be HDPE or RCP

Water Distribution

Existing water lines that will be in conflict with proposed building footprints and site improvements will need to be rerouted and reconnected. The sizes of proposed domestic water and irrigation services will be based on demands determined by the project MEP and Landscape architect. The sizes of the fire water system will be based on the California fire code requirements.

- Backflow devices shall be provided for each system (domestic, fire, and Irrigation)
- Waterlines shall have 3' minimum cover
- Water lines 4" and larger shall be PVC C900 material
- Irrigations lines shall be PVC schedule 40
- Recycled irrigation lines shall be purple pipe
- Fire Hydrants shall be placed at 300' maximum spacing and approved by the local fire authority
- FDC's shall be placed within 100' of a hydrant
- See Goal #7 in the "Sustainability Goals" section for reduced water usage goals
- All valve covers shall be affixed with the valve number

Gas Distribution

4CD new buildings are required to be all-electric and older buildings are shifting toward being all-electric through retrofits. All of this infrastructure has to be maintained and repaired and replaced by 4CD. That results in a lot of costs and risks associated with keeping a natural gas system. Transitioning away from this system reduces 4CD O&M costs and future investments into a system that is expected to be out of use, shortly. California is also shifting away from natural gas, and in doing so, the cost of natural gas is expected to rise quickly (and possibly exponentially) if a solid transition plan is not in place. When a project is impacted by existing gas lines or existing gas lines run through a project, every effort shall be made to consider electrifying systems being served by those lines, over investing in the repair and replacing of the gas infrastructure. Designers shall look toward the future and propose ways to mitigate upgrades to gas, and consider capping and abandoning gas lines instead of replacing as much as possible, balanced with the safety and operability of the system. Existing gas lines that will be in conflict with proposed building footprints and site improvements will need to have downstream equipment electrified or have the gas lines rerouted and reconnected, or some other alternative. An analysis of options should be presented to 4CD with pros and cons, including cost impacts. Any Gas line improvements shall follow PG&E Greenbook requirements.

BUILDING SYSTEMS GUIDELINES

The Building Systems Guidelines presented in this section provide a framework for the future design of facilities.

Major building systems (structural, mechanical, plumbing, and electrical) are presented in the next few pages.

STRUCTURAL APPROACH

This section outlines the District's efforts in both voluntary and mandatory structural upgrades. While voluntary upgrades demonstrate proactive measures to enhance structural integrity, certain impacts may require mandatory efforts.

SUMMARY OF STRUCTURAL EVALUATION/RETROFIT TRIGGERS

The California Administrative Code (CAC) Sections 4-306 through 4-309 regulate the structural requirements for altering existing buildings in public schools, including when a full structural evaluation of the lateral force resisting system (LFRS) is required. For projects with a cost over $100,000 that include structural work, there are four primary factors to be considered to determine if an evaluation/upgrade will be required:

- **Financial**: If the cost of the reconstruction, alteration, or addition of the project exceeds 50 percent of the replacement value of the existing building, then a required evaluation/rehabilitation is triggered. DSA's Interpretation of Regulations (IR) EB-4 Section 3 states that for K-12 and community college buildings, the default replacement value shall be per the Office of Public School Construction (OPSC) values, Alternative valuation methods are included in section 3.3 of the IR EB-4.
- **Occupancy**: If there is a change of occupancy that results in a structure being reclassified to a higher-risk category, then a required evaluation/rehabilitation is triggered. Risk categories are defined in the California Building Code Table 1604.5 and allow for a greater degree of resilience in certain structures.
- **Demand**: If there is an increase in lateral demand in any story or element exceeding 5-10% (usually incurred by increased seismic mass or wind area), cumulative since the original construction, then a required evaluation/rehabilitation is triggered.
- **Capacity**: If there is a decrease in the lateral capacity of a story or element exceeding 5-10% (usually incurred by removing part of the lateral system), then a required evaluation/rehabilitation is triggered.

If one of the above triggers is met, a full evaluation is required. The existing building must be analyzed, and retrofitted, if necessary, to meet the current building code. If the above triggers above are avoided, then an evaluation is not required. However, the District has the option of providing a voluntary seismic upgrade to address any deficiencies that are not otherwise triggered. Design team shall confirm with District if a voluntary upgrade is desired.

PLUMBING GUIDELINES

WATER CONSUMPTION MONITORING

All facilities shall install submeters and integrate them with the building management system (BAS) to closely monitor water usage across various systems and enhance water consumption efficiency. Submeter shall be installed to monitor water consumption in the systems listed below.

a. Total cold water entering the building.
b. Total hot water consumption from the central hot water system, sub-meter cold water makeup to hot water system.
c. Total reclaimed water entering the building.
d. Total irrigation water
e. Makeup water to the reclaimed water system.
f. Makeup water to cooling towers, evaporative coolers, and steam & hot-water boilers.

For further clarity on additional sub-metering requirements, it's advisable to consult with District representatives. Moreover, coordination with Division 23 to ensure compliance with established metering standards.

BACK FLOW/CROSS CONTAMINATION PREVENTION

To prevent backflow and avoid cross-contamination, several measures need to be implemented. Provide a backflow preventer at all new construction buildings. Coordinate with the Civil to install the backflow preventer on the site or to locate it inside the building. Backflow will be prevented by installing a backflow prevention device at each individual point of possible contamination, where devices such as vacuum breakers or air gaps per California Plumbing Code section 603 where an industrial water piping system is fed from the domestic water piping.

If reclaimed water is used within the building, consult the Campus representative for the approved list of authorized cross-contamination testing and local water agencies. Domestic cold water must be provided as a backup source for reclaimed water; it shall be supplied through air gaps; Reduced-pressure zone backflow preventer is not an acceptable backflow preventer for connecting domestic and reclaimed water systems.

A swing arm backflow preventer in the reclaimed water system is not an acceptable alternative to an air gap. Except with explicit permission of the Campus and local water agency, in the event an air gap system is not feasible.

DOMESTIC COLD WATER

District Office and Contra Costa College campuses don't have site-supplied reclaimed water. Therefore, potable water must be used for all water needs only on these campuses.

Cold water distribution shall be provided to all plumbing fixtures and equipment that require water connections. Emergency eyewashes, showers, and drenching hoses shall be supplied with domestic cold water. For ease of maintenance, isolation valves shall be provided for groups of fixtures, and each fixture shall have an isolation valve. New branch piping shall be provided with branch shut-off valves. Water piping velocities shall not exceed 8ft/sec and a minimum of 35 psi at the highest and farthest fixture. Valves shall be installed on all services provisioned for future connections. Water hammer arrestors shall be provided per PDI-WH-201. Access panels shall be provided for valves for service and maintenance. Water piping shall not be routed through the electrical room, elevator machine room, telecom, and similar rooms. Water piping shall not be routed under the building slab if possible. "Dead leg" branches on water lines shall be cut back as close as possible to the mains or nearest active tee. PEX pipes shall not be used. Mechanically formed tee fittings utilizing mechanically extracted collars or brazed outlets shall not be used. Copper Type L, K shall be used. Soldered and press fittings are allowed to be used in the new construction and remodel projects.

DOMESTIC HOT WATER/HOT WATER RETURN

Hot water distribution shall be provided to all plumbing fixtures and equipment that require hot water connections. Hot water and hot water return piping velocities shall not exceed 5ft/sec and 3ft/sec, respectively. A return system with the circulating pump shall be considered based on piping configuration and supply distances. Piping, valves, and access shall be the same as domestic cold water and insulated to CPC requirements. A master thermostatic mixing valve or a point-of-use mixing valve shall be provided to maintain hot water distribution/supply temperature.

DOMESTIC WATER HEATING

Districtwide Sustainability Goals established goals for campuses to achieve by 2035, with intermediate targets in 2025 and 2030. The campus design standards aim to help the district achieve these goals for reductions in natural gas and overall energy consumption and greenhouse gas emissions through requirements for both new buildings and retrofits. Retrofits of existing gas-fired water heaters shall evaluate and use heat pump water heater technology.

The goal is to implement all-electric water heaters in the new buildings and major retrofits. Design considerations should accommodate various configurations, including the use of heat exchangers that utilize either campus loop hot water or building heating hot water sources where available. For facilities with lesser hot water demands, options like a hybrid integrated storage type air source heat pump or a pure storage type air source heat pump shall be explored. Additionally, incorporating solar thermal panels with a small storage tank can significantly augment the sustainability of the heating system. Provide tankless point-of-use water heaters for remote fixtures to ensure immediate hot water availability, optimizing energy use. For the kitchen, gymnasium, and locker room shower areas, a minimum of (2) heat pumps, each sized for 50% design load, should be provided for larger capacities to further enhance system reliability. Storage tank water temperature shall be maintained at 140 degrees Fahrenheit or higher. Electric resistance storage heaters are not allowed.

SANITARY WASTE AND VENT

An efficient and compliant sanitary waste and vent system shall be provided, with sanitary and vent piping for each plumbing waste-producing fixture. Floor drains with trap primers shall be provided in restrooms, mechanical rooms, and elsewhere as required. The possibility of flush valve trap primer and P-Trap primers shall be explored. If it is not feasible, then provide mechanical trap primer or electronic trap primer. All sanitary and grease piping shall be sloped at a minimum ¼ inches per foot. Deviation from a minimum 2% slope must be approved by the AHJ. Mechanical equipment drains from boilers, hot water heaters, and shop equipment shall be indirectly drained to the waste system at the mechanical room floor drain. Use gravity flow for all building drainage systems where it is impossible; obtain approval from Campus representatives to provide sewage ejectors. This system shall also collect equipment condensate. Liquid waste from areas where oil and gasoline are present shall pass through an oil/sand trap, oil filtration system, and sand trap before connection to the campus sewer. Grease waste shall pass through the grease interceptor before connecting to the sanitary system. Floor drains in toilet rooms shall have vacuum breaker trap primers. Piping shall be no-hub cast iron with neoprene sleeve gaskets and 301 stainless steel clamps for sewer and vent with an option for DWV copper for 2 inches and smaller. PVC/ABS pipes shall be provided for underground piping for the drainage system except for grease waste. Underground piping clamps shall be 304 stainless steel. Condensate drain piping shall be DWV copper.

