



PRINCETON UNIVERSITY
FACILITIES DEPARTMENT
DESIGN STANDARDS MANUAL

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**Princeton University
Office of Design and Construction**

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The *Princeton University Design Standards Manual* is a living document established to guide Design Consultants through many phases of project development. It serves to consolidate and organize the range of institutional knowledge retained by the University Facilities Department Staff. It is intended to be updated bi-annually, although more current individual sections or supplements may be distributed or posted on an as-needed basis. Items in **dark orange** text represent these bi-annual updates. In addition, a web-based version of the document is available on the Princeton University Facilities Department Web Page @ <http://facilities.princeton.edu/sites/default/files/DSM.pdf>.

Compliance with the *Princeton University Design Standards Manual* is a contractual obligation of consultants retained under Article VI (j) of the university standard *Architect/Engineer Design Services Contract*. Responsibility for any non-compliant design and/or resulting installation falls within the respective consultant's scope of services. It is important that this document be reviewed, understood and any exceptions noted prior to entering into any such agreements. The Designer is expected to comprehend all aspects of the standards, including document preparation and review guidelines covering requirements for all submissions from schematic design through closeout requirements. In addition, dissemination of all pertinent sections of this manual to sub-consultants or appropriate members of the project team is the responsibility of the lead consultant under contract.

Please note that this document is not distributed to contractors. Therefore, items herein identified as part of Contractor or CM responsibility will only become known when shown on consultant's contract documents. *The Designer's documents are to include information pertinent to the contractor's scope of work (such as as-built information) so that the standards may be consistently applied.* Therefore, consultants' document coordination effort must include those items in the *Princeton University Design Standards Manual* that impact a contractor's or CM's ability to conform as well. This requires that consultants include all such contractor requirements from this manual in respective CSI specification sections and/or Drawings prior to document release.

The format for all sections contained in the *Princeton University Design Standards Manual* is consistently presented for ease of use. In addition to Design and Review Guidelines, each topic or section contains an introduction, list of internal contacts, appropriate code references, as well as an appendix of further informational references pertinent to the topic. Access to these appendices may be achieved through the respective Project Manager or through a web-based version available on the Princeton University Facilities Department Web Page @ <http://facilities.princeton.edu/sites/default/files/DSM.pdf>. Consultants are encouraged to take advantage of these resources to supplement information found in this manual.

The information contained within the *Princeton University Design Standards Manual* is not intended to limit design expression or material selections, but rather guide Designers in ways to expedite project completion within acceptable university guidelines. Exceptions to any design standard herein may be openly discussed and modified if the designer obtains written approval through the Project Manager. This process must be initiated through the Project Manager to assure proper notification and review, as well as to assure accurate and timely updates to the

manual. The use and inclusion of these standards in bid documents does not relieve the consultant or Architect of the responsibility and legal liability for any bid documents created from these standards.

Questions regarding content, cost or schedule impact to respective projects are to be directed through the Project Manager or Facilities Procurement Office before commencement of Design Services. Additional technical feedback may come from the internal contacts listed in each section. Any comments or improvements to this manual shall be welcome through these contacts or the AVP Office of Design and Construction (609) 258-3403. The *Princeton University Design Standards Manual* is intended for sole use on Princeton University related buildings and Facilities Department projects and may not be disseminated for any other purpose.

1. Introduction

Four (4) of Princeton's large and diverse group of administrative departments support the physical needs of the university's educational mission. They plan, design and care for the buildings and grounds, house and feed students, and generate the energy that heats, cools and powers our buildings. Within the **Facilities Department**, the majority of design team interaction occurs with the Office of the University Architect, Office of Design and Construction, Facilities Engineering, Real Estate Development and Grounds and Building Maintenance. These are most actively involved in development of plant and facility design, construction and preservation.

Although design consultants form a contractual relationship with the **Facilities Department**, it is often necessary to incorporate standards from related university administrative clients in the course of a project. The primary non-Facilities client is often **University Services**, primarily consisting of Dining Services, Housing & Real Estate Services, Conference & Event Services and Parking & Transportation Services.

In addition to Facilities and University Services, The **Office of Information Technology (OIT)** and **Department of Public Safety (DPS)** represent the balance of administrative departments that maintain design standards in this document. These clients are equal stakeholders in the planning of each construction or renovation project, although additional administrative departments may contribute programming needs on an individual basis.

2. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

1. Princeton University Governance:
<http://www.princeton.edu/main/about/governance/>
2. Princeton University Facilities website
<http://facilities.princeton.edu/about-us>

3. Facilities Department Organization and Function

The Facilities' Department responsibilities and staff complement are described below. All functions are located in MacMillan Building unless noted otherwise.

Departments/Functions

Office of the Vice President

The Office of the Vice President provides leadership to the numerous departments that comprise the entire Facilities Organization. The OVP coordinates efforts across those departments to ensure that the skills and resources of the Facilities Organization support the University's academic mission. They also support the sustainability mission of the University as they lead the effort to steward Princeton's resources in the most efficient and effective manner.

University Architect

The University Architect provides long-range planning support, including land use, zoning considerations and regional developments; coordinates and participates in Campus architectural development. Other services include environmental graphics and landscape design.

Office of Design and Construction

The Design and Construction Office manages capital projects (whether new construction or renovations) from design through construction phases. They act as liaison between the University department sponsoring the project and the rest of the project team, including designers, subcontractors, and contractors. Other services include coordination of interior design and furniture planning. (about half located at 200 Elm Drive)

Engineering and Campus Energy Department

The Engineering and Campus Energy Department provides a full range of engineering services including the mechanical, and electrical disciplines. It also administers utilities and infrastructure construction projects, operates the utility plants, and drives the University's energy and water conservation programs.

Office of Sustainability

The Office of Sustainability coordinates and advocates comprehensive sustainability efforts in university affairs through collaboration with students, faculty, staff, and administrators. The Office works in close collaboration with the Princeton Sustainability Committee (PSC) and its working groups to continue developing Princeton's leadership in addressing the intersection of economics, environment, and culture that defines a sustainable campus. The Office also administers the High Meadows Foundation sustainability fund which supports the research, education, and civic engagement components of the Princeton Sustainability Plan.

Operations

Operations maintains the buildings, grounds, labs, security and utility distribution systems on our main and Forrester Campuses, as well as off-campus graduate housing, faculty and staff housing, and commercial properties. We are responsible for civil engineering, environmental compliance, grounds and building maintenance, the vehicle maintenance and inspection garage, our fire and security alarm systems as well as management of solid waste and recycling streams.

Finance Administrative Services

Finance and Administrative Services (FAS) provides the Facilities operating departments with shared services including: budget, finance, materials management, procurement and contract administration, and support for information technology hardware and enterprise systems, including space planning and mapping (Archibus), work order and asset management (Maximo) and construction management (SharePoint and Primavera). FAS also operates the Facilities Service Center (FSC), which provides a central point of contact for the campus community, whether in person, by phone, email or via the web. The FSC resolves facilities related questions or problems (including custodial services, repairs, housing, pest control etc.) by direct action or referral.

Real Estate Development

The Office of Real Estate Development reports to the Vice President for Facilities, and provides property development and project management services for properties located 'off-campus.' We seek to leverage our staff through outside partners, and we leverage our real estate assets for their highest and best uses. We entertain traditional project structures as well as those uniquely available on a project-by-project basis. Projects range from administrative buildings, to residential, to multi-user projects.

4. University Services Department Organization and Function

Departments/Functions

Dining Services

Dining Services provides food services to the Princeton University community. It operates the University dining halls and related facilities for students, faculty, staff, and visitors. This department serves more than 3,000 student contract dinners in addition to operating several cafeteria facilities that rely mainly on cash business, as well as providing catering services for special events, luncheons, receptions, and dinners. (main office located at 26 College Road West)

Housing and Real Estate Services

With support from the rest of the Facilities organization, the Housing and Real Estate Services Department handles all aspects of the University's housing program. Currently, Princeton provides housing for over 5000 undergraduates and 1600 graduate students. Housing also manages several hundred units of faculty and staff housing. The Housing and Real Estate Services Department is responsible for on-campus dormitories, as well as a diverse stock of apartment buildings and single family homes. The department provides comprehensive property management services and monitors the use and condition of University housing facilities and furnishings, with special emphasis on concern for fire and life safety and sanitation. As such, Housing and Real Estate Services is a primary stakeholder for all work performed in any University dormitory or residential rental unit. Work in Princeton Housing units must be performed according to established protocols for notification and security. (main office located at New South)

Conference and Event Services

Conference and Events Services promotes appropriate use of available University facilities in periods of lower usage, especially during the summer months. Coordinates conferences and meetings for official University functions. It administers University policies concerning the use of University resources by external organizations and groups. Conference and Event Services assists University departments sponsoring conferences. (main office located at 71 University Place)

Transportation and Parking Services

Princeton University's Transportation & Parking Services provides reliable and safe parking and transportation services that enhance the quality of life while promoting sustainability, accessibility and mobility on campus for the Princeton University community. The office is responsible for all campus transportation and parking operations as well as event parking and TigerTransit shuttle services. Transportation & Parking Services also provides Transportation Demand Management (TDM) - reduction of single occupancy vehicle commutes to campus – to the campus community by offering car and van pool, car sharing, mass transit subsidy, and biking programs. (main office located at New South)

5. Department of Public Safety Organization and Function

The Department of Public Safety is the primary department at the University charged with creating a safe and secure environment. This task, however, is not one we can accomplish alone.

Our efforts to maintain a safe and secure environment rely on our ability to develop collaborative relationships with the many communities that make up the University. We believe

that through partnering and problem solving, we can make Princeton one of the safest universities in the nation. Please refer to Section 2.7