STORM WATER DRAINAGE

Building roof drain and piping system to be designed based on the rainfall intensity mentioned in the California Plumbing Code. Roof and overflow drainage shall properly drain roof areas into the site storm drain system. All storm drain piping shall be sloped at a minimum of 1/8 inches per foot. Piping shall be no-hub cast iron with neoprene sleeve gaskets and 301 stainless steel clamps. Underground piping clamps shall be 304 stainless steel. PVC/ABS pipes shall be provided for underground piping for the storm system.

GREASE/ SAND/OIL INTERCEPTORS

Grease interceptors shall be provided to remove fat, oil & grease from kitchen wastewater; it shall be located for easy access and maintenance, preferably outside. It shall be coordinated to locate 10ft away from any air intake. Campus representatives shall approve undercounter grease traps. Provide plaster, sediment, or sand traps at sinks that may discharge these materials into the waste system. Examples include sculpture rooms, pottery rooms, earth science and geology laboratories, greenhouse sinks, etc. Consider the use of a central large separator for a series of sinks or an area. All traps or separators below sinks shall be accessible, with easy-opening tops. Sand/Oil interceptor shall be provided for waste lines serving parking garage floor drains.

ELEVATOR PITS

A sump pit shall be provided inside elevator pits. The water removal system shall not be provided in the elevator pit. Remote sump pit and sump pumps shall be provided to pump any water entering the elevator pits.

WATER QUALITY

All drinking fountains shall be provided with point-of-use filters to ensure better drinking water quality. Refer to the *District's Manufacturer Spreadsheet* for the recommended drinking fountain Manufacturer & Model.

WATER REUSE SYSTEM

Dual Plumbing shall be provided in all new buildings to supply reclaimed water to all non-potable water fixtures and irrigation systems if the campus has a reclaimed water network. Campus reclaimed water on the site shall be utilized as a non-potable water resource. Grey water, rainwater harvesting, and black water treatment plants are not expected to be provided in each building. Domestic cold water backup shall be provided in each building with an air gap. A break tank with a distribution pump shall be provided. Bypass to the backup distribution pump shall be provided to feed non-potable fixtures using campus site water pressure. Backup water from the break tank will be pumped when reclaimed water is unavailable. Backup shall be an automatic switchover. Provide all required controls for the automatic switchover. The backup system shall be set to operate at regular intervals to avoid water stagnation and to keep the backup system operational on the regular basis. For further clarity on the additional reuse system, it's advisable to consult with Campus representatives.

PLUMBING FIXTURES

Plumbing fixtures shall meet the minimum requirement of California Green standards and LEED to ensure efficiency and sustainability. Refer to the District's Manufacturer Spreadsheet for the recommended Plumbing Fixture Manufacturer & Model.

a. Commercial Water Closet
   - Water Closet shall be wall mounted type with flush valves.
   - The flush valve shall be manually operated.
   - Flow per flush: 1.28 GPF or less.

b. Commercial Urinal
   - The urinal shall be wall-mounted with a top spud.
   - The flush valve shall be manually operated.
   - Flow per flush: 0.125 GPF or less.
   - Architect to coordinate with District representatives on the urinal stalls when all gender-neutral restrooms are planned.

c. Commercial Lavatory
   - Commercial metering faucets
   - Flow: 0.5 gpm or less

d. Commercial Sink
   - Commercial faucet
   - Flow: 1.0 gpm or less

e. Emergency Eyewash/ Shower
  - All emergency eyewash and showers shall comply with CCR Title 8, Section 5162, ANSI standard Z358.1-1981.

f. Drinking fountain
  - With the cooling system and bottle fillers

g. Hose bibbs
  - Within 20' of air handling units
  - Roof hose bibbs- Provide hose bibbs 100 ft from center to center with 50' radius hose coverage.
  - Façade hose bibbs- At least one hose bibb on each side of the building.

INDUSTRIAL COLD WATER

The industrial cold water systems shall be supplied through backflow preventers by the domestic cold water systems. Industrial water shall supply laboratory fixtures (sinks, cupsinks, hoods) and mechanical equipment requiring makeup water. Piping shall be Type L copper with soldered or press fitting. Design condition, piping, valves, and access shall be the same as domestic cold water. Install backflow preventer in an accessible location with the lower a minimum of 1' above the floor and the upper a maximum of five feet (5'-0"). Provide drainage receptor below the devices for testing or malfunction, like floor sink, floor drain, mop sink.

INDUSTRIAL HOT WATER/HOT WATER RETURN

The industrial hot water systems shall be supplied through backflow preventers by the domestic cold water systems. Industrial water shall supply laboratory fixtures (sinks, cup sinks, hoods). Piping shall be soldered with Type L copper. Design condition, piping, valves, and access shall be the same as domestic cold/hot /hot water. Industrial hot water shall be generated in a separate heater preferably and supplied from the industrial cold water system. The industrial hot water return system with the circulating pump shall be looped within the Industrial system. It shall not return to common heater if common heater serves domestic and industrial. A separate industrial loop heater shall be provided.

INDUSTRIAL WATER HEATING

Similar to domestic hot water heaters, The goal is to implement all-electric water heaters in the new buildings and major retrofits for industrial and process water heating. Design considerations should accommodate various configurations, including the use of heat exchangers that utilize either campus loop hot water or building heating hot water sources where available. For facilities with lesser hot water demands, options like a hybrid integrated storage type air source heat pump or a pure storage type air source heat pump shall be explored. Additionally, incorporating solar thermal panels with a small storage tank can significantly augment the sustainability of the heating system. For remote fixtures, installing tankless point-of-use water heaters ensures immediate hot water availability, optimizing energy use. A minimum of (2) heat pumps, each sized for 50% design load, should be provided for larger capacities to further enhance system reliability. Storage tank water temperature shall be maintained at 140 degrees Fahrenheit or higher. Electric resistance storage heaters are not allowed.

LABORATORY WASTE AND VENT

Laboratory fixtures shall be drained and vented with corrosion-resistant piping connected to a double contained limestone neutralization tank with a sampling station. No automatic monitoring and controls are required in the neutralization tank. The tank shall drain to the sanitary sewer outside the building. Above grade piping material shall be mechanical joint or cold-fusion welded polypropylene, high silicon iron (Duriron), or glass. Below grade piping shall be cold-fusion welded polypropylene or high silicon iron (Duriron). Piping shall be sloped ¼ inch per foot.

NATURAL GAS

The Electric Bunsen burner option shall be coordinated with the laboratory team as an alternative to gas. If gas service is needed in the laboratory, portable propane tanks may be an option to consider prior to adding a new gas service to the building. Gas pressure shall be reduced at the building to 7-inch water column. A seismic shutoff valve shall be provided at each building. Provide natural gas submeter and shall be monitored in ALC. Gas shall be distributed to laboratory benches and other uses as needed. Laboratory gas system shall be sized based on 1 cfh per lab outlet with no diversity. Bench Valves: Ball type with tapered sockets with ball and seat compatible with piping materials. Provide valve operating wrenches. Emergency gas shutoff shall be provided in each lab. Piping shall be threaded or welded Schedule 40 black steel. For the availability of gas service to the new building, consult with district representatives. If there are no site gas service available, local gas cylinders shall be provided.

LABORATORY PURIFIED WATER

Depending on the number of outlets and amount of water needed, either a central purified water system or a central reverse osmosis system with point of use deionization units may be provided. The system shall be designed as a continuous loop without dead legs, and connection lengths to faucets shall be limited to 6 pipe diameters. System water pressure shall be no more than 60 psig and water velocity at least 3 feet per second. Piping shall be cold-fusion welded non-pigmented polypropylene.

LABORATORY COMPRESSED AIR

An air compressor shall provide compressed air to lab benches where required. System shall be designed for 125 psig at compressor and 90 psig in distribution line, with adjustable pressure reducing valves at laboratory points of connection above ceiling to provide 15 psig air at outlet. Air shall be oil free and dried to minus 40ºF dew point. Air compressor package shall have air cooled, oil-free type duplex compressors (N+1). System shall be provided with a main tank and end of line surge tank and will be sized based on a 60% diversity factor and 1 cfm per lab outlet. Piping shall be Type L copper with silver brazed joints, cleaned and bagged.

LABORATORY VACUUM

A vacuum pump shall provide vacuum to lab benches where required. System shall be designed for minus 23 inches of mercury. Vacuum pump shall be a skid mounted duplex system (N+1) with a liquid interceptor with drain. System shall be sized based on a 60% diversity factor and 0.5 cfm per lab outlet. Piping shall be Type L copper with silver brazed joints. Local laboratory vacuum pumps, if any, shall discharge into the fume hood exhaust system ductwork.

SPECIALTY LABORATORY GASES

Specialty gases shall be provided by local gas cylinder stations. Piping shall be Type L copper, ACR grade, nitrogen purged, with brazed joints for CO2, N2, He, and Ar. Stainless steel shall be used for ultra-high purity gas piping.

LABORATORY OUTLETS

Provide hoods, laboratory tables with required type outlets manufactured by Water Saver Faucet Company, T&S Brass Company or equal. Specify valves on laboratory benches, tables and other equipment with index handles showing type of service. Use appropriately lined metal faucets for DI.

ENERGY EFFICIENCY / SUSTAINABILITY

The Districtwide Sustainability Goals established goals for campuses to achieve by 2035, with intermediate targets in 2025 and 2030. The campus plumbing design standards aim to help the District achieve these goals for reductions in overall energy and water consumption through requirements for both new buildings and retrofits. See the District-wide Sustainability Guidelines for more information.

Energy and water conservation measures for consideration include the following.

a. Fixtures
   - Low-flow fixtures
   - Dual flush toilets

b. Domestic and Industrial Hot Water
   - Size recirculating pumps for a 10°F temperature drop
   - Low flow showerheads without flow restrictors
   - Minimum R-16 insulation for storage tanks and packaged water heaters

c. Compressed Air and Vacuum Pump Systems
   - Do not provide once through cooling water systems.
   - Provide intercooled and aftercooled, 2 stage compressors/pumps for 5 HP systems and larger.

ELECTRICAL GUIDELINES

CODES AND STANDARDS

Systems shall be designed in accordance with the most recently adopted editions of the following codes:

- California Building Code (CBC)
- California Electrical Code (CEC)
- State of California Code of Regulations (CCR), including “Title 24” Energy Efficiency Standards
- NFPA-72 National Fire Alarm Code
- NFPA-101 Life Safety Code
- California Occupational Safety and Health Act of OSHA
- Division of the State Architect (DSA)
- Local fire marshal requirements

Reference standards of the following shall be used for design.

- ADA – Americans with Disabilities Act
- AEIC – Association of Edison Illuminating Companies
- ASTM – American Society of Testing and Materials
- IEEE – Institute of Electrical and Electronic Engineers
- ICEA – Insulated Cable Engineers Association
- NEMA – National Electrical Manufacturers Association
- NFPA – National Fire Protection Association
- IESNA – Illuminating Engineering Society of North America
- SMACNA – Sheet Metal and Air Conditioning Contractors’ National Association Seismic Restraint Manual: Guidelines for Mechanical Systems (conduit supports only)
- UL – Underwriters’ Laboratories
- USGBC – United States Green Building Council’s LEED Guideline

ELECTRICAL SERVICE

All new construction shall be designed for all-electric buildings, including all-electric HVAC and plumbing systems and food service equipment.

Electrical service shall be sized based on the following general purpose minimum load densities.

Space Type	Load Density
Corridors and Circulation Areas	Receptacle - 0.5 watt/sf
Offices	Power - 2 watts/sf
Conference Rooms	Power - 2 watts/sf
Classrooms	Receptacle - 3 watts/sf
Computer Labs	Receptacle - 10-15 watts/sf
Science Labs (Dry Lab)	Power - 5 watts/sf
IT rooms	Power - 20 watts/sf

For lighting power densities, follow prescriptive energy code requirements.

Additional power may be required based on specific program and equipment requirements and shall be confirmed by the engineer of record.

Include a minimum of 20% spare capacity at the electrical service for future expansion.

SWITCHBOARDS

Switchboards shall be dead front; indoor, front accessible. Switchboards shall comply with all applicable provisions of UL891 and NEMA PB-2 for low voltage distribution switchboards. Equipment short circuit ratings shall be determined from the existing 12kv distribution available fault data. Coordinate with campus facilities for any available fault current data during design.

Switchboards shall be constructed with silver-plated copper bars of 98% conductivity sized for 1000 amperes per square inch current density. The main circuit breaker shall be molded case type with adjustable long-time delay and ampere setting, short-time delay and pickup, adjustable instantaneous pickup. Ground fault pickup and delay with trip indicator. Feeder breakers shall be fully rated, group mounted, molded case type.

METERING

Multi-function microprocessor based meters shall be provided in each new main switchboard for monitoring of system power and energy in each building. The meters are intended to measure the whole building demand and energy, as well as the individual end uses, such as lighting, HVAC, domestic hot water heating, elevators, plug loads, IT loads, etc. The building level meter shall be a separate meter, rather than a combination/sum of all the submeters.

All meters shall connect to the 4CD BAS via BACnet IP. District BAS is Automated Logic WebCTRL. Meters shall include local connection via ethernet plug in to allow users to access trends and information on the spot. Confirm with 4CD if meters also need to be connected to Skyspark 4CD energy dashboard.

Refer to the District's Manufacturer Spreadsheet for recommended electrical metering manufacturers.

TRANSFORMERS

Step down dry-type distribution transformers shall be located in local electrical rooms to supply area 120/208 volt receptacle loads. Transformers shall be dry type, 220 degree C insulation, 150 degree C rise, NEMA TP-1 compliant.

Transformers serving computer loads and other non-linear loads shall be K-13 rated.

PANELBOARDS

Panelboards shall be surface mounted in electrical rooms with copper bus. Provide panel directory and nameplates; door-in-door construction with separate hinge. Panel to be fully rated for the available fault current.

Panelboards serving sensitive equipment such as: BAS panel, fire alarm control panels, and other project specific sensitive equipment; shall be equipped with a surge protective device (SPD).

GROUNDING

The electrical service to each building shall be provided with a grounding electrode system terminating to a wall mounted ground bus in each main electrical room. Exothermic connections shall be made to this bus.

The grounding electrode system shall consist of building steel, concrete encased conductor (Ufer), water main, and driven ground rods. Grounding electrodes shall be interconnected and bonded to the main ground bus.

A single #3/0 grounding conductor shall be extended to the TMGB from the electrical room ground bus. Confirm required size with IT designer.

Separate equipment grounding conductors shall be included in all raceways and branch circuits. This includes 120/208 volt receptacle circuits, 277 volt lighting circuits, and motor circuits.

CONDUCTORS AND CONDUIT

Wiring systems shall consist of color coded solid copper conductors for sizes #12 and smaller and stranded copper for sizes #10 and larger. MC cable installation shall not exceed 6ft. Circuits shall be sized to meet Title 24 requirements for voltage drop.

All conduit in public areas shall be concealed. Use one size up for conduit bodies and wide radius elbows for conduits.

INTERIOR LIGHTING SYSTEMS

Design lighting levels shall be consistent with the current IESNA recommended Illuminance foot-candle levels.

In general fixtures shall be lamped with LED lamps, incandescent lamps are not allowed.

Interior lighting shall be 3500K color temperature with a CRI of 90.

Lighting Fixtures shall consist of the following:

Offices	2x4 foot recessed LED luminaire, 2x2 acceptable for smaller rooms
Corridors	2x4 foot recessed LED luminaire or recessed 4 inch downlight 2x2 acceptable for smaller spaces
Classrooms	Pendant and/or recessed continuous row direct and indirect Led luminaire with low glare lens
Computer Labs	Pendant and/or recessed continuous row direct and indirect Led luminaire with low glare lens
Mech/Elect.Rooms	4 foot suspended/surface mounted LED strip luminaire
Stairwells	4 foot wall mounted LED luminaire with opal lens and integral occupancy sensor

In addition other downlights, wall sconces, wall washers and other specialty lighting fixtures may be used in specific areas based on the spaces particular requirements.

LIGHTING CONTROL SYSTEMS

Lighting controls shall comply with current Title 24 standards and consist of a digital lighting control system with panels located in the electrical rooms. Digital lighting system shall be wired for all new construction and connected to the 4CD BAS system via Bacnet IP for remote interface, monitoring and shut-off for code mandated HVAC occupancy shut-off requirements. Provide tie into BAS system in coordination with Division 25 and Division 27.

Retrofit or renovation projects can provide wireless lighting control devices on buildings that do not currently have BAS tie in. Wireless control system is a separate secure system that does not use the buildings WI-FI data system.

For any retrofit or renovation projects with an existing BAS system with lighting currently tied into the BAS, provide the same functionality with tie in for new lighting controls.

Occupancy sensors shall be wall mounted passive-infrared in small offices and ceiling mounted dual-technology or ultrasonic in open spaces. The digital lighting system shall provide a timeclock for general public area occupancy. Digital dimmer switches shall be provided for user override of preset controls. Photo-sensors shall be located per Title 24 to continuously dim lighting when sufficient daylight is available. Luminance Set-points shall be per IESNA recommendations.

Classrooms to be provided with scene switches. Typical classrooms have approximately 4 scenes. Coordinate with 4CD/end users for final programming (e.g. for presentation mode, etc.).

Controlled receptacles where required by Title 24 code are to be fully labelled and provide a non-controlled receptacle at each controlled receptacle location.

Exterior lighting shall be controlled via the BAS system's timeclock schedule for dusk to dawn with delay routines. Provide motion sensors as required by title 24.

Refer to the District's Manufacturer Spreadsheet for recommended lighting control manufacturers.

EXTERIOR LIGHTING SYSTEMS

The lighting standards intent is to meet aesthetic goals, address LEED standards, meet municipal requirements and to provide a safe environment for pedestrians and vehicles.

All lighting shall be appropriately scaled for its installed location.

Lighting design (physical fixtures, motion detection, off-hours, etc.) shall minimize night light pollution and promote dark night skies, balanced with consideration for safety.

Integrate lighting with other infrastructure to provide clear views along path of travel, such as bollards and seating areas.

All pole luminaire heights shall be less than 24 feet for maintenance purposes.

Create hierarchy of lighting (through color, intensity, fixtures, etc.) to complement circulation and wayfinding hierarchy systems and promote placemaking.

Utilize cut-off lighting fixtures to meet LEED and be dark-sky compliant.

Lighting should be considered that adds more visual interest to the site including accentuating key landscape and architectural features.

Exterior lighting is to be 4000K color temperature.

Lighting Fixtures shall generally consist of the following:

- Roadways and Parking Areas: Pole mounted luminaires with integral motion sensors.
- Pedestrian pathways: Decorative pole mounted luminaires.

Each pole light is recommended to be provided with it's own fuse. Use splitbolts with tape coating instead of wire nuts.

Designers shall review existing lighting at the campus and assess retrofit options as well as matching current installed luminaires during the design process. Refer to the District's Manufacturer Spreadsheet for recommended manufacturers.