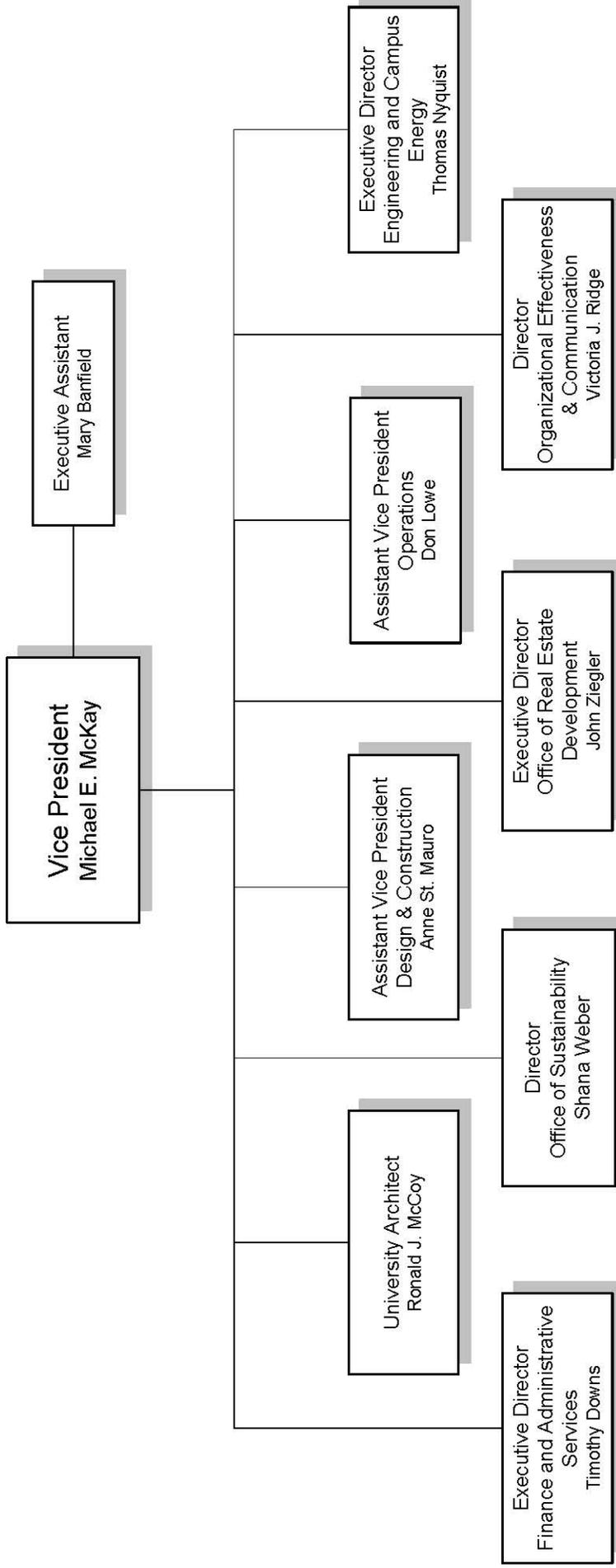
6. Office of Information Technology Organization and Function

The Office of Information Technology OIT has responsibility for overseeing Princeton's academic and administrative systems and the information technology infrastructure that supports them. We are proud of the fact that Princeton is widely seen as a leader in providing a robust infrastructure for campus computing and in identifying and deploying new technologies that enable academic innovation in teaching, learning, research, and scholarship. Please refer to Sections 2.6 and 4.1

END OF DOCUMENT

Facilities

Office of the Vice President



1. Introduction

One of the University's Guiding Principles for Future Expansion, as articulated by the Administration in 2003, is to "build in an environmentally responsible manner - a manner which is sensitive to geography, sensitive to energy and resource consumption and works to sustain strong community relations."

These Sustainable Building Guidelines are intended to provide direction and resources for the sustainable design and construction of new buildings and the comprehensive renewal of existing buildings for capital projects at Princeton. The requirements of this process are described in this Section of the *Princeton University Design Standards Manual* (DSM), which complements other Sections containing requirements particular to specific building programs or systems. These Guidelines are summarized as follows:

1. Set goals and benchmarks for each project.
2. Conduct site survey and evaluation of existing conditions.
3. Model various methods of meeting goals and benchmarks and use results to make decisions.
4. Repeat the modeling and analysis as the design is developed to refine decisions.
5. Review and monitor the expected outcome during documentation and construction.
6. Measure outcome to determine success, and establish benchmarks for future projects.

By employing Life-Cycle Cost Analysis and Social and Environmental Impact Assessment the University is better equipped to make informed decisions regarding expenditures of resources.

These Guidelines describe a process to be implemented along with the requirements of the Energy Guidelines found in Section 3.3 of the DSM. Many of the Life-Cycle Analyses will draw on data and analyses conducted in response to the Energy Guidelines. The Office of Design and Construction and Office of Sustainability are resources for both consultation on sustainable project planning as well as current initiatives underway on campus.

The LCCA process is applicable to projects of all sizes. However, for small scale renovation projects with existing envelopes, and predetermined HVAC system selections, a shortened version of this LCCA approach is appropriate. On these small scale projects, the Project Manager will assist in determining the limits of the LCCA to apply to the project.

In addition, new construction and major renovation projects will benchmark against a LEED silver rating. The University will determine if formal project certification will be sought. Early on in the project it will be determined if LEED is the appropriate third party certification system for the project or if other systems will be sought in lieu of or in addition to LEED (ie: Sustainable Sites Initiative, Living Building Challenge).

2. Contacts

- | | |
|--|----------------------------------|
| A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, the Construction Office, or as applicable) | |
| B. Program Manager for Standards | MacMillan Building, 609-258-1330 |
| C. Director of Facilities Engineering | MacMillan Building, 609-258-5472 |

D. Facilities Sustainability Manager

MacMillan Building, 609-258-1518

E. Institution Recycling Network (IRN)

<http://ir-network.com/>

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

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A Social and Environmental Impact Assessment Considerations	Appendix 1.2-2		
B Cost Components of Life-Cycle Cost Analysis	Appendix 1.2-3		
C Building Component Useful Life Data	Appendix 1.2-4		
D Life-Cycle Comparative Studies Worksheet	Appendix 1.2-5		Appendix 1.2-5
E OPR Template	Appendix 3.13-1	Appendix 3.13-1	
F Cx Roles and Responsibilities Matrix	Appendix 3.13-4	Appendix 3.13-4	
L Sample of High-Performance Systems Matrix	Appendix 3.3-10		

4. Outline of Process

A. Integrated Design

Building in a sustainable manner requires consideration of the network of complex systems as well as the individual systems through an integrated design process. The Project Team will be defined at the outset of each project, and will include university representatives for the client/user, the Facilities Project Manager, the Office of Sustainability, the Office of the University Architect, the Design Team, and the Construction Manager. The Design Team will be comprised of all of the project design consultants including the architect, civil, structural and building systems engineers, the landscape architect, and any specialized consultants. All of the members of the Project Team must collaborate to find the beneficial relationships among site and building systems that result in an environmentally sustainable outcome in support of the program. The Design Team must be committed to working through a collaborative process to learn new ways of considering these systems.

In addition, new construction and major renovation projects will benchmark against a LEED silver rating. The University will determine if formal project certification will be sought. Early on in the project it will be determined if LEED is the appropriate third party certification system for the project or if other systems will be sought in lieu of or in addition to LEED (ie: Sustainable Sites Initiative, Living Building Challenge).

B. Organizational Meetings

In order to work collaboratively as a Project Team, the Design Team will plan and facilitate workshops and meetings with university representatives specifically to further the integrated design process:

1. **Sustainability Charrette Planning Meeting:** During the Pre-Schematic Design ✓PS-5 phases (Scoping / Feasibility / Programming) the Project Team will meet with the University to discuss the format of the Charrette. The University will lead off the meeting with a more global view of campus goals and expectations. The University can also lend support to the design team discussing what has been learned from previous projects.
2. **Sustainability Charrette:** During the Pre-Schematic Design phases the Project Team will meet to establish goals and objectives with respect to sustainable building design, benchmarking and metrics. Ideally this will be done as part of a broader agenda focused on overall project goals including program, campus planning and project-budgeting. If those goals have already been set, a meeting focusing specifically on sustainable design objectives which are mutually supportive of other project goals will be conducted
3. **Life-Cycle Cost Analysis (LCCA) Workshop:** During the Pre-Schematic Design phases, after the Sustainability Charrette, the Project Team will hold an LCCA Workshop. While the Sustainability Charrette will set project intentions and outcome, the LCCA Workshop begins to set focus on the specific paths to those outcomes. The intent of this workshop is for the Design Team to identify the study categories recommended for LCCA, the method(s) of analysis proposed, the social and environmental impacts proposed for evaluation in conjunction with the Life Cycle Cost Analysis (LCCA), and to confirm project parameters and data, including that required to be provided by Princeton. The LCCA Workshop must occur after the Sustainability Charrette in order for the Design Team to make recommendations in support of the Project Sustainability Goals.
4. **Life-Cycle Cost Analysis (LCCA) Reviews:** During Schematic Design the Project Team will meet to review the initial findings of the LCCA studies. The Design Team will prepare the analysis to compare alternatives. The purpose of the review is to enable the Project Team to make decisions based on the Project Sustainability Goals. This process will be repeated before the conclusion of Design Development.
5. **Sustainability Charrette Recap:** At each design milestone the Project team will meet with the University to discuss the project sustainability goals and ongoing reports.
6. **Construction Meetings:** During the Pre-Bid meeting, the Facilities PM and the Design Team will convey project sustainability objectives to bidders. Requirements will be reviewed again at the Pre-Construction meeting and at Pre-Installations meetings for relevant trades.

C. Required Documentation

Following is a summary of documentation requirements for the sustainable design and Life-Cycle Cost Analysis (LCCA) process:

1. Project Sustainability Goals - Ongoing Report to be delivered at SD, DD 50%, 85% and 100% review. Overview of how the project is tracking towards its sustainability goals
 - Record of Initial Project Sustainability Goals from the Sustainability Charrette, including benchmarking objectives and metrics
 - Projected Energy Usage
 - Record of largest energy impacts & priorities based on preliminary energy model in conjunction with the MEP Design Intent document. Refer to Appendix 3.3-4 for MEP Design Intent documentation requirements
 - Energy Model reports see Appendices 3.3-12 through 3.3-19
 - LCCA Reports (including final decisions – with VE notations if applicable)
 - Annotated LEED checklists – (include other rating/certification systems as appropriate)
 - Stormwater Goals

Pre-Schematic Design:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
Sustainability Charrette	During pre-schematic design	Identify project sustainability goals, benchmarking and metrics ✓PS-5	Submit report summarizing overall goals with status, projected energy usage, LCCA reports, LEED checklists, stormwater goals.
Massing Energy Model	During pre-schematic design	Develop a preliminary energy model based on conceptual massing. Use ASHRAE maximum allowable lighting, envelope, and HVAC parameters. Use the energy model to identify target areas for energy savings.	
LCCA Workshop	During pre-schematic design after development of Massing Energy Model	Identify group of energy efficiency measures to study. ✓PS-9	
Conceptual Envelope Workshop	During pre-schematic design after development of Massing Energy Model	Identify basic envelope strategy and peak heating and cooling load targets, as per Envelope Design Guidelines. ✓PS-8	

Schematic Design:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
LCCA Review 1	Beginning of schematic design	Review energy efficiency measures / materials selections to develop during schematic design. ✓SD-15	Submit LCCA studies – including complete Excel files
Envelope Review 1	100% schematic design	Demonstrate prescriptive or trade-off envelope compliance. Review daylighting strategy, perimeter thermal comfort, and perimeter HVAC strategy. ✓SD-14	Submit Preliminary COMcheck report.
SD Energy Model	100% schematic design	Develop ASHRAE 90.1-2010 Appendix G compliant model with all three baselines. If lighting is not designed yet, set targets for lighting power densities.	Submit input/output spreadsheet with zoning diagram.
Daylight Review 1	100% schematic design	Glazing factor calculation for typical rooms.	Submit glazing factor calculation spreadsheet OR report of results from daylight model.
Energy / Commissioning	100% schematic design	Identify and prioritize largest project energy impacts ✓SD-18	Submit preliminary Commissioning Plan and MEP Design Intent
Other Goals	100% schematic design	Track performance from set pre-schematic goals.	Submit report summarizing overall goals with status, projected energy usage, LCCA reports, LEED checklists, stormwater goals.

Design Development:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
LCCA Review 2	Beginning of design development	Review energy efficiency measures / materials selections to develop during schematic design. ✓DD-8	Submit LCCA studies – including complete Excel files
Envelope Review 2	100% design development	Demonstrate prescriptive or trade-off envelope compliance. Review daylighting strategy, perimeter thermal comfort, and perimeter HVAC strategy. ✓DD-7	Submit updated COMcheck report.
DD Energy Model	50% design development	Develop ASHRAE 90.1-2004 Appendix G compliant model with all three baselines. Check progress against energy targets. Test any additional measures identified in LCCA Review 2. Test a minimum of six energy efficiency measures individually.	Submit updated input/output spreadsheet with zoning diagram.
Daylight Review 2	100% design development	Glazing factor calculation for typical rooms OR daylight simulation.	Submit updated glazing factor calculation spreadsheet OR report of results from daylight model.
Energy / Commissioning	100% design development	Identify and prioritize largest project energy impacts	Submit updated Commissioning Plan and MEP Basis of Design
Sustainability	100% design development	Track performance from set pre-schematic goals. ✓DD-25	Submit report summarizing overall goals with status, projected energy usage, LCCA reports, LEED checklists, stormwater goals.

Construction Documents:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
CD Energy Model 1	Beginning of construction documents	Develop ASHRAE 90.1-2007Appendix G compliant model with all three baselines. Check progress against energy targets. Model only what has been kept in the design after any value engineering exercises.	Submit updated input/output spreadsheet with zoning diagram.
CD Energy Model 2	85% construction documents	Develop ASHRAE 90.1-2007Appendix G compliant model with all three baselines with no approximated values.	Submit updated COMcheck report, zoning diagram, input/output spreadsheet, fan power spreadsheet, glazing factor calculation spreadsheet and final energy modeling report.
Energy / Commissioning	50% construction documents	Document and track project energy impacts	Submit project specification and list of equipment to be commissioned.
	85% construction documents	Document and track project energy impacts	Submit list of pre-functional and functional tests
Sustainability	50% construction documents	Track performance from set pre-schematic goals.	Submit report summarizing overall goals with status, projected energy usage, LCCA reports, LEED checklists, stormwater goals.
	85% construction documents		

✓CD-13

5. Life-Cycle Cost Analysis

In adopting Life-Cycle Cost Analysis (LCCA) as part of a process of sustainable design and construction, Princeton establishes the life-cycle cost of a building element or system as a unit of measure for decision-making. LCCA requires that the Project Team consider not only the initial construction costs of a building system, but also the long-term costs including utilities, operations and maintenance and, ultimately, disposal or re-use.

The primary goal of implementing this approach is to create transparency in the design and decision-making process so that decisions are made considering whole life-cycle implications of a project. Cost-effective solutions are not inherently sustainable solutions, but decisions based on an understanding of economic performance, when considered in conjunction with social and environmental performance, will result in effective and efficient choices of the greatest value to the University.

Princeton University Standards and Metrics have been established for use in Life-Cycle Cost Analysis. The utilization of these standards is critical to ensure that there is consistency and comparability of life-cycle data across projects as well as to inform decision-making in future projects.

LCCA Process / Procedural Guidelines

The primary method of Life-Cycle Cost Analysis (LCCA) will be a comparison between two or more alternatives for each of the topics identified for study during the LCCA Workshop. The alternatives should be viable options under consideration for the project.

Life-Cycle Cost Analysis (LCCA) will be formally documented and reviewed twice during the design process, in the Schematic Design and Design Development phases. However, the principles and knowledge gained by these studies are applicable at any stage in the design

process. The Project Team will work together in the preliminary design stages to lay out the schedule and study categories to maximize the value of these studies for each specific project.

Project Benchmarking

As part of the sustainable design process, the Project Team will establish the performance of other industry or University projects as benchmarks against which to compare the present project. time, these performance benchmarks will establish a broad basis of comparison for new work. Project LCCA documentation to be stored on the project page of the Princeton Collaborative System.

Study Categories

The following building systems shall serve as the basis for the selection of the LCC studies:

1. Energy Systems
2. Electrical Systems
3. Building Envelope
4. Siting / Massing Strategies
5. Structural Systems
6. Mechanical Systems
7. Water Systems
8. Interior Materials

Six (6) or more Life-Cycle Cost Analyses are required at both the Schematic Design and Design Development phases. At least one (1) of these studies shall be within the Building Envelope category, one (1) within the Energy or Mechanical Systems category, and one (1) from the Interior Materials category. No more than three (3) of the studies shall be conducted within a single study category.

The LCCA of interior materials is of particular interest to the University as they represent a widely expanding area of building and finish components and play a significant role in the overall sustainable characteristics and performance of the project. Designers are encouraged to explore and study and report on the cost-effectiveness of materials within this category.

Certain study categories may be more relevant to particular building types or projects and project-specific priorities will be established at the initial LCCA Workshop in the Pre-Schematic Design phase. However, the above study categories/ building systems do not operate in isolation. The energy model and Life-Cycle Cost Analyses shall be developed with an understanding and acknowledgement of the inter-relationship of building systems on the life-cycle costs and impacts of the project.

Energy Modeling and Design Tools

Energy modeling is a prerequisite to conducting the Life-Cycle Cost Analysis (LCCA) component of the comparative studies. A preliminary energy model will be developed in the Schematic Design phase in order to identify and document the largest energy impacts of the project. Refer to Appendix 3.3-5 (MEP Basis of Design). The energy model will also serve as the platform from which to analyze energy consumption rates of the alternate options in both the Schematic and Design Development phases. The energy model will continue to be refined throughout the design phases. A final run of the model incorporating the selected LCCA elements will be performed and documented prior to the conclusion of Construction Documentation phase.

CO₂Tax

There may be added future cost for electric power due to potential government mandated CO₂ emissions reduction legislation. Therefore, a “CO₂ tax” shall be included in the energy analysis to account for these anticipated costs. This tax represents the monetary value on the environmental impact of foregoing a proposed supplemental conservation effort to the project. Standard cost information, including utility costs, maintenance costs and building components as well as CO₂ tax for use in the LCCA studies is included in Appendix 1.2-3 (Cost Components of Life-Cycle Cost Analysis) for this data.

Social and Environmental Impact Assessment

Life-Cycle Cost Analysis (LCCA) does not directly address the social and environmental life-cycle impacts of design alternatives. These costs and benefits should be presented and evaluated in conjunction with the results of the LCCA studies performed. While tools are available to assist the Project Team in conducting this analysis, it is ultimately up to the Project Team to determine the method of assessment most compatible with project objectives. See Appendix 1.2-2 for a list of considerations for social and environmental impact assessment. This list is not intended to be all-inclusive, but to highlight anticipated issues for review and discussion.

Life-Cycle Cost Analysis (LCCA) information shall be presented in conjunction with social and environmental impacts to facilitate decision-making. The University standard deliverable of this format is illustrated in Appendix 1.2-5 (Life-Cycle Comparative Study Worksheet).

6. LEED Rating System (or other system as applicable)

While the University may not require certification, an annotated checklist is to be provided with sufficient back up documentation as required for specific credits for all rating systems benchmarked during the project. This is to ensure compliance with credit requirements.

7. Materials Selection

Conscientious design is the first step towards controlling the generation of solid waste on a building project. Effective design-stage waste reduction strategies include existing building reuse, optimization of building program, envelope and systems energy efficiency, the use of alternative building materials (salvaged, recycled content and rapidly renewable materials), detailing and dimensioning to limit material waste, proper planning for the storage and collection of recyclables, and sustainability-oriented design specification language and contractor requirements.

Durability, maintenance and aesthetics are the primary criteria for materials selection. Over its history, Princeton has developed a number of materials standards which can be referenced throughout the pertinent sections of the *Princeton University Design Standards Manual*. These standards have been developed based on a material’s proven ability to meet the programmatic, maintenance and aesthetic performance goals of the University through the test of time and use.

Changing technologies have resulted in a wealth of new materials on the market and the potential for their application in Princeton building projects is encouraged provided adequate evaluation of the primary criteria cited above. Where identified as critical to the support of project goals and objectives, a Life-Cycle Cost Analysis (LCCA) of a newly proposed material (in comparison to

an existing material standard or precedent) may serve as the basis of this evaluation. Evaluation of the life cycle cost implications of any suggested new material is recommended when not specifically identified for evaluation through the LCCA process or on small-scale projects. The social and environmental impacts of proposed materials selection should also be included in this evaluation.

There is ample opportunity with the campus' small projects to make conscientious design decisions pertinent to material selections. Design teams should submit selections/studies to the Project Team for consideration.

8. Waste Management

✓CD-1

Design Specifications and Construction Waste Management

Establishing waste reduction goals and implementing cost-effective Construction Waste Management techniques can significantly reduce environmental impact and provide economic advantages for projects of all types and scales. Currently, the University's established goal is for the recycling of 95% of all eligible materials post-abatement.

Project specifications shall require the contractor to submit a Construction & Demolition Waste Management Plan for approval by the University at the beginning of the submittal and review period (or earlier when applicable). This plan must include but is not limited to:

- Analysis of the proposed job site waste to be generated, including the types of recyclable and waste materials generated (by volume or weight).
- A list of each material proposed to be salvaged, reused, or recycled during the Project
- A list of proposed recycling facilities to be used in the project
- An outline of proposed Project Waste Management meetings (At a minimum, waste management goals and issues shall be discussed at the Pre-bid meeting, Pre-construction meeting and regular jobsite meetings).
- Materials Handling Procedures for removal, separation, storage, and transportation.
- A Communication Plan for informing subcontractors and crews about the Waste Management Plan, establishing job-site instruction, notification and signage procedures for waste management and providing a methodology for documenting and reporting quantities and types of materials reused, salvaged, recycled, and disposed.
- Proof of distribution times, weights, etc from trucks removing debris from the project site

9. Site Design

The campus master plan speaks to both campus-wide and neighborhood-specific strategies for

- utility distribution
- stormwater management
- energy efficiency goals/targets
- sustainable landscape strategies and planting materials
- paving materials
- exterior lighting plan
- transportation & parking plan
- potable water use plan

A significant percentage of exterior site work on campus is associated with capital projects. Design teams are thus encouraged to select Life-Cycle Cost Analyses(LCCA) that are both

appropriate to project specific goals and might contribute to the overall implementation of the Campus Plan.

10. Bird Safe Building Design

✓PS-5

In keeping with Princeton's tradition of thoughtful landscape design, campus building design should be mindful of the local and migratory bird populations. The University encourages design strategies that promote bird safe building design.

See the American Bird Conservancy report on [Bird Safe Building Design](#) for guidance. In addition the [Glass Collisions](#) page on their website offers passive design strategies as well as active strategies (in the form of tested and ranked products).

The greatest potential for understanding and managing the environmental impacts of a project is through early and multi-disciplinary consideration of site selection criteria, building siting, orientation, massing, material selection, water usage, stormwater management and landscaping strategies. The Sustainability Charrette (to be conducted during the Pre-Schematic phases) and the Life-Cycle Cost Analysis (LCCA) process are intended to ensure that these critical issues are addressed by the design team in a timely and holistic manner.