EMERGENCY EGRESS LIGHTING

For new construction, power for emergency and egress lighting shall be supplied by central lighting inverters. When a generator is also provided, the central lighting inverter will be connected to the generator. Do not supply emergency and egress lighting solely from a generator.

Provide emergency relay for all egress lighting so that controls are bypassed during emergency conditions for lighting to be energized at full output.

MECHANICAL SYSTEMS POWER

Distribution equipment shall be located in mechanical rooms and on rooftops to serve fans, chillers, and related equipment. Motor control centers shall be considered where control and distribution can be centralized.

The typical voltage source configuration to motor loads shall be 480 volts 3- phase 3-wire. Motors with a nameplate rating 75 HP and greater shall have VFD controllers or equivalent reduced voltage starting.

PHOTOVOLTAIC SYSTEMS

The District prefers PV to be mounted to parking canopies in lieu of roof-mounted PV when possible. All PV systems shall meet all structural DSA requirements.

BATTERY ENERGY STORAGE SYSTEMS (BESS)

Provide BESS systems where required by code. Provide options to the District to minimize or eliminate BESS by using code calculation methodologies and exceptions. BESS systems, where required, shall be located outside where possible.

ELECTRICAL POWER STUDIES

All projects shall include electrical power studies and all studies shall be provided to the District upon project completion. Provide both reports in PDF format and power study models in native format. Studies shall include at a minimum short-circuit studies and arc flash studies. Selective coordination studies shall be provided when required by code.

The project is responsible for completing all measures required from the power study. This includes altering, upgrading, or replacing equipment upstream of the project and/or building, if required. Label all electrical equipment with arc flash labels.

ELECTRICAL TESTING REPORTS

All projects shall include electrical testing reports for insulation testing, torque testing, and ground fault protection (if applicable). All reports shall be provided to the District upon project completion.

ENERGY EFFICIENCY / SUSTAINABILITY

Energy conservation measures for consideration include the following:

- Lighting
  - Incandescent lighting is not allowed.
  - Use high efficacy luminaires with low glare.
  - Zone task lighting separately wherever energy efficiency can be improved by these measures.
  - Illuminance levels are to be based on IES standards, do not over light spaces. Direct lighting to task areas where possible.
  - Provide luminaries with replaceable drivers and LED boards where possible.
  - Recommend to select fixtures from DLC recommended list.
  - Refer to Districtwide Sustainability Goals section for energy compliance requirements.
  - New construction buildings shall be designed to reduce lighting power via implemented demand response system from campus network integrated into the BAS for activation of demand response on the lighting control system.
- Power
  - Provide energy efficient transformers compliant with Federal Code 10 CFR Part 431 and DOE 2016 efficiency requirements or better.

COMMISSIONING

The mechanical, electrical, and plumbing systems should be commissioned by an independent commissioning authority under separate contract directly with 4CD or its representative. All projects shall include LEED enhanced commissioning unless otherwise approved by the 4CD project manager. All electrical meters shall be included in commissioning scope.

MECHANICAL GUIDELINES

DESIGN CRITERIA

Weather Data

Weather data for all buildings complying with Title 24 Energy Standards using the Prescriptive Approach shall be from Title 24 Reference Joint Appendix JA2 per Section 140.4(b)3. Heating design temperatures shall be no lower than the Heating Winter Median of Extremes values. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wetbulb (MCWB) values. Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent cooling design wetbulb values.

The above shall also apply to 4CD buildings complying using the Performance Approach except for laboratories using predominantly 100% outdoor air shall be designed for the 0.1% Cooling design temperatures since laboratories are more critical and the use of predominantly 100% outdoor air makes them more susceptible to capacity shortages during extreme weather events.

These requirements are summarized below based on Title 24 2022 Appendix JA2. Use the latest values if this appendix is updated.

Weather Data

Application	Climate Zone 3 (Contra Costa College-San Pablo)	
	Heating	Cooling
All Occupancies, Prescriptive Approach	29°F	84°F DB 63°F MCWB 66°F WB
Laboratories, Performance Approach	29°F	90°F DB 65°F MCWB 69°F WB

Design Indoor Temperatures, Humidity, and Ventilation

The following table includes defaults for load calculations unless directed otherwise by 4CD or by applicable codes.

Interior Design Conditions

Space Type	Cooling		Heating		Ventilation			
	Drybulb Temperature (°F)	Relative Humidity (%)	Drybulb Temperature (°F)	Relative Humidity (%)	Ventilation Rate	Exhaust Rate	Pressurization	Recirc Air? Class of Air
Offices, conference rooms, corridors, lobbies	75	Not Controlled	70	Not Controlled	Larger of 0.15 cfm/ft2 and 15 cfm/p	0	NA	Yes Class 1
Classrooms, dry labs	73	Not Controlled	68	Not Controlled	Larger of 0.15 cfm/ft2 and 15 cfm/p	0	NA	Yes Class 1
Wet labs	73	Not Controlled	68	Not Controlled	Largest of: 1 cfm/ft2 (6 ACH) occupied 0.67 cfm/ft2 (4 ACH) unoccupied; cooling load; hood exhaust	Larger of lab hoods and as req'd for pressurization	-75 cfm per door negative	No Class 2
Enclosed commercial copy/print	75	Not Controlled	70	Not Controlled	0.15 cfm/ft2	As req'd for pressurization	0.05" negative	No Class 2
Restrooms	78	Not Controlled	68	Not Controlled	Transfer air	-75 cfm/ fixture	Negative	No
Loading dock	Not Controlled	Not Controlled	Not Controlled	Not Controlled	Transfer or outdoor air	-0.75 cfm/ft2	Negative	No
Kitchen	78	Not Controlled	68	Not Controlled	As req'd for makeup air	Per kitchen hoods	Negative	No
Dining	75	Not Controlled	68	Not Controlled	Larger of 0.15 cfm/ft2 and 15 cfm/p	0	Negative	No to offices, Yes to kitchen Class 2
Janitor Closets	Not Controlled	Not Controlled	Not Controlled	Not Controlled	Transfer air	-1 cfm/ft2	Negative	No
Telecom, IDF, MDF	78	Not Controlled	Not Controlled	Not Controlled	0	0	NA	NA
Mechanical, electrical, elevator control, plumbing	90	Not Controlled	Not Controlled	Not Controlled	Transfer air	0	NA	NA
Flammable and chemical storage	Not Controlled	Not Controlled	Not Controlled	Not Controlled	Transfer or outdoor air	6 ACH	Negative	No

Where ventilation is indicated to be by "transfer air", spaces should be conditioned using fans that induce air from adjacent conditioned spaces to the listed space as required to maintain the maximum space temperature listed or to makeup the exhaust rate listed; supply air from cooling and heating air handlers shall not be used.

Class of Air refers to the classification described in Title 24, which originates from ASHRAE 62.1. There are recirculation and separation distances in these codes that are tied to the Class of Air.

Internal Loads

Cooling system capacity shall be based on the following default load densities (load per conditioned square feet) unless otherwise noted by 4CD or stipulated by specific equipment in a specialized space. Lighting loads shall be confirmed with the lighting designer. For space types not listed, design conditions shall be determined by the design team based on expected equipment and lighting needs with approval from 4CD.

Default Internal Load Density

Occupancy	Lighting (W/ft2)	Equipment (W/ft2)	People		
			Density (ft2/person)	Sensible (Btu/hr per person)	Latent (Btu/hr per person)
Office ≤250 ft2	1.0	1.5	100	250	200
Office >250 ft2	0.8	1.5	150	250	200
Classroom	1.1	1.0	20	250	200
Breakroom	1.0	1.5	41	250	200
Conference room	1.2	1.0	20	245	155
Corridor/Occupied Storage	0.5	0.0	200	250	250
IDF/MDF/server	0.5	50.0	–	–	–
Lobby	1.2	0.2	150	250	250
Labs	1.0	6.0	100	250	200
Equipment/instrument rooms	0.5	15.0	200	250	200
Toilet	0.5	0.0	300	250	250

Central fan systems and risers, and central plant loads, shall be sized based on the total coincident load multiplied by a diversity factor. The following are default diversity factors to be used unless otherwise directed by 4CD.

Area	Diversity
Lab equipment loads, typical use	50%
Lab equipment loads, high use	100%
VAV fume hoods	50%
CAV fume hoods	100%
Lab occupancy	90%
Lighting power load (all spaces)	90%
Occupancy (all non-lab spaces)	75%
Plug loads (all non-lab spaces)	50%

HVAC System Design Temperatures

The following are default values for HVAC system design temperatures to be used unless otherwise directed by 4CD.

HVAC System Default Design Temperatures

Design Condition	Heating	Cooling
Maximum design supply air (at outlet)	95°F	65°F
Minimum design supply air (at outlet) perimeter zones	–	57°F
Minimum design supply air (at outlet) interior zones	–	62°F (note 1)
Design hot/chilled water supply	125°F	42°F
Design hot/chilled water temperature difference	≥25°F (note 2)	≥24°F (note 3)
Design open condenser water approach to wetbulb	–	7°F
Design condenser water temperature difference	–	15°F

1. Interior zones shall be sized for 5°F above AHU design supply air temperature to allow for warmer supply air temperature during cool weather on economizer
2. To minimize the cost of hot water distribution systems, heating coils, including VAV reheat coils, shall be selected to provide a minimum of 25°F ΔT. This may be possible with oversized 2-row coils depending on the manufacturer and circuiting options. Other manufacturers may require oversized 3-row coils. Use of 4-row coils is not acceptable due to high airside pressure drop. 4-pipe changeover coils should be able to produce even larger ΔTs or a lower HWST can be used.
3. Temperature difference shall be that which results from 8 row/10 fpi coils on AHUs, 6 row/10 fpi coils on fan-coils, and 4-rows on 4PVAV zones.