END OF DOCUMENT

1.3 Project Responsibility Checklist

1. Introduction

The project responsibility checklist is intended to assist Project Managers in developing consistent approaches to respective phases of every project. Although not every task herein is listed or necessary, the overall method of project delivery commonly follows this format and serves as the University’s standard. Dates are to be inserted by the Project Manager as each task is completed by the University or A/E. **Shaded areas** indicate the responsible party. Please note that many tasks have a dual responsibility between the University and A/E. The following symbol will be used as a cross reference throughout the manual noting the respective item number within the checklist: **✓#AA-00**

List of Acronyms Used

BIM	Building Information Management
DCA	Department of Community Affairs
EHS	Environmental Health and Safety
FPG	Facilities Planning Group
FPO	Facilities Procurement Office
FRC	Facilities Resource Center
GIS	Geographic Information Systems
LCC	Landscape Coordinating Committee
LCCA	Life Cycle Cost Analysis
PACA	President's Advisory Committee on Architecture
PCS	Princeton Collaborative System
PMG	Project Management Group
PRPB	Princeton Regional Planning Board
SPMIS	Space & Property Management Information Systems

2. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

- A. A/E Fee Proposal Budget Outline Appendix 1.3-1
- B. Programming Guide Appendix 1.3-2

3. Checklist

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
PC-1	Review Program requirements with University for completeness and suitability; review development density and building scale proposed			
PC-2	Review the relationship of project to Campus Master Plan with OUA. Outline the Campus Plan goals for the Project and review the relevant technical appendices with the design team.			
PC-3	Determine University's time schedule for contracting, construction and occupancy			
PC-4	Design Services (See "Fee Proposal Budget Outline" appendix 1.3-1)			

		A&E	P.U.	N/A
PC-5	Pre-contractual review meeting for items 1-4			
PC-6	Meet with Facilities Procurement Office to discuss A/E agreement, including: a. Standard University General Conditions b. Princeton University Facilities Design Standards Manual c. Standard University Professional Services Agreement (as applicable) d. Project Description e. Discuss billing format f. Requirement for BIM as part of design documentation g. Other			
PC-7	Review appendix 1.3-2 for supplemental program guidance			
PC-8	Discuss Schedule, cost and scope for existing condition survey, if required			
PC-9	Discuss role that Construction Manager may play in survey prior to schematic design phase			

Tasks During Pre-Schematic Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
PS-1	Review and agree upon budget parameters with respect to any proposed concept designs			
PS-2	Meet with Accessibility Review Committee to discuss requirements for Accessibility Programming Document			
PS-3	Review site sustainability issues in relation to campus master plan			
PS-4	Coordinate parking impacts of projects, including department relocations with OUA.			
PS-5	Sustainability Charrette: Project Team education and goal-setting * review site sustainability issues in relation to campus master plan, including stormwater management strategies * explore options with respect to life cycle implications * meet with Facilities Sustainability Manager to discuss sustainability issues for project * consider siting, orientation and design parameters/assumptions * determine Project Sustainability Goals and targets to include in program			
PS-6	Record of Project Sustainability Goals			
PS-7	High-Performance Systems Matrix			
PS-8	Conceptual Envelope Workshop * Identify Solar Transmission & Envelope Heat Gain Limits * Identify preliminary envelope and systems strategies			
PS-9	Record LCCA study categories selected and benchmark assumptions to be used			

		A&E	P.U.	N/A
PS-10	Review University commissioning process and commissioning goals			
PS-11	Meet with Facilities Engineering Department to review project utility interconnects and regional campus MEP parameters, including OIT Assess the opportunity to bury overhead utility wires with OUA.			
PS-12	Meet with University Energy Plant Manager to ascertain the anticipated utility demands			
PS-13	Confirm Property ownership and survey boundaries / impacts / easements and title searches			
PS-14	Review need to discuss zoning and land use issues with OUA, University Land Use Attorney and consulting Civil Engineer			
PS-15	Meet with University Code Analyst to ascertain local / state project review jurisdictional issues as well as previous building variations and/or violations			
PS-16	If classroom design is contemplated, meet with PM, University AV/Classroom Planner and the University Registrar to gain oversight during programming			
PS-17	For existing structures, determine information, resources and approach required for a comprehensive building survey.			
PS-18	If dormitory design is contemplated, meet with PM and University Housing Office to ascertain program review committee constituency			
PS-19	Meet with Executive Director of the Department of Public Safety to determine level of security assigned to project			
PS-20	Meet with University Coordinating Architect to determine the need for LCC and LPC reviews. Schedule reviews at each design milestone if necessary.			
PS-21	Meet with University Code Analyst to define code strategies and discuss ADA and NJ barrier-free code interpretations affecting the project			
PS-22	Meet with Accessibility Review Committee to review final Accessibility Programming Document			
PS-23	Meet with University Code Analyst to determine code strategies and discuss fire alarm / fire suppression code interpretations affecting the project including fire code remediation requirements as outlined by state and local AHJs			
PS-24	Meet with Managers of Facilities Mechanical & Electrical Engineers to ascertain types of MEP systems to be installed			
PS-25	Meet with EHS to review hazardous materials and environmental modeling requirements. Coordinate with Facilities Operations: Baseline radon level testing needs to be recorded and submitted for any project disturbing basement slab or slab on grade conditions (new projects and renovations)			

		A&E	P.U.	N/A
PS-26	Meet with SPMIS for archived drawings requirements to be used as background			
PS-27	Coordinate with OUA on need for vehicular traffic analysis around proposed site, including deliveries, accessibility requirements, university grounds vehicular access, etc			
PS-28	Discuss collateral programming and site issues that relate to adjacent buildings with the appropriate stakeholders, including OUA			
PS-29	Assist University with selection of CM * Assist with preparation of project description and schedule * Schedule and attend CM interviews as applicable * Assist with reference checks			
PS-30	Initiate CM pre-construction services contract			
PS-31	Initiate set-up of Princeton Collaborative System (PCS) website collaboration tool and verify training on procedures and requirements with project team			
PS-32	Confirm that Program requirements have been completed and reviewed with the end user			
PS-33	Coordinate any requirements for renderings and fundraising documentation with University Development Office Representative and OUA			

Tasks During Schematic Design Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
SD-1	Project Meetings to determine / refine program and sustainability goals with: * End User * Building Services * Engineering * Grounds and Building Maintenance * Administrative Representative * Dining Services * EHS * Public Safety * OUA * Others			
SD-2	Establish Project Schedule, including completion dates for each phase.			
SD-3	Review requirements for site analysis test pits and testing (such as borings, perc tests, etc.) necessary for proper execution of site work and request such information from the University. Assist University in securing proposals for this work.			
SD-4	Review site survey including building, mechanical, electrical and structural surveys			

		A&E	P.U.	N/A
SD-5	Review all data supplied, including program, budget, legal, site, code, space and special owner requirements. Record all data. Verify design complies with established requirements.			
SD-6	Prepare functional space diagrams			
SD-7	Meet with Facilities Engineering to gather load and performance data associated with proposed MEP systems			
SD-8	Prepare basic design documents to include: <ul style="list-style-type: none"> * Site plan with diagrammatic indicators showing relationships * Vertical sections through the site as required * Principal floor plans * General descriptive views * Illustrative sketches, models or renderings as required (Reference A/E Contract Article VII (b))			
SD-9	In coordination with OUA, assemble Site Plan approval documentation, including traffic and parking analysis, in accordance with PRPB requirements per University Land Use Attorney's recommendations			
SD-10	Meet with Asst Manager for SPMIS to review methodology for calculating net and gross areas/ ratios in conformance with University requirements			
SD-11	Meet with the Building Documents Coordinator to review CAD quality assurance			
SD-12	Preliminary Energy Cost Budget Model			
SD-13	Sustainability strategy and progress update.			
SD-14	Envelope Review 1 - identify and prioritize the largest project energy impacts			
SD-15	Perform preliminary LCCA comparative studies			
SD-16	LCCA Review 1 of initial comparative study results; select appropriate LCCA elements to incorporate into the project			
SD-17	Record of LCCA Review 1 - include updated project schedule and budget with incorporated LCCA elements			
SD-18	Submit preliminary Commissioning Plan and MEP Design Intent			
SD-19	Submit Statement of Design Criteria to University for review and comment to clarify expectation of deliverables <ul style="list-style-type: none"> * Schematic Design documents * A/E Building requirements * Program data * Other 			
SD-20	Calculate areas and volumes and analyze plan efficiency of the design by usable area, area per person or other method; review programmatic/ performance assumptions to look for opportunities for shared spaces, volume reduction, increased space efficiency, material use and reduction, optimization of water and energy use			

		A&E	P.U.	N/A
SD-21	Prepare Schematic Design documents in conformance per the phased submission requirements listed within each respective section of the DSM			
SD-22	Submit Schematic Design documents (drawings, descriptions, calculations, outlines and statements of probable construction cost, reports) to University, post to PCS			
SD-23	Submit civil drawings to stormwater management consultant for review and comment			
SD-24	Meet with LCC to discuss landscape and stormwater design.			
SD-25	Meet with Executive Director of Public Safety to develop Security Programming Document			
SD-26	Submit documentation that major system equipment has adequate space allotments in all major MEP spaces			
SD-27	Review and update schedule of completion dates for this and all subsequent phases			
SD-28	Receive approval prior to proceeding to Design Development phase			

Tasks Prior to Starting Design Development Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
SD-29	Review need and scope for special consultants and confirm that schedule and budget is met			
SD-30	Update list of owner-supplied or existing owner equipment and respective utility requirements to be transferred into new facility			
SD-31	Confirm all on-site trades requiring owner-supplied labor			
SD-32	Meet with Architectural Engineer for Standards to discuss room numbering strategies			

Tasks During Design Development Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
DD-1	Discuss need for any phasing of project and site logistics; review project schedule to ensure/ include adequate time for sustainability activities (construction monitoring, commissioning, other documentation, training)			
DD-2	"Pre-meeting" to review DCA code issues with University Code Analyst, review Project Code Checklist			
DD-3	Prepare cover sheet to include site/ location plan as well as: * Index of drawings * Directory of consultants with contact information * Building data * Applicable code summary data			
DD-4	Assemble/submit site plan approval documentation in accordance with PRPB requirements per University Land Use Attorney's recommendations.			

		A&E	P.U.	N/A
DD-5	Prepare site/ location plan indicating building locations and extent of site improvements			
DD-6	Refine / develop LCCA comparative studies			
DD-7	Envelope Review 2			
DD-8	LCCA Review 2 - verify alignment with Project Sustainability Goals and benchmarks			
DD-9	Record of LCCA Review 2, include updated project schedule and budget			
DD-10	Register Project for LEED certification (or applicable rating system)			
DD-11	Submit net and gross area and volume calculations			
DD-12	Prepare preliminary draft of the Project Manual. Have consultants prepare their portions and coordinate.			
DD-13	Identify sustainable strategies / LCCA elements that require coordination/ development in specifications. Solicit CM input for opportunities in construction and delivery of sustainability issues			
DD-14	Confirm that Division 1 specifications are coordinated with University's respective standard construction agreements			
DD-15	Be sure to include the standard University specifications from the DSM for the following sections: <ul style="list-style-type: none"> • Building Automation System • Elevators • Fire Alarms • Commissioning 			
DD-16	Provide timely and coordinated responses to all DD review comments prior to submission of all future Construction Documents.			
DD-17	Identification of alternates generated in review of 100% DD documents.			
DD-18	Review of unreconciled budget items in submissions from Construction Manager and Independent Estimator. Attend Budget Reconciliation meeting with CM.			
DD-19	Committee meeting to discuss DD presentation and authorization to proceed to construction documentation phase			
DD-20	Determine schedule for Owner's pre-purchased items			
DD-21	Site Logistics meeting			
DD-22	Confirm Discipline Review meetings have been completed for Schematic and Design Development Phases			
DD-23	Submit civil drawings to stormwater management consultant for review and comment			
DD-24	Meet with LCC to discuss landscape and stormwater design.			