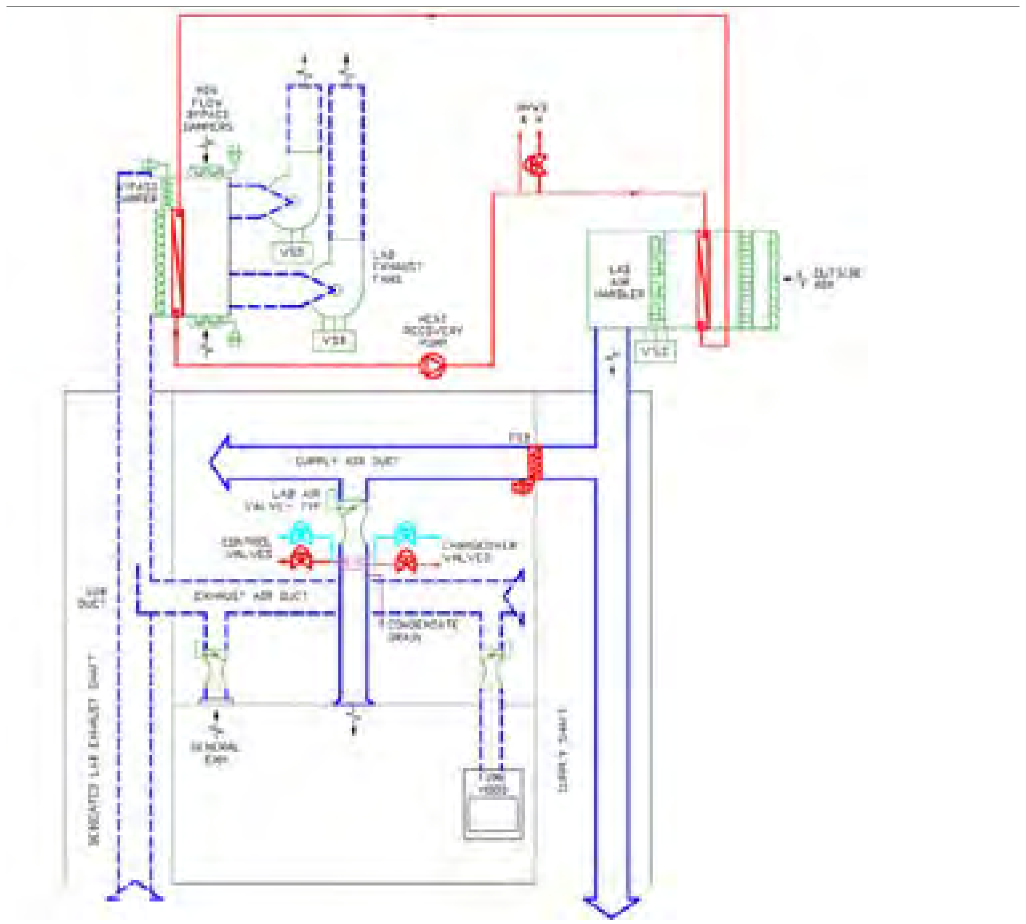
HVAC SYSTEM SELECTION

Air Distribution System Selection

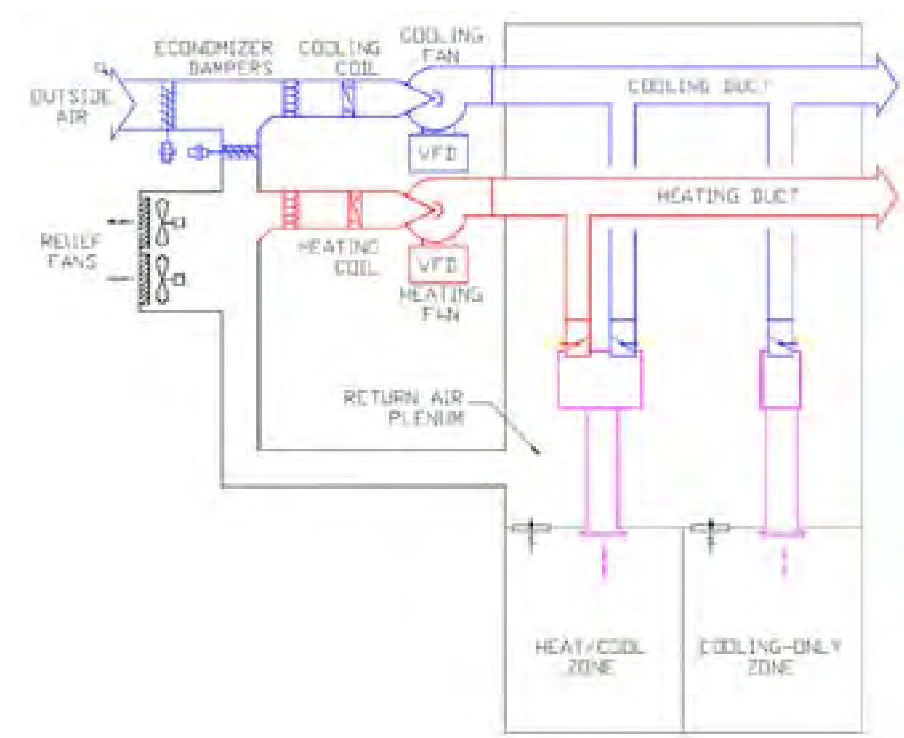
HVAC air distribution system selection will depend on the individual building and campus, so rigid selections cannot be mandated. But the following shall be used as a guide unless otherwise directed by 4CD.

Occupancy Type	Rank	System Type	Comments
Classroom	Best	Single Zone VAV	Include economizer and CO2 DCV. Fan must have variable volume ECM or VFD with minimum speed of 20% or less. If a packaged unit is used, compressor must have variable capacity. Economizer relief should be by barometric dampers if possible, or variable speed relief fans (powered exhaust). Minimum outdoor airflow must be dynamically controlled, not fixed damper
	OK	DOAS plus zonal fan-coil or VRF	DOAS must meet all prescriptive Title 24 requirements including Exception 6 to Section 140.4(e)1 (economizer requirement) and 140.4(p) (DOAS requirement) using Exception 3 to Section 140.4(p)2 and 140.4(q) (exhaust heat recovery) except in CCC (climate zone 3). Each zone must have a VAV box controlling outdoor air with both DCV and economizer logic. Economizer/ventilation relief should be by barometric dampers if possible, or variable speed relief fans (powered exhaust). Zone fan-coil fan must have variable volume ECM or VFD with minimum speed of 20% or less. DOAS must also be variable speed controlled by duct pressure.
	OK	VAV reheat Dual fan/dual duct VAV	Classrooms have high and highly variable ventilation rates so they can be inefficient when many classrooms are served by a single VAV air handler. But this may be the most practical option for multistory buildings especially those with a mixture of classrooms and other spaces such as offices that then can be served by a common air hander.
	Not allowed	Radiant Chilled beams Underfloor	Since ventilation rates in classrooms are so high, heating and cooling loads can be readily handled with air without additional non-air zonal systems. Plus radiant cooling and chilled beams are prone to condensation due to high space latent loads so ventilation air must be dehumidified at a substantial energy penalty. These systems also have high first costs. Underfloor air distribution has high first costs and is prone to control issues due to leaking floors and obstructed underfloor plenums.

Occupancy Type	Rank	System Type	Comments
Laboratories	Best	Four Pipe VAV (4PVAV)	See schematic below. This design, which is installed in the new Science Building at CCC, has no inefficient reheat typical of other lab systems but it requires chilled water be piped to each zone. Zone coils should be 4-row or 6-row changeover coils using 6-way valves where possible. The use of one coil reduces first costs and energy costs and substantially improves hot water ΔT even with very low HW supply temperatures. A run-around heat recovery system as shown below must be provided in Climate Zone 12, and should be cost evaluated in Climate Zone 3.
	Good	VAV reheat	Use a conventional VAV reheat system when budget constraints preclude 4PVAV. Include run-around heat recovery as noted above.
	Not allowed	Radiant Chilled beams Underfloor	Since ventilation rates in labs are so high, heating and cooling loads can be readily handled with air without additional non-air zonal systems. Plus radiant cooling and chilled beams are prone to condensation due to high space latent loads so ventilation air must be dehumidified at a substantial energy penalty. These systems also have high first costs. Underfloor systems are not appropriate for labs due to possible chemical spills.



Occupancy Type	Rank	System Type	Comments
Offices	Best	Dual fan/dual duct VAV	See schematic below. Include economizer with relief provided by barometric dampers if possible, or variable speed relief fans (powered exhaust). Include exhaust heat recovery where prescriptively required by T24; include bypass dampers on both sides. Zone control logic should be snap-acting (see Guideline 36) for all zones except conference rooms which shall use mixing logic. VAV boxes should be constructed with retrofit air valves ducted together in the field, rather than manufactured DD boxes which have high pressure drop and limited hot deck damper sizes.
	Good	VAV reheat	VAV reheat is not as efficient as dual duct, but it requires less mechanical room (or roof) space, less shaft space, and less ceiling space so might be best for some buildings. Include economizer, relief, and heat recovery as noted above for DFDD.
	OK	DOAS plus zonal fan-coil or VRF	See application requirements under Classrooms above. Fan-coil costs are 3x the cost of VAV zones and have higher maintenance costs, and the limited economizer capability hurts energy and indoor air quality performance. But VRF may be the best choice from a cost perspective for small buildings not connected to a central plant.
	Not allowed	Radiant Chilled beams Underfloor	Radiant cooling and chilled beams are prone to condensation due to high space latent loads so ventilation air must be dehumidified at a substantial energy penalty. These systems also have high first costs. Underfloor air distribution also has high first costs and is prone to control issues due to leaking floors and obstructed underfloor plenums.