		A&E	P.U.	N/A
DD-25	Sustainability strategy and progress update			
DD-26	Submit final MEP "Basis of Design" Document and updated Commissioning Plan			

Tasks Prior to Starting Construction Document Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
DD-27	Review the project program and verify compliance with the design documents			
DD-28	Review scope of items to be provided by owner or otherwise not included in construction documents			
DD-29	Meet with University the Building Documents Coordinator to ascertain all CAD documentation procedures prior to initiation of CDs			

Tasks During Construction Document Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
CD-1	Prepare 50% CDs in conformance with PU Facilities Department Design Standards Manual (latest Release) and the phased submission requirements listed within each respective section			
CD-2	Submit 50% CDs to Project Manager for University Tech Teams and post on PCS			
CD-3	Attend all 50% CD Tech Team review meetings and record all minutes and review commentary			
CD-4	Provide timely and coordinated responses to all CD review comments prior to submission of all future documentation			
CD-5	Identification of add/ deduct alternates generated in review of 50% Construction Documents			
CD-6	Review of unreconciled budget items in submissions from Construction Manager and Independent Estimator. Attend Budget Reconciliation meeting with CM			
CD-7	Coordination of anticipated site logistics planning			
CD-8	Prepare 85% CDs in conformance with PU Facilities Department Design Standards Manual (latest Release) and the phased submission requirements listed within each respective section.			
CD-9	Submit 85% CDs to Project Manager for University Tech Teams and post on Centric Projects			
CD-10	Attend all 85% CD Tech Team review meetings and record all minutes and review commentary			
CD-11	Submit civil drawings to stormwater management consultant for review and comment			
CD-12	Meet with LCC to discuss landscape and stormwater design			
CD-13	Sustainability strategy and progress update			

		A&E	P.U.	N/A
CD-14	Provide timely and coordinated responses to all CD review comments prior to submission of all future documentation			
CD-15	Identification of add/ deduct alternates generated in review of 85% Construction Documents			
CD-16	Review of unreconciled budget items in submissions from Construction Manager and Independent Estimator. Attend Budget Reconciliation meeting with CM			
CD-17	Attend all Value Engineering meetings to assist in budget reconciliation			
CD-18	Review Contractor's temporary power requirements for coordination with university Engineering Department			
CD-19	Determine alternates to be documented and priced			
CD-20	Review list of potential sub-contractors for project			
CD-21	Prepare documents for filing of permits and approvals			
CD-22	Coordination of final Project Manual. Confirm that Division 1 specifications are coordinated with University's respective standard construction agreements.			

Tasks During Bidding and Negotiation Phase

Responsibility & Date Completed

Item #	Task Description	A&E	P.U.	N/A
BN-1	Attend Pre-Bid Conference to review contractor responsibilities including: <ul style="list-style-type: none"> * Waste Management Plan implementation * Materials certificate collection * Health & Safety Plan Implementation * Site Management / Protection * Commissioning data collection * Contractor parking / access to site * Noise Issues * Considerations regarding the Academic Calendar * Sustainability record keeping and certification (if applicable) 			
BN-2	Evaluation of proposed substitutions and add/ deduct alternates			
BN-3	Review all discipline scope documents prepared by Construction Manager and propose changes move to CD sub contractor list review			
BN-4	Final logistics plan review with CM & GBM, including review of University temporary offices and power requirements, as well as contractor parking requirements and provisions			
BN-5	Review of bid lists			
BN-6	Attend all Subcontractor bid openings			
BN-7	Attendance at Descoping of contractor bids			
BN-8	Final determination of items in / out of scope			
BN-9	Review of projected construction schedule			

Tasks During Construction Administration Phase

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
CA-1	Pre-Construction Meeting to discuss:			
	* Submittals / Tech Reviews			
	* Construction Document Control Process			
	* Role of PCS collaboration tool			
	* Project Sustainability goals and design features			
	* Contractor input - opportunities for construction innovation and efficiencies			
	* Sustainability and Commissioning protocols			
CA-2	Post 100% Construction Documents in PCS; update throughout CA to include revised drawings, addenda, bulletin, etc. word to talk about conform set			
CA-3	Ongoing Monitoring and Certificate Collection - examples:			
	* Construction Waste Management			
	* Construction IAQ Plan			
	* Collect Materials Certifications			
CA-4	Maintain Commissioning documentation			
CA-5	Attendance at regular project site meetings with Construction Manager			
CA-6	Submission of regular multi- discipline field observation reports			
CA-7	Response to RFIs, Submittal reviews and building component preconstruction reviews			
CA-8	Ongoing Review of Project Schedule, Invoices, Change Orders			
CA-9	Review and reconciliation of contractor's proposed changes, project change orders and scope changes			
CA-10	Submit individual Change Order review recommendation letters for each proposed CO			
CA-11	Assist University Commissioning Agent in documentation of pre-functional and functional testing			
CA-12	Punch list preparation and follow-up			
CA-13	Inspect project for substantial completion, provide notification to government agencies who require inspection prior to occupancy			
CA-14	Provide written certification of substantial completion			
CA-15	Attend acceptance testing for all major building components			
	* UL			
	* ASTM			
	* Other			

Tasks During Project Close-Out

Item #	Task Description	Responsibility & Date Completed		
		A&E	P.U.	N/A
CO-1	Review submitted Operations and Maintenance Manuals as required.			
CO-2	Review submitted As-Built Documents from CM			
CO-3	Review systems training requirements and attend selected training sessions * Fire Alarm * ATC * Mechanical Systems * AV			
CO-4	Provide Final Commissioning Report			
CO-5	Provide Final Sustainability Checklist			
CO-6	Post-Occupancy Evaluations			
CO-7	Follow-up Lessons Learned meeting and record comments			
CO-8	Schedule end-of-warranty walk-throughs at 11 months post-substantial completion date			

END OF DOCUMENT

1. Introduction

The main Campus of Princeton University is primarily located in the Town of Princeton. **Additional campus properties are also located in neighboring West Windsor, and Plainsboro Townships.** The municipalities **all have** building department which are responsible for review** and inspection of construction activity within its boundary. Full compliance with Federal, State and Local regulatory requirements on any project is the responsibility of the prime professional of record. ****The State of New Jersey is responsible for some review in the Town of Princeton.**

Project code compliance is the responsibility of the Primary Design Professional. The University Code Analyst is not intended to be the Code Consultant for the projects. When necessary, a Code Consultant shall be engaged to assist the Design Team with all Regulatory matters. The selection and use of a Code Consultant is subject to review and approval the University Code Analyst, in conjunction with the Project Manager and Primary Design Professional.

2. State Review

✓PS-15

Construction projects in the state are regulated by the New Jersey Uniform Construction Code (NJUCC or simply UCC). The UCC adopts - and modifies - model codes that provide control and standards for construction. These model codes, such as the IBC (International Building Code), the National Standard Plumbing Code, and the National Electrical Code (among others) are listed in subchapter 3 of the UCC.

Fire safety projects may be initiated under the New Jersey Uniform Fire Code (NJUFC or UFC), which is more condensed in scope than the UCC; however, fire safety work is often undertaken as part of a larger project requiring UCC compliance. It is incumbent upon the Designer to become familiar with the UFC and UCC and the applicable sections of adopted subcodes, including those design elements that require commissioning and periodic testing in accordance with those sections.

Presently, there is an ongoing program with the State of New Jersey Division of Fire Safety to address and improve specific fire safety features and conditions in certain University buildings. Those improvements are identified; and they are approved, monitored and certified to be compliant with the State Uniform Fire Code by the New Jersey Division of Fire Safety when they are determined to be so, solely by them. The University maintains a process for soliciting fire safety consulting services from **Architects and Professional MEP and FP Engineers** to better understand previously cited (UFC Division 3 and 4) fire code violations, recommend compliance, and provide continuity in the required approval closeout process.

✓PS-23

This assistance to project teams is a separate design service solicited by the university and available at any project phase, but particularly useful at programming and project closeout. Implementing this process will layer additional fire safety consulting services within the Project Team at no cost to the designer of record, unless specifically directed otherwise in the description for project services. In all cases, it is necessary for the designer of record to contact the University Code Analyst and Project Manager to further discuss and determine if or how this part of the project will be accomplished.

- D. *Development Guidelines*, Princeton Sewer Operating Committee Public Document
- E. Site Plan Instruction Packet, Princeton Planning Board Public Document
- F. Environmental Safety Risk Management Master Plan, 2002 Consult Project Manager
- G. Notice to New Jersey Licensed Architects Appendix 1.4-1
- H. Code Sheet Information Checklist Appendix 1.4-2
- I. **Certification of Documents for Electronic Plan Review Submissions** Appendix 1.4-3

6. Review Guidelines

Initial planning and preliminary design will be conducted through the Office of Design & Construction with the University department responsible for project initiation. FM Global is the University’s current property insurance carrier. Effort should be made to comply with FM standards. If FM designs are not feasible – the design team is to communicate no compliance with the Project Manager. As the project moves toward the construction documentation and code review phases, it is required that the project be submitted to the University for an internal “Tech Team” review process through the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of CDs, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, **University Code Analyst**, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

7. Procedural Guidelines - Preliminary Design & Design Development ✓PS-15

During preliminary design, the Designer is to consult with University Project Manager to ascertain the need for site plan and zoning approvals, and the need for legal counsel for the early stages of a project. The Designer is to cooperate with any adjunct professionals providing assistance to the University, and is to coordinate his work with other disciplines so a cohesive set of documents is produced for local board review. Refer section 2.9 Site Planning for further information on zoning and site planning issues.

During preliminary design and design development the Designer is to consult with the Project Manager and the University’s Code Analyst to define code strategies and to discuss any code interpretations affecting the project. ✓PS-23

During Design Development conduct a "Pre-meeting" with the University Code Analyst to review DCA code issues. ✓DD-2

The Designer is also to review and incorporate the Code Sheet Information Checklist, refer to Appendix 1.4-2.

8. Procedural Guidelines - Code Review Applications and Submittals

Prior to submitting an application for project review, the Designer will prepare the project application forms, including (where applicable) the DCA *Project Review Application for ePlan Review*, request for "Return to Local" (RTL) letter and the forms for local review. The Designer is to meet again with the Code Analyst to review the application forms and any supporting documentation. All submissions made to the Department of Community Affairs or to the Division of Fire Safety are to be channeled through the University's Code Analyst. Official Applications will be made by the University with the Code Analyst responsible for signing all applications and "RTL" letters. Likewise, all communications during the review process are to be made through the Code Analyst; this individual acts as liaison between the University and the State construction agencies, and is responsible for continuity in the applicability of code issues from project to project. It is imperative that this continuity be maintained.