Cooling & Heating System Selection

For campuses that have existing central heating and/or cooling plants, they shall be used for all buildings provided they have available capacity, if underground piping costs are not excessive (e.g. reasonable distance from the building to piping mains), and if the plant is all-electric (plants with gas-fired plants need not be used as discussed below). 4CD must approve for these exceptions to be applied.

Space heating for HVAC systems in new buildings and major renovations (e.g. gut-remodel) shall be all-electric; new gas-fired equipment in new buildings and major renovations shall not be permitted. Since heat pumps are expensive to install/operate and have large space requirements, attention shall be paid to maximize energy efficiency and conservation, avoid excessive equipment oversizing, and to leverage heat recovery opportunities where practical.

For retrofits of HVAC systems in existing buildings, including end-of-service life equipment replacements, every reasonable effort shall be made to decarbonize HVAC systems through both electrification of space heating systems as well as improved energy efficiency of associated systems. For example, several case studies have demonstrated 50% or greater reductions in natural gas consumption through improvements to the control of air-side HVAC systems consistent with the 4CD BAS standards.

Retrofits of existing gas-fired boilers serving heating hot water systems shall include a detailed evaluation of the feasibility of electrification, including but not limited to:

- Impact of lower supply water temperatures on capacity of pipe distribution and hot water coils through engineering calculations or field testing
- Risk of water leaks at pipe couplings at lower water temperatures through field testing
- Available outdoor space for air-to-water heat pumps
- Structural implications for rooftop heat pump applications
- Available electrical infrastructure at building
- Peak load determination (do not simply match existing equipment capacities)

New gas-fired space heating equipment shall only be permitted in retrofits if electrification is not feasible with practical mitigating measures, and with approval of 4CD. In such cases, alternative decarbonization efforts shall be considered through related efficiency measures, such as:

- Peak load determination to avoid oversizing of boilers
- Ensuring high plant turndown capability (10:1 or greater)
- Reducing heating hot water loads through air-side controls upgrades according to District BAS standards.

The table below describes a number of retrofit scenarios and some possible replacement HVAC systems for retrofits other than major renovations (note: the list of possible replacement systems is not exhaustive):

Occupancy Type	System Type	Comments
Gas-fired boiler	Air-to-water heat pump generating low temperature hot water (e.g. 120-130 F)	If hot water distribution and coils are compatible with reasonable modifications and available space
	Air-to-water heat pump generating high temperature hot water (e.g. 150-170 F)	If there are available, proven products and available space
	Heat recovery heat pump or chiller	Where there are suitable simultaneous heating and cooling needs
	Gas-fired boiler, with additional decarbonization through associated efficiency measures	If all-electric solutions are infeasible
Packaged single zone rooftop unit with furnace	Packaged single zone rooftop unit with heat pump	Replacement furnace units not permitted
Multiple-zone rooftop unit and hot water reheat terminals	Variable volume and variable temperature (VVT) heat pump unit	VVT units arranged to serve zones with similar load profiles
	Dual fan dual duct unit with air-to-air heat pumps	See discussion in previous Section
	VAV rooftop unit and hot water reheat	See discussion in previous Section
	DOAS and zonal fan-coil or VRF	See discussion in previous Section

For new buildings and major renovations, a life cycle cost analysis shall be performed at the Schematic Design stage to compare alternative system designs that comply with in Districtwide Sustainability Goals. LCC analyses shall include consideration of differential O&M costs between alternatives. All assumptions used in the evaluation shall be clearly stated. Utility rates, escalation, etc. used in the analysis shall be confirmed with 4CD. Every attempt should be made to ensure that all energy conservation measures with a simple payback period of less than 10 years are installed. The design process shall include attention to energy efficiency for systems not covered by Title 24.

Laboratory Systems

The following shall be used as a guide to the design of laboratory exhaust systems for new buildings as well as major retrofits unless otherwise directed by 4CD.

a. The design team should review and consider I2SL laboratory design guidelines I2SL Best Practices.

b. A single exhaust system shall be used to provide both general lab exhaust (for ventilation) and fume hood exhaust. This reduces the concentration of contaminants in the hood exhaust which reduces stack height and minimum exhaust momentum, and also has lower first costs than separate systems.

c. A wind tunnel study shall be conducted to:

- Determine minimum stack height and minimum exhaust momentum/velocity based on exhaust location, wind speed and direction, building architecture, and any nearby buildings that could influence dispersion. Fume hood stack height shall be as tall as feasible within architectural constraints (if any) to reduce stack velocity and fan energy, but in no case shall be less than 10 feet above the adjacent accessible roof surface. It is a 4CD policy that tall exhaust stacks on labs are considered acceptable architecturally – form follows function – so architectural issues shall only drive the reduction of stack height where approved by 4CD based on a detailed report of pros and cons to help 4CD make this decision.

- Determine exhaust rate/velocity as a function of wind speed and direction so that exhaust rate/velocity can be reduced dynamically by the control system. The 4CD master BAS specification include sequences of operation that can vary exhaust rate based on input from a wind speed station.

d. For exhaust systems smaller than about 15,000 cfm total, two single-inlet centrifugal fume hood exhaust fans should be used, each sized for 100% of the design exhaust rate and ducted at 45° discharge into a single discharge stack. This allows each fan to normally operate at 50% airflow to maintain stack velocity with immediate and automatic response to a fan failure, and no requirement for lead/standby logic. Note that the fans must be selected so they can operate at 50% airflow at design static pressure without operating in surge region. If the wind tunnel study shows that significant airflow turndown is possible (e.g. to <70% of design) for systems larger than about 15,000 cfm total, then the design team should consider three fans, each sized for 50% capacity, discharging into independent stacks that are ganged tight to each other (cigarette pack) to make one effective plume. (Because of the large turndown, using two fans at 100% each will likely have surge issues unless selected well away from the fan's surge line, which increases fan energy.) Note that mixed flow fans should be considered when three fans are used to reduce space requirements. Fans with induction cones or nozzles shall not be used since they have not proven to be effective at reducing stack height at a given discharge momentum.

e. Where the wind tunnel study indicates a minimum exhaust rate/velocity must be maintained, two staged bypass dampers shall be provided each sized for 50% of the bypass air rate required (minimum stack rate minus minimum hood exhaust rate with sashes close) at inlet plenum design static pressure. This provides for redundancy and more stable control.

f. Each fan shall have an all-stainless steel backdraft damper, either barometric or motorized.

g. Fume hood exhaust fans should be powered off the emergency power system. Makeup air handlers need not be on emergency power since fume hood sash closers are to be used to allow for safe exiting, as discussed below. All control systems required to be functional during loss of utility power shall also be powered off the emergency power system.

h. A runaround exhaust air heat recovery system shall be provided where required under the Air Distribution System Selection section with either:

- The exhaust coil sized for ~350 fpm (to minimize impact dirt accumulation) with a drain pan piped to the lab waste system. The coil will be regularly power-washed through an access door located upstream of the coil with effluent going to the lab waste system. This design avoids any hazardous waste and has lowest energy use, but requires the most space.

- The exhaust coil sized for ~500 fpm with a MERV 8 filter system upstream and a bypass damper around the coil and filter sized for ~≤0.2" pressure drop. The filters may require bag-in/bag-out capability if required by 4CD.

Coils and filters shall be between the fan backdraft damper and fan inlet to allow for isolation during maintenance. The runaround system shall include two pumps sized at 50% each and include a connection to the hot water system (as shown in the 4PVAV figure above) to avoid having to provide another expansion tank and makeup water connection and to provide emergency heat should the runaround system fail.

Heating and cooling plants shall be downsized based on the load reduction provided by the heat recovery system; this load reduction

i. Sound absorbing duct lining shall not be used in lab exhaust ducts. If sound attenuators are required, they shall be packless and of stainless-steel construction.

j. Labs that are “hood dominated” (meaning the design airflow to the lab is due to the exhaust rate from hoods when sashes are open), and “load dominated” (design rate is due to cooling loads) shall be VAV. “Ventilation dominated” (design rate is due to minimum ventilation rate/ACH) may be constant volume provided the design team is confident that hoods will not be added in the future, causing the lab to become hood dominated.

k. All fume hoods in VAV labs shall be VAV type with sash position sensors and shall have automatic motorized sash closers, factory provided with the hood, and controlled by a presence sensor over the sash. If the lab exhaust fans are powered off the emergency power system, then sash closers and their controls as well as all lab BAS controls shall also be powered off the emergency power system. The sashes shall be commanded closed by the BAS upon loss of utility power, as well as upon loss of makeup air in general, to reduce exhaust airflow and allow safe exiting from labs without the need for additional pressure relief devices. Coordinate with the lab equipment specifier to be sure fume hood sash closers are included with hoods and include a dry contact input to cause them to close despite the status of the presence sensor. Sash closers also significantly reduce energy use and improve hood safety. Note that sash closers were included in the new CCC Science Center building.

l. For “load dominated” labs where the airflow required by the cooling load is more than ~25% above that required for minimum ventilation or hood makeup, a separate auxiliary cooling system (such as a CHW or DX fan-coil) shall be provided to allow AHU supply air to be reduced to that required for minimum ventilation or hood makeup. This reduces energy use by reducing the quantity of outdoor air that requires conditioning.

m. “Hood dominated” labs shall have fast-acting controls, including pressure independent air valves on VAV fume hoods and for the makeup air supply and general exhaust. Fast-acting controls should be used also for load dominated labs to allow for hoods to be added in the future without having to change out air valves and controls. All airflow and pressurization controls shall by the BAS; a separate “lab control system,” as may be offered by the air valve manufacturer, is not desired nor allowed. Valves may be from any manufacturer provided they:

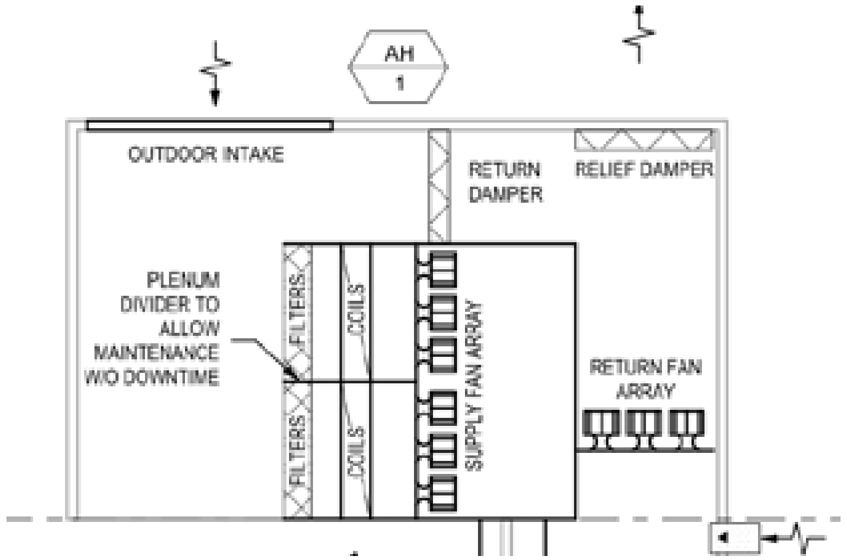
- Are pressure independent, either inherently using closed loop feedback controls or due to the valve design (e.g. venturi);
- Have the ability to control airflow to a setpoint provided by the BAS;
- Have a feedback output proportional to airflow; and
- Have damper position feedback (this requirement precludes the use of venturi type pressure independent valves since damper position is not known) either hardwired or via BACnet. The BACnet interfaces should be used where available.
- Have the capability of temporarily overriding the minimum (sash-closed) exhaust airflow setpoint, either hardwired or via BACnet, if the lab is using sash closers to provide for safe exiting but has so many hoods that even minimum hood exhaust with sashes closed results in excessive room pressures.

The 4CD standard air valve is AccuValve with BACnet interface.

n. Laboratory ventilation rates are indicated in Section 1.2 for both occupied and unoccupied modes. A lab is considered occupied when both of the following are true: the room is scheduled to be unoccupied per the BAS occupancy schedule and the room occupancy sensor (that used also for lighting control) indicates the room is unoccupied. Airflow rates are specified on a per unit area basis (cfm/ft2) instead of air change rate (air changes/hr.) to be more fundamentally correct – source strength of pollutants is not a function of ceiling height and labs with higher ceilings technically should have the same or lower (not higher) ventilation rates for the same pollutant source strength. The equivalent air change rates for rooms with a 10 foot ceiling height are listed in Section 1.2 for reference only.

o. Where labs and spaces such as classrooms and offices are intermingled in the same area, a single air handler should be used to serve both with return air only from the classroom/office areas. This reduces the overall amount of outdoor air that the building requires and also reduces first costs. In this case, a return fan should be used for return/exhaust from offices, rather than a relief fan, as it allows the damper on the outdoor air intake to be eliminated. See BAS master specification for control sequences for this design.

p. Where possible, provide a plenum divider to allow half of an AHU to be shut off for maintenance while still operating the other half. This is possible when the AHU serves both offices and labs as described in the previous comment. See figure below:



OTHER DESIGN CONSIDERATIONS

Flexibility and Maintenance

HVAC systems shall be designed with operations and maintenance in mind as a key priority. When evaluating alternatives, HVAC system selection shall consider total cost of ownership, including ongoing O&M costs. Where multiple HVAC systems are provided, designers shall strive for consistency in system type for ease of operations, within one building and, as practical, across buildings within the campus. Though novel HVAC systems and equipment offerings that help achieve campus sustainability goals are welcomed, project teams shall consider operability and demonstrated performance in other installations.

Zone Heating Capability

All zones should have heating capability except those with high internal loads such as copy rooms, IDF rooms, etc. Heat may also be omitted to interior portions of large open office plans with no roof loads since the perimeter zones can provide heat and ventilation to both areas. But heat should be provided to all lightly loaded interior zones, such as private offices, all conference rooms, and all classrooms to ensure they can be properly ventilated without overcooling. With heat at all zones, it is possible to eliminate heating coils at cooling air handlers.

VAV Box Schedules

All zones shall use the “dual maximum” VAV box logic and ventilation control logic that has been preprogrammed into the BAS for both dual duct and reheat systems. This requires that VAV box schedules include the following information:

- Cooling maximum airflow setpoint. This is the maximum airflow required to meet cooling design loads at design cooling supply air temperature and design cooling space temperature.
- Heating maximum airflow setpoint. This is the maximum airflow required to meet heating design loads at design heating supply air temperature (which shall be no more than 20ºF above space temperature setpoint per Title 24) and design heating space temperature. Note that it is limited to 40% of the Cooling maximum airflow setpoint when complying with Title 24 using the Prescriptive approach. It may be higher when complying via the Performance approach if the higher setpoint is included in the energy model.
- Minimum area-based outdoor air ventilation rate. This is the area-based rate per Title 24 Part 1 Sub-Chapter 3 Section 121. Typically this equates to 0.15 cfm/ft2.
- Minimum occupant-based outdoor air ventilation rate. This is 15 cfm/person times the design number of occupants.
- Whether spaces that are not occupied, as sensed by the lighting control occupancy sensor passed to the BAS via BACnet, can have zero ventilation per notes in the ventilation rate table in Title 24. This is called “occupied standby” mode and is allowed for almost all spaces in 4CD buildings except labs.
- Whether the zone has a CO2 sensor for demand-controlled ventilation. CO2 DCV is required by Title 24 for densely occupied spaces such as classrooms and conference rooms. The CO2 sensor is a standard option included in the thermostat provided with the BAS.

Note that there is no need to enter a minimum airflow rate – either delete the “minimum” column in the schedule entirely or enter “AUTO” in place of a rate. This shall be the approach used unless otherwise approved by 4CD. The BAS will determine the minimum rate dynamically based on the ventilation requirement, occupancy sensors, window switches, and CO2 sensors.

Natural Ventilation

Use of only non-powered ventilation, e.g. through the use of stack effect and wind, in lieu of mechanical ventilation systems is not effective in extreme weather and thus not allowed by code to serve as the sole ventilation system; a mechanical system is also required. However, mixed mode (hybrid) natural/mechanical ventilation systems are encouraged as a popular amenity in areas where windows are not shared (e.g. private offices, conference rooms) provided their operation is made to be mutually exclusive via the control system. This shall be done using window switches tied to the BAS; see 4CD master BAS specifications.

Ceiling Fans

Low speed, low noise ceiling fans should be used for spaces with high occupant activity levels, such as gyms and exercise rooms, rather than designing HVAC systems for lower space temperatures. ASHRAE comfort calculations show that occupant comfort for these spaces cannot practically be provided by maintaining cold space temperatures, and energy used to do so is definitely higher. Ceiling fans should also be considered as an energy conservation measure in other spaces to allow warmer space temperatures. Ceiling fans shall include override controls readily accessible to occupants since air movement for comfort is highly personal.

HVAC Zoning

All areas of the building shall be zoned as required to prevent non-uniform temperatures due to variable heat gain from outdoor exposure, variation in people density, etc. Each zone shall have its own thermostat(s) and terminal unit. The following zoning criteria shall be followed unless otherwise indicated by 4CD:

- Exterior and interior rooms shall not be served by the same zone.
- Enclosed rooms with different exposures shall not be served by the same zone.
- All enclosed corner rooms shall be separately zoned.
- Rooms shall be grouped onto the same zone only if space functions are similar, e.g. offices shall not be zoned together with classrooms or conference rooms.
- Each conference room shall be separately zoned if larger than 6 occupants.
- Each classroom shall be separately zoned.
- No more than 2 private exterior offices shall be served by a single zone but 1 is preferable.
- No more than 4 private interior offices shall be served by a single zone but 2 is preferable.
- Each room with an operable window shall have a separate zone (which shall include a window switch to shut off HVAC when the window is open).
- Enclosed production copy rooms shall be served by separate zones.

Noise

HVAC systems shall be designed to maintain the following Noise Criteria levels under normal operating conditions when spaces are occupied:

Area	Maximum NC
Lecture Halls Large Classrooms Teleconference	25
Small Classrooms Private offices General conference rooms	30
Open offices Corridors Reception/lobbies	40
Toilet rooms Storage	45
MDF/IDF/Computer rooms	55
Laboratories	50

Control of fan noise shall be achieved primarily through good acoustical design practice including air handler and duct design. Internal duct liner is acceptable at fan inlets and outlets and terminal unit discharge ducts and plenums but should be limited to that required to meet noise criteria. Liner shall not be used where it may get wet (e.g. cooling coil sections of AHUs and fan-coils, near outdoor air intakes, dishwasher exhaust) or on contaminant exhaust systems (e.g. grease exhaust, fume hood exhaust). Sound attenuators in general shall not be used due to high cost and pressure drop; with the proper selection and location of fans, proper air distribution design, and use of duct liner, sound attenuators should not be required. The exception is lab exhaust where no liner is allowed and fan pressure, and thus fan sound power, is high; this is discussed in the Laboratory Systems Section above.

Air Distribution Systems

The following are required design and construction practices unless otherwise approved by 4CD.