Only 100% complete documents are to be submitted to the DCA for review. The intent is to prevent needless and time-consuming review by the State agency, and review comments brought on by incomplete information. **Partial or phased submissions of the subcode disciplines are acceptable, provided the discipline submitted is 100% complete.** The Designer is to refer to the plan submission checklist in the *Application for Plan Review*.

DCA utilizes "*ePlans*", a web-based electronic Plan Review process, for the review and approval of all documents. After the initial application for electronic Plan Review, "*ePlans*" allows all submissions to and from DCA to be transmitted electronically via the internet.

The University Code Analyst is the project Applicant of Record and Manager of all submissions and correspondence to and from DCA. The design professionals of record shall submit all documents for plan review to the University Code Analyst through the Princeton University Share Point Website set up for the Project. A separate file area titled "NJ DCA", is provided for all DCA intended submissions, correspondence, and subsequent approvals for the project. Please refer to the DCA "*ePlan Review Users Guide*" for addition information; Appendix _____

DCA ePlan Review requires the design professional to submit a brief narrative describing the Project and work to be performed when the Application for ePlan Review is submitted.

DCA ePlan Review also requires the top right corner of each drawing; and the cover of all Specifications, Reports, calculations, and other similar documents to be provided with a 3" x 5" blank area, 3/4" in from the top and right edges of the document for the DCA Electronic Approval Stamp. This requirement could potentially interfere the design professional's standard title block design, and would require redesign of each Title Block affected.

All ePlan Drawing are to be uploaded individually by sheet in the Landscape orientation. All Specifications, Reports, calculations, and other similar publications are to be uploaded separately as a complete document. DCA reserves the right to request additional uploads of individual pages, sections and volumes when determined by them to be necessary.

Upon submission of the Application to DCA for ePlan Review, a DCA Project Number will be assigned to the project. The DCA Number is required to be added to the bottom right corner of all drawings; and the cover pages of all Specifications, Reports, calculations, and other similar publications prior to uploading the remaining documents to DCA.

Electronically submitted documents prepared by design professionals are to be equivalent in content and completeness as traditional signed and raised sealed paper documents. Each Design Professional shall attest that the electronic documents were developed under their supervision by completing the “Certification of Documents (for Electronic Plan Review Submissions)” form and pencil shading the raised seal embossment for easy identification when copied. The “Certification of Documents (for Electronic Plan Review Submissions)” Form is available in the Appendix, or can be provided by the Project Manager or Code Analyst.

Upon DCA (electronic) Approval and Release of (ePlan) Reviewed documents, the design professionals are to download the “Stamped” documents from the Princeton University Share Point Project Website (NJ DCA); and print, Sign and seal, and provide 2 copies to the University Project Manager for application of construction Permits. Rubber stamp and computer generated signatures are not acceptable in New Jersey.

The Architect and Engineer(s) of Record’s name and license number must appear on the Drawings in the Title Block, and on the cover page of Specifications, Calculations, Detail Books, Reports, and other similar design publications. The UCC provides further information on the requirements for original signatures, sealing documents, and Title Block compliance.

All Architectural and Engineering Firms are required to be licensed to practice their professions in New Jersey. In addition, the firm or firms, as the case may be, must be registered with the New Jersey Treasury Department for state Architects or with the New Jersey State Board of Architects for out-of-state firms, or equivalent for Engineering Firms (refer to Appendix 1.4-1).

9. Procedural Guidelines - Organization of Submittal Drawings

In order to maintain project schedule it is sometimes necessary to request partial release of Drawings from the DCA, and to obtain construction permits from the local agency for discrete parts of the project. The likelihood of this necessity should be discussed early with the University Project Manager and the Code Analyst. In order to facilitate partial release, the Drawings and specifications should be set up with easily separable sections related to the following categories:

- A. Footings and Foundations
- B. Structural Framework
- C. Exterior Building Components
- D. Interior Building Components
- E. Elevator
- F. Other Building Elements
- G. Underground & Underslab Utilities
- H. Plumbing
- I. HVAC & Mechanical
- J. Electrical
- K. Fire Suppression/Sprinklers
- L. Fire Protection/Fire Alarms

10. Procedural Guidelines - Timely Response to Review Comments

During the Plan Review process, time is essential when responding to inquiries and comments from the review agencies. Designers and their consultants are to respond to DCA comments within one week, unless technically infeasible. **When Responding to Comments, the comment is to be re-copied first, followed by the Response** to simplify re-review by the agency.

All questions and Responses to Comments are to be directed through the University Code Analyst for submittal to DCA.

11. Procedural Guidelines - Code Variances and Variations

During the course of code review, or during construction, it often becomes necessary to apply for relief from some requirement of the UCC or a subcode. The Designer will be responsible for preparing such an application (a variance under the UCC, a variation under the NJ Fire Code) in consultation with the Code Analyst. The application is made to the agency responsible for code review. The application typically includes a written narrative outlining difficulties in complying with code requirements, and a description of the proposed alternative with any mitigating features which might offset the code deficiency. The application might include sketches and photos in support of the request for relief. Official application will be made by the University, with the Code Analyst responsible for signing and submitting to the applicable agency.

12. Procedural Guidelines - Permit Application to Local Agency

Permit applications to local municipalities consist of at least two signed and sealed sets of project documents. Documents are submitted to the municipality with completed application forms for each major trade involved in the project (building, fire safety and protection, plumbing, HVAC, electric, elevator).

The Designer shall be responsible for assisting the Project Manager in gathering the required information for permit application, including fixture and device counts, equipment ratings, incoming utility service sizes, etc. to facilitate a complete submission. Permit application, delivery, pick-up, and fee responsibility are determined by the Project Manager and the Code Analyst.

Plumbing, Electrical and Fire Protection sub-code application forms must be signed and sealed by the licensed Contractor responsible for the work; the Designer will cooperate in this procedure as well.

13. Procedural Guidelines - Approved Construction Documents

During construction, site conditions often necessitate changes in the work. Revisions to Drawings are to be submitted to the DCA (or the responsible review agency) for approval, and are to be incorporated into the approved set of Drawings that is to be kept at the job site. It is a UCC requirement that the approved permit release Drawings are kept at the site.

Frequency of Updates:

The State Uniform Construction Code requires all structures to be built from approved Documents at all times. As field changes occur, Construction documents are required to be updated and resubmitted to the Plan Review Authority having jurisdiction for Amended Review

and Release. For State DCA projects, the documents are required to be upgraded continuously over the course of the project. As Built Documents, only, are not acceptable, and are not submitted to the State for approval unless specifically requested by the DCA. The same procedure should be followed for field changes on Local Plan Review Projects, but less frequent updates and or submission of As Built Drawings at the end of the job have been allowed by the Local Construction Officials on a case by case basis. Advance permission from the Construction Official is required for this exception to be allowed. Otherwise the documents are required to be upgraded continuously. The Code Analyst can assist the Designer with the exact frequency and packaging requirements for submitting for Amended Releases.

Drawings illustrating revisions must be submitted for review on full sized sheets that can easily be incorporated into and maintained with the full approved set at the worksite.

Changes to documents that have been submitted for Plan Review, or that have already been “Released” for construction, must be reviewed, and approved by the Plan Review Authority Having Jurisdiction. To minimize the time and effort needed to review the document again, all changes must be identified on the documents in a clear manner for the reviewer, and a written narrative describing each change must accompany the submission. A sentence or two is all that is required for each change, provided it adequately conveys the general idea of the amendment to the reviewer.

A courtesy copy of all changes submitted to DCA should also be submitted to the local Permitting Authority if the project is under construction. Failure to do so could result in problems during scheduled or periodic inspections of the work.

Revisions made to documents that have already been “Released” for construction by DCA will be subject to additional Plan Review fees. The cost for such reviews will be calculated on an hourly basis. All additional fees due must be paid in full prior to receipt of the “Amended Release”. Reimbursement of costs for changes made to “Released” documents shall be the responsibility of the organization that initiated them unless that organization is Princeton University, or if Princeton University specifically agrees to assume them.

14. Periodic Testing Requirements

Periodic testing requirements of non-commissioned fire related building elements will be determined by the Project Manager and University Code Analyst. A list of required periodic tests will be developed during Design Development and distributed to the Design Team. Beginning with the 50% CD submission, the Design Team shall initiate detailed documentation of the testing procedures (a step by step guide to aide in administering the test). These procedures shall be complete and documented for review by all authorities having jurisdiction.

Outside consultants may be available as needed to help develop these procedures. Consult with the Project Manager should the project require the aide of outside consultants.

END OF DOCUMENT

1. Introduction

This section will provide the requirements for documentation and procedures for archiving all University Project Documents. The University is committed to utilizing digital technology in the creation of building information, including 2D Computer Aided Drafting (CAD) and Building Information Modeling (BIM). In addition to assisting the design and construction process, these technologies, as organizational tools, provide the basis for a number of important future University functions, including space management, maintenance and operations.

This section includes requirements for specific formatting and procedural requirements for drawing production, particularly related to CAD, but also pertaining to BIM as well as printed materials.

During the Schematic Design Phase, the Designer must meet with the Facilities Space and Property Management Information Systems (SPMIS) Administrator to review the process for the square foot calculation of areas and classification of operational uses for the various elements of the building program (see Appendices 1.5-4A and B). **The Designer shall contact the Architectural Engineer to schedule a meeting to review the University CAD and BIM Standards.**

2. Contacts

- | | |
|---|------------------------------------|
| A. The Project Manager (in the Office of Design and Construction, the Engineering Department, Grounds and Buildings Maintenance, or as applicable). | |
| B. CAD Archivist | MacMillan Bldg. 609-258-4926 |
| C. SPMIS Administrator | MacMillan Bldg. 609-258-6794 |
| D. Engineering - Mgr of CAD Dept. | MacMillan Bldg. 609-258-1689 |
| E. Architectural Engineer for Standards | 200 Elm Drive, 609-258-2094 |
| F. GIS Analyst | MacMillan Bldg. 609-258-8205 |
| G. Digital Deliverables Specialist | 200 Elm Drive 609-258-9339 |
| H. Building Document Coordinator | MacMillan Bldg. 609-258-7685 |

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

Princeton University Standard *A/E Design Services Contract* – Article XIV
Princeton U Standard *General Conditions -For All Construction Contracts* – Clause F2
<http://facilities.princeton.edu/suppliers/supplier-terms-and-conditions>

- | | | |
|--|----------------|-----------------|
| A. Princeton University CAD Standards / Template | Appendix 1.5-1 | 1.5-1 (dwg) |
| B. Princeton University BIM Specification | | Appendix 1.5-2 |
| i. BIM Execution Plan Template | | Appendix 1.5-2A |
| ii. Model Level of Development Matrix | | Appendix 1.5-2B |
| iii. PU File Naming & Model Packaging Standard | | Appendix 1.5-2C |
| iv. Building Elements List - sample | | Appendix 1.5-2D |

- v. BEL Attributes (BIM360FIELD) – samples Appendix 1.5-2E
- vi. Archive Documents (BIM360FIELD) - As Built library deliverables Appendix 1.5-2F
- C. Princeton University Building Drawing located in Planning Vault, Office of Design and Construction – MacMillan Building See Building Document Coordinator
- D. National CAD Standard (approved by NIBS, AIA and CSI) <http://www.nationalcadstandard.org/>
- E. Fire Alarm / Signage Nomenclature Spreadsheet Sample, Princeton University Appendix 2.8-2
- F. Princeton University Room Numbering Guideline Appendix 1.5-3
- G. FICM – (Facilities Inventory and Classification Manual), Chapter 3 – Building GSF/NASF calculation standards Appendix 1.5-4A
- FICM – Chapter 4 – Room Category and Type Space Standards Appendix 1.5-4B

4. Room Numbering Requirements

It is the intent of all projects to have permanent room numbers assigned during the Design Development Phase. It is the responsibility of the Designer to initiate and complete this process, and the Project Manager’s responsibility to gather required approvals. All Drawings shall include the University approved final room numbering system. **Once all room spaces and numbers are defined all CAD and BIM files shall have viewable room identifiers.**

Guidelines have been established for the process to be followed in the assigning of numbers and designations for both net assignable and non-net assignable spaces. The Designer should anticipate the incorporation of these standards into the construction documents for the project and should work with the Project Manager to conform to the system set forth in Appendix 1.5-3.

To facilitate the establishment of room numbers, a meeting with the Architectural Engineer for Standards and Design team should occur before the start of Design Development. This meeting will clarify the appropriate method for assigning room numbers based on previous University Projects. ✓SD-32

5. Existing Documentation Availability and Distribution

- A. Record/As-Built documents from previous projects in various formats are available through the Office of Design and Construction – See Building Document Coordinator ✓PS-26
- B. Current building floor plans are maintained in AutoCAD. Please see the CAD Archivist for details.

6. Archiving Requirements

- A. For the preparation of As-builts and Close Out Documents there is a requirement of coordination between the A/E and Contractor per *Clause F2* of the *General Conditions*

For All Construction Contracts and Article XIV of the standard A/E Design Services Contract. The following requirements are to be provided in their native format (2D/3D), **required University CAD/BIM formats**, as well as reproducible PDF files and hard copies as noted in the Summary of Archiving Requirements chart on page 4.

1. **Record Drawings/Model and Project Manual** – Consists of A/E-produced versions of the latest Construction Document set submitted. The A/E is to produce a set of documents that include all changes (sketches, bulletins, addendums, etc) authored by the design team. These documents will be included in a full size set of drawings and specifications and not as separate attachments. **If a project is documented using a BIM, the project model files shall also be submitted. (See Appendix 1.5-2 for requirements)**

Not to be confused with the contract alternate for *Comprehensive Archive Drawings and Specifications* per Article XIV of the standard A/E Design Services Contract.

2. **As-Builts** – Consists of Contractor or Sub-Contractor produced documentation of work in place of respective systems. Submission requirements may be found in individual Specification sections of the Contract Documents. At a minimum, all systems listed in Specification shall be submitted by the Contractor **in PCS with an indexed drawing list**. Refer to the Summary of Document Archiving Requirements in this section for details.

7. Closeout Documentation Review

Prior to submission to the University all closeout documentation listed herein as either contractor-produced or A/E-produced shall bear the equivalent review process as all prior submittals to date. This likely requires the A/E certification that the version sent to the University meets requirements of its respective CSI section. Second and third submissions may be necessary for quality assurance.

Summary of Document Archiving Requirements⁶

	Electronic Bookmarked PDF Reproducible (PCS)	Electronic Native format & CAD Drawing¹ (PCS)
<u>I. RECORD DRAWINGS⁵</u> <i>(A/E-PRODUCED)</i>	ascii compliant or .pdf formatted index	
Latest Construction Document Issue of:		
• Landscape, Site and Civil Drawings	X	X
• Architectural Drawings	X	X
• Structural Drawings	X	X
• Mechanical Drawings	X	X
• Plumbing Drawings	X	X
• Fire Protection Drawings	X	X
• Electrical	X	X
• Special Consultants (signage, curtain wall/envelope, security, furniture, sustainability, etc.)	X	X
<u>PROJECT SPECIFICATION MANUAL</u>		
Latest Construction Issue	X	
<u>II. THIRD PARTY FILE DRAWINGS–</u> <i>(PU-PRODUCED)</i>		
U/G Utilities	X	X
Site Plan	X	X
Land Survey	X	X
<u>III. MAINTENANCE / AS BUILT DOCUMENTS–</u> <i>(CM or GC -PRODUCED)³</i>		
Final Approved Submittals & Product Data (PER CSI SECTION)	X	
O&M Manuals (PER CSI SECTION)	X	
• Include any final approved submittals for ea. item of product data in O & M manuals.		
Warranties (PER CSI SECTION)	X	
Schedules		

Footnotes:

¹ Only one copy of the digitals are required

² Scanned images may also include converted electronic files in .PDF format

³ For projects w/out a CM or GC, consult with Project Manager to determine required As-Built documents

⁴ “Amended” refers to the As-Built condition conforming to the latest construction document issue.

⁵ Collecting and submitting this info from all sub-consultants is the responsibility of the lead Designer under contract.

⁶ Project Field Manager to coordinate additional on-site set requirements of GBM.

Summary of Document Archiving Requirements (*continued*)

	Electronic Bookmarked PDF Reproducible (PCS)	Electronic Native format & CAD Drawing¹ (PCS)
IV. MAINTENANCE / AS BUILT DOCS (cont'd)– (CM or GC-PRODUCED)³	ascii compliant or .pdf formatted index	
As built requirements are listed at the end of each section of the <i>Princeton University Design Standards Manual</i>	X	
In addition, any amended ⁴ Architectural or Engineering elements including:	X	
• Amended reflected ceiling plans with room heights	X	
• Amended building floor plans with actual room numbers, built-in furniture and equipment, and door swings	X	
• As-built room finish schedule annotated with all mfr., colors, model nos., styles, sizes, of all installed finishes including:	X	
a. ceilings	X	
b. floors (for tile include grout details) & stairs	X	
c. trim	X	
d. installed accessories (coat hooks, blackboards, screens, etc.)	X	
e. window treatments	X	
• all equipment schedules (amended with as-built information: room number, model, qty, etc.)	X	
• Amended envelope details: mixed designs, color additives, manufacturers, or masonry suppliers, flashing details	X	
• Actual stone identification and source	X	
• Grout/Caulking – actual mfr., type, color	X	
• Amended window installation details	X	
• Furniture Installation Plans	X	X
• Fire Detection	X	X
• Security and Access Control System	X	X
• Fire Suppression	X	X
• Air Temperature Controls	X	X
Final Approved Shop Drawings for:		
• Steel	X	X
• Pre-Cast	X	X
• Duct work	X	X
• Curtain Wall/ Glazing	X	X
• Signage	X	
• As required by Project Manager	X	X
MEP Coordination Drawings	X	X

8. Formatting of Printed Deliverables – As Built Drawings (from Contractor)

A. Document Identification

1. Project Title
2. Drawing Title
3. Project Location
4. Document Submission Date
5. Name and Address of Subcontractor
6. Contact Name and Telephone Number
7. Revision Dates
8. Scale and North Arrow include the specific **horizontal and vertical** reference (NAD83, Grid or Magnetic) to any applicable information such as deed, filed plan
9. Datum and Grid/Ground Scale Factor Notes

9. Formatting of Electronic Deliverables

A. Document Identification

All requirements for document identification from printed deliverables apply to electronic deliverables. Princeton University maintains both 2D CAD standards and BIM specifications which include requirements such as pen weights, layers, layer naming, file naming and title blocks. (Keynotes are not acceptable in documents. All notes to appear on the detail sheets)

Refer to appendix 1.5-1 for 2D CAD standards and templates.

Refer to appendix 1.5-2 for BIM requirements

At the end of Schematic Design the team is to publish both the CAD and PDF files so that PU can internally review the CAD documents for compliance with the 2D CAD standards (1.5-1).

B. Formatting of CAD Deliverables

Contact the **Building Document Coordinator** for options regarding transferring of data.

AutoCAD™ is the CAD software employed by Princeton University. The AutoCAD™ DWG © format is file format used by Princeton University to store and manipulate CAD drawings. Princeton University utilizes the current version of AutoCAD™ to guarantee the compatibility with Princeton University CAD/CAFM Systems, all CAD files must be in AutoCAD™ file format within 2 releases of the current version. More information regarding file structuring layering can be found in Appendix 1.5-1.

For final Record Document submission individual files formatted per sheet will be required.

C. BIM Deliverables: The use of BIM is required as indicated in the specific-project A/E Design Services Contract. Refer to Appendix 1.5-2 for detailed BIM requirements

1. Software: Autodesk software, including Revit and Navisworks will be used. See Appendix 1.5-2.
2. Project Level BIM Execution Plan: Project Team will develop a project BIM Execution Plan, as well as a BIM Level of Development Matrix, which will include both the minimum BIM requirements as specified, and project-related BIM goals, processes,

- protocols and levels of development identified by the project team. This plan will be updated and modified periodically to reflect the needs of the upcoming project phases.
3. A copy of Record Model and As-Built Model will be submitted by A/E and Contractor respectively at project completion.

D. PDF Deliverables:

1. Drawings: 1 consolidated file per discipline (i.e. architectural, mechanical) bookmarked and layered from CAD export
 - o For final Record Documents individual sheets will be required in addition to consolidated files.
2. Specifications: 1 consolidated file per volume bookmarked per spec section and named informatively

E. Deviations: Deviations from these requirements are only permitted with written approval of Princeton University.

10. Use of Princeton University Existing Digital Data

The University strives to be completely digital and therefore have been focused on converting the existing hard copy utility plans to digital CAD drawings. The utility data has been compiled over the Universities CAD Planimetric Base Map which was developed through a Aerial Photography and Orthophotography mission in 1999, supplemented by yearly planimetric updates and GPS collection of additional features both surface and subsurface when exposed for maintenance purposes.

Authorized Users can acquire the latest Princeton University digital campus map by contacting the GIS **Analyst**.

The Princeton University digital campus map conforms to the New Jersey Stateplane NAD 83 US Survey Feet (horizontal datum) and NAVD 88 US Survey Feet (vertical datum).

*The Designer shall not base designs on vertical data from any Princeton University supplied source. All vertical and horizontal values shall be independently verified by the consultant. **BIM models shall be correctly documented in regards to horizontal and vertical datum.***

11. Positional Tolerance Requirements for Internal Bldg Conditions, Surveys and As-Builts

All CAD drawing models should be drafted at full scale in architectural units, such that one drawing unit equals one inch.

As-builts and Record Documents should meet or exceed the following:

It is typically required that exterior building dimensions recorded within CAD drawings must reconcile to within one inch of actual building dimensions as measured in the field, and interior building dimensions must reconcile to within one-half inch of actual field dimensions. However, individual project specifications may vary slightly.

For information regarding external conditions, refer to Section 2.9, Site Planning.