- Duct mains upstream of VAV boxes and ductwork to VAV boxes (“medium pressure”), shall be sized and designed per these articles:
  - VAV System Duct Main Design, ASHRAE Journal April 2019
  - VAV Box Duct Design, ASHRAE Journal July 2015

- Low pressure ductwork shall be sized on average no more than 0.1” per 100’ friction rate.
- Flexible ductwork shall not be used on medium pressure duct systems upstream of VAV boxes.
- Elbows should be radius type with either a full radius or reduced radius with splitter vanes.
- The ceiling and architectural shafts shall be used as return air plenums without sheet metal return air ducts or duct risers. Doing so reduces first costs and energy costs. The reduced ceiling congestion also indirectly reduces costs of other trades and improves future flexibility with respect to architectural changes. However, the lack of ductwork can, ironically, lead to constricted return air paths because of inattention to obstructions such as full height walls. Care must be taken to maintain low velocity return air paths from each space back to supply air and relief fans. Lined sound boots must be used for return air transfer at all spaces designed for NC 30 and less and as recommended by the project acoustical engineer. See Return Air Systems, ASHRAE Journal, March 2015

Water Distribution Systems

The following are required design and construction practices unless otherwise approved by 4CD.

- Piping shall be sized based on life cycle costs or using the sizing tables in this paper: Optimizing Design & Control Of Chilled Water Plants, ASHRAE Journal, December 2011.
- Variable flow systems shall not be balanced in accordance with this paper: Doubling Down on Not Balancing Variable Flow Hydronic Systems, ASHRAE Journal December 2017
- Hot water heating systems shall consider the design and operational factors impacting heating loads and equipment efficiencies identified in this design guide: Hot Water Heating Design and Retrofit Guide.
- Piping shall not be run through IDF rooms, telecom rooms, etc. where leaks can damage electronic equipment, except for piping serving AC equipment in the room. Where such piping is located above electronic equipment, provide auxiliary (secondary) drain pans to minimize damage due to leaks.
- CHW coils do not require an auxiliary (secondary) drain pan where high condensate switches are provided.

Reliability and Redundancy

The following applications shall have fully redundant (N+1) devices in parallel such that failure of one device will not reduce capacity below design capacity:

- Lab exhaust fans serving fume hoods
- Air handlers serving critical computer rooms
- Fans in air handlers serving labs. If the air handler also serves non-critical spaces such as offices, then additional redundancy beyond the fans needed for offices is not required since airflow to offices can be limited in case of fan failure.

The following applications shall have a minimum of N devices in parallel each sized for 1/N of the load where N=2 at a minimum:

- Building hot water pumps
- Building chilled water pumps
- Fans in air handlers larger than 10,000 cfm

In general, where two or more devices operate in parallel, automatic backdraft dampers/check valves shall be provided to prevent backflow and each device shall have its own variable speed drive.

Where multiple fans in air handlers are required, plug fan arrays shall be used. They should be sized so that motors are 7.5 HP or smaller to allow for ease of replacement. When the number of fans is 6 or more, backdraft devices are not required provided slots are installed at each fan inlet to allow a fan to be manually blanked off should it fail. Fan arrays shall have a minimum of two variable speed drives and at least one variable speed drive per every three fans.

Variable speed drives shall not include bypass starters; VFDs have proven sufficiently reliable without them and bypass starters nearly double the cost of the drive.

Maintenance Access

Space shall be provided around all equipment for routine maintenance and inspection in strict accordance with recommendations of the manufacturer. Mechanical drawings shall show dashed maintenance access envelopes for all equipment to ensure space is provided during the design phase. Piping or other equipment appurtenances shall not encroach into maintenance access areas.

For motors over 7.5 HP, a lifting eye should be provided over the motor to allow ease of replacement.

Air handlers, pumps, and other major equipment shall be accessible without having to climb a ladder unless approved by 4CD.

Equipment such as terminal units located above ceilings shall be located where readily accessed for maintenance. Where possible, locate units in corridors where it is assured no furniture or equipment will be located below. Do not locate over:

- Light fixtures
- Ceiling height partitions
- Large, difficult-to-move furniture such as file cabinets, lab benches, and desks
- Large ducts, piping etc. that could limit access
- Inaccessible (e.g. drywall) ceilings unless there are no practical options. If required, access doors shall be provided to allow for complete and ready access to filters, valves, and all components requiring routine maintenance
- Ceilings of rooms designed for NC 25 or less

Access doors or panels shall be provided in HVAC equipment, ductwork and plenums as required for in-situ inspection and cleaning of the following:

- Outdoor air intake plenums
- Mixed air plenums
- Upstream of all heating coils, including those in VAV boxes
- Upstream and downstream surface of cooling coils
- Filters
- Drain pans
- Fans

Commissioning

The mechanical, electrical, and plumbing systems should be commissioned by an independent commissioning authority under separate contract directly with the campus or its representative. All projects shall include commissioning equivalent to LEED enhanced commissioning unless otherwise approved by 4CD.

Ventilation

Ventilation rates shall be in accordance with Title 24, section 121. These rates supersede those in the California Mechanical Code and thus CMC rates may be ignored. ASHRAE Standard 62.1 also does not apply to California, except for LEED certified buildings where calculations may be needed to demonstrate compliance with LEED prerequisites and to achieve the credit for 30% above Standard 62.1 rates. Title 24 rates are already about 30% above Standard 62.1 so this credit is usually readily achieved.

Outdoor air measurement and control and/or CO2 sensors are required in accordance with Title 24. Airflow measurement and demand-controlled ventilation control strategies are outlined in the 4CD Division 25 BAS master specifications.

HVAC system designs shall prioritize indoor air quality, particularly to classroom areas, such as through the use of HVAC systems with airside economizers. Airside economizers offer high energy efficiency and provide additional outdoor air above minimum ventilation requirements when ambient conditions are favorable. Research has shown the health, energy, and economic benefits of economizer systems, which can reduce airborne disease transmission and sick leave.

Filtration

Custom and modular air handlers serving occupiable areas shall include:

- 2-inch MERV 8 pleated prefilter. This filter shall serve as a construction filter and be permanently removed post-construction. (Prefilters have proven to not significantly prolong high efficiency filter life yet they increase energy costs and maintenance costs. They may be retained on a case-by-case basis if deemed desirable by 4CD staff.)
- 12-inch MERV 13A bag filter. In areas where wildfire smoke can be expected, consider using 22-inch MERV-15A filters. Bags are preferred to cartridge filters because they are less expensive and easier to maintain. The large depth is to reduce pressure drop and provide a long change out frequency, typically 12 to 24 months depending on local particle sources in the outdoor air.

Fan-coils and packaged units serving occupiable areas shall include MERV-13A filters, preferably 4-inch to reduce pressure losses through filters and reduce change out frequency, but no less than 2-inch per Title 24.

Ducted fan-coils serving non-occupiable areas, such as IDF rooms, shall be protected with minimum 2-inch MERV 8 pleated filters.

Ductless fan-coils can use the filter provided standard by the manufacturer.

Exhaust for biohazard and radioactive material cabinets shall include HEPA filters with bag-in/bag-out cabinets.

Note that MERV-A 13 and 15 ratings are "A" ratings, which means they are rated per ASHRAE Standard 52.2 including preconditioning per Appendix J. Filters that do not use the preconditioning step are usually an electret type that quickly lose their charge in the field which can drop their MERV rating 3 or more points. Bag filters almost never use this electric charge so can be relied on to meet the MERV-A rating, but the A-rating of 2-inch and 4-inch filters must be verified by the filter manufacturer.

BUILDING AUTOMATION SYSTEM

The current standard Building Automation System (BAS) for 4CD campuses is a high power direct digital control system manufactured by Automated Logic Corp (ALC) with standardized control sequences. No other manufacturers or control sequences shall be used except where required to repair and existing system from another manufacturer. For HVAC retrofit projects, all controls for the particular systems and equipment being retrofitted shall be updated to follow the 4CD standard using ALC controls.

Sequences of Operation

The control sequences included in the 4CD BAS master specifications are largely based on ASHRAE Guideline 36 and have been shown to deliver excellent energy efficiency and thermal comfort. Using consistent sequences for standard applications across the district also improves ease of maintenance and problem diagnostics. Standard sequences have also already been fully programmed and debugged, so using them reduces costs. Therefore, the sequences in the BAS master specifications shall be used verbatim for any of the standard applications covered. Custom sequences are acceptable for non-standard applications but should be based as much as possible on the master sequences.

Construction Documents

All 4CD projects shall use the Division 25 BAS master specifications:

- 250000 Building Automation Systems - CCCCD master
- 259000 Building Automation Sequences of Operation - CCCCD master

This is to ensure uniformity among BAS system installations and control sequences. Note that specifications include many choices and options that are often mutually exclusive, so it is imperative that they be carefully edited by an engineer who is experienced in controls and very familiar with the HVAC systems used on the project.

Control diagrams shall be provided on construction documents for all HVAC and plumbing systems controlled by the BAS. Example diagrams are shown in sample graphics files in AutoCAD format that may be obtained from 4CD. The design engineer may use them or create their own provided all of the points and interlocks are shown.

ENERGY EFFICIENCY AND SUSTAINABILITY

The Districtwide Sustainability Goals established goals for campuses to achieve by 2035, with intermediate targets in 2025 and 2030. The campus mechanical design standards aim to help the District achieve these goals for reductions in natural gas and overall energy consumption, as well as greenhouse gas emissions, through requirements for both new buildings and retrofits. See Districtwide Sustainability Guidelines for more information.

Title 24 Building Energy Efficiency Standards

For projects that comply with Title 24 using the Performance Approach pathway, each of the three building components (envelope, indoor lighting, and mechanical/domestic hot water) shall meet or exceed the performance of the Standard design for that component alone. CSU campuses have the same requirement – the procedure is documented here: CSU Compliance Requirements for 2022 Title 24 Building Energy Efficiency Standards

Note that most retrofit projects, however small, are considered "alterations" per Title 24 and thus fall under the Standards. Compliance, and demonstration of compliance, is required whether or not the project is required to be submitted to DSA.