END OF DOCUMENT

1. Introduction

Much of Princeton University's historic campus was originally designed in ways which may not have provided for accessible routes and features to all parts of its buildings. Nevertheless, one of the goals of every University project is to enhance and improve the accessibility of the campus and its buildings, and to create accessible routes to and through University facilities, accomplished without assistance or special knowledge.

Moreover, it is the goal of the University that all new construction and renovation be designed and include features to allow for independent use to the highest extent possible of all campus facilities by all individuals regardless of disability. The University is committed to ensuring access for individuals with disabilities, including but not limited to students, employees, occupants, spectators, participants, consumers, or visitors.

Princeton University is subject to regulations under the federal laws known as the Rehabilitation Act and the Americans with Disabilities Act, as well as the New Jersey Law Against Discrimination ([N.J.S.A. 10:5-12](#)) (*LAD*). Under applicable law, disabilities may include physical, mental, sensory or cognitive impairments or disorders

The Designer is responsible for meeting all applicable codes as referenced in the New Jersey Uniform Construction Code, as well as all regulations implementing the Americans with Disabilities Act, specifically the ADA Accessibility Guidelines ("ADAAG") as adopted by the Department of Justice. For all projects, in addition to meeting the above referenced codes and standards, project-specific goals identified by the University to enhance and improve the accessibility of the campus and its buildings must be considered and incorporated by the Designer. No modification may be undertaken that makes the campus *less* accessible. It is the University's long term goal to have an accessible campus.

For projects involving ground up construction, the design team shall meet with the University Code Analyst early in the programming phase to discuss accessibility with respect to the project design. New buildings will follow accessibility code requirements to the full extent of both state and federal law; in the event of a conflict, the design must comply with the more restrictive standard.

For renovation work, The Designer shall meet with the University Code Analyst and accessibility consultant as directed by the Project Manager early in the programming phase to discuss the project goals with respect to accessibility. Refer to Section 6 below.

2. Contacts

- | | |
|---|--|
| A. The Project Manager | Office of Design and Construction |
| B. University Code Analyst | MacMillan Building, 609-258-6706 |
| C. University Accessibility Consultants | NK Architects, Morristown, NJ
Contact Project Manager to coordinate |

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

PDF

AutoCAD

A. Campus Accessibility Map

<https://facilities.princeton.edu/sites/default/files/Accessibility.pdf>

B. Princeton University

Typical Barrier Free Details

Appendix 2.1-2

Appendix 2.1-2

C. Sample Accessibility Program Document

Appendix 2.1-3

D. **United States Access Board**

<https://www.access-board.gov/research/completed-research/dimensional-tolerances>

4. Applicable Codes and Federal Standards

Refer to Princeton University Design Standards Chapter *1.4 Regulatory Agencies* for additional information regarding applicable codes and regulatory procedures

Some Codes and Regulations that are of primary importance include but are not limited to:

A. U.S. Department of Justice, Americans with Disabilities Act Accessibility Guidelines (“ADAAG”)

A. [New Jersey Uniform Construction Code \(NJUCC\)](#)

B. [New Jersey Applicable Codes and Standards](#)

C. [New Jersey Uniform Fire Code](#)

D. ICC/ANSI A-117.1 American National Standard for Accessible and Useable Buildings and Facilities

It is the responsibility of the Designer to comply with the currently adopted versions of the applicable codes and current federal standards at the time of submission to NJDCA and/or other authority having jurisdiction. In the event of a conflict between the State and Federal standards, the designer shall design to the more restrictive standard unless directed by the University in writing.

Designers should not simply design to code. **Designers should follow the suggested best practices for dimensional tolerances as outlined by the United States Access Board** so that installed work will always fall within federal and state guidelines.

5. University Review Guidelines

Initial planning and preliminary design will be conducted through the Office of Design & Construction with the University department responsible for project initiation. ✓PS-21 ✓PS-22

For new construction projects, while all projects shall comply with codes and standards identified earlier in this section, the Designer shall also meet with the University Code Analyst early in the programming phase to discuss the project goals that supplement code requirements with respect to accessibility. The Accessibility Consultant may be included at the discretion of the Project Manager for initial project review. The designer shall then develop an Accessibility

Program Document restating the agreed goals and supplemental code requirements for the project.

For renovation projects, the Designer shall meet with the Accessibility Review Committee to discuss the project goals with respect to accessibility. In addition to the client/user, the committee is comprised of the University Program Manager, University Code Analyst, The Office of Disabilities Services, the Design Professional and the University Accessibility Consultant. During this phase, the Designer shall develop an Accessibility Program Document for review by the committee (See Appendix 2.1-3). This document shall be submitted during the programming phase and will serve to determine the scope of the accessibility improvements to be included in the final scope of work for the project.

As all projects move toward the construction documentation and code review phases, it is required that the project be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. The following deliverables and milestone reviews are to be included:

- A. Accessibility Program Document(s);
- B. Completion of Schematic Design;
- C. Completion of Design Development
- D. At 50% completion of construction documents;
- E. At 85% completion of construction documents;
- F. At 100% completion of construction documents, if required, at the discretion of the Project Manager

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives and the University Accessibility Consultant as required by the Project Manager. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

The accessibility consultant will be included in the Accessibility Committee and the Tech Team in the above referenced reviews at the direction of the Project Manager, but at a minimum will be consulted during the Program Document Phase, at the completion of Design Development and at 85% or 100% completion of construction documents.

6. Design and Procedural Guidelines

First and foremost, no alterations may be made to buildings or areas on campus that make the campus *less* accessible.

The Designer must become familiar with the barrier-free requirements in the NJUCC, NJIBC Chapter 11, and the ICC/ANSI A117.1 American National Standard for Accessible and Useable Buildings and Facilities, and should also be familiar with requirements promulgated by the

Americans with Disabilities Act (ADA). Refer to Chapters 1.4 (Regulatory Agencies) and 2.9 (Site Planning) for additional information.

As identified above in Section 5, accessibility goals for each project shall be established during the programming or pre-schematic phase of each project. The University's goal for all addition and renovation projects is to provide accessible facilities in areas served by accessible entries and along accessible routes, and to provide those entries and routes whenever feasible as part of the project.

✓PS-2

For all projects, new and or renovation, the Designer in conjunction with the Project Manager and the University Accessibility Review Committee, shall meet as required to review all project-specific goals at the pre-schematic phase of the project. The result of the meeting(s) shall include the Accessibility Program Document (See Appendix 2.1-3). This document shall serve to identify and coordinate access considerations with adjacent portions of the building(s) and campus. The content goal of the Accessibility Program Document shall include at a minimum, a review of the following project-specific accessibility goals:

- Connection of the new or existing building with the existing campus accessible routes and or transportation features. These include but are not limited to the Tiger Transit and the Campus Accessibility Map.
- If applicable, modification of existing entrances to provide -accessible ingress
- Access to Primary Function spaces in the building
- Access to accessible Toilet facilities in the building
- Access to all public services in the building
- Identification of existing non-compliant conditions as related to the Project Program
- If applicable, workplace accommodations as appropriate for the building type
- If applicable, accommodations for Housing

For any project with exterior component(s), zoning or planning approval may be required. This process normally incorporates all accessible features such as exterior ramps, so the Designer should consult the Project Manager at the beginning of the project regarding this process as it can be time consuming and projects are often time-sensitive. Each Project Manager for a project which disturbs an exterior site in any way should meet with the University Architect to determine whether the extent of the disturbance requires formal review by the Landscape Coordinating Committee, or informal review by the University Coordinating Architect, or whether the University Landscape Project Manager simply needs to be informed so that appropriate site restoration can be undertaken after completion of the project. Refer to Chapter 2.9, section 6 for additional information.

The Designer is responsible (in consultation with the Project Manager) for preparing construction documents and applications for project review by local and State code agencies. Prior to submitting an application for project review, the Designer will meet with the University Code Analyst and will then prepare the project application forms, including (where applicable) the DCA's Project Review Application, the Application for Plan Review and the forms for local review. The Designer is to meet again with the Code Analyst to review the application forms and any supporting documentation.

Should a variation from NJUCC code requirements be necessitated by the design of the project, the Designer will be responsible for preparing the application for relief, along with supporting

documentation. A variation application will normally be prepared and submitted prior to completion of 100% Construction Documents. It should be noted that there is no process for, nor permission of variation from Federal Standards.

Designers should be cognizant of normal construction tolerances, and as such, exercise appropriate judgment in applying code minimum or maximum dimensions so that installed work will always fall within federal and state guidelines

7. Guidelines and Requirements for Documentation

The Designer shall provide documentation in adequate detail for accessible features such that will allow review agencies to approve the project. Typical information that is inadequately documented includes door sizes and specific related hardware, clearances required for accessible passages, bathroom layouts, operating features, mounting elevations of devices and equipment, etc. Proposed conditions shall be shown to comply with the requirements of the New Jersey Uniform Construction Code and its barrier free subcode, NJIBC Chapter 11, and with ICC/ANSI A-117.1 American National Standard for Accessible and Useable Buildings and Facilities, a referenced subcode to the NJUCC and the Federal standards as identified by the Americans with Disabilities Act.

Survey data (elevation/grade along paths; ground to floor differential; floor to floor measurements, change of level within a story) will prove useful for both design and review. Site plans need to show, at a minimum, the accessible parking spaces needed for the project along with a compliant wheelchair route to each accessible entrance.

8. Other Considerations for Accessible Design

Designers should review the following with the Project Manager and University Code Analyst, to ascertain approaches to accessibility and design features that might be unique to Princeton facilities which are above and beyond the requirements of the Code Requirements. **The following items may include but is not limited to:**

Site Related Design Issues:

1. Parking
 - Code required signage
 - Slope and surface
 - Striping
 - Parking accounting
 - Van accessible requirements
 - Accessible connections to buildings and transit
2. Curb Ramps, Curb Cuts & Accessible Routes
 - Tactile surface as required
 - Changes in level and material
 - Handrails
3. Walking / Travel
 - Lighting
 - Site stairs and required handrails
 - Handrails

4. Exterior and Interior Ramps
 - Coordination of Cross Slope with proper drainage
 - Appropriate slope
 - Appropriate lighting
 - Ramp size and cross slope
 - Layout of landings
 - Handrails and associated reduction in clear width
5. Exterior Signage
 - Directional Signage (Wayfinding)
 - Refer to Section 2.8 Environmental Graphics

Building Related Design Issues:

6. Building Entrances
 - Automatic door openers – size & placement
 - Vestibule depth
 - Pull clearances in relation to wall thickness and recess of door
7. Floor Surfaces
 - Flooring material transitions
 - Thresholds
 - Slip resistance
8. Doorways
 - Door width
 - Clear floor space and arrangement
 - Push and pull clearances
 - Landings
 - Clearance related to designed furniture layout
9. Toilet and Bathing Rooms
 - Clear floor space
 - Plumbing fixtures
 - Toilet accessories
 - Toilet vestibule clearances
 - Mounting heights for towel dispensers
10. Elevators
 - Minimizing use of chair/stair lifts
 - Locations that maximize accessibility to public/common spaces
11. Operational Building Components (See Appendix 2.1-2)
 - Mounting heights
 - Clear floor space
 - Reach range
12. Protruding Objects
13. Clear Floor Areas
14. Interior Signage
 - Braille Requirements
15. Handrails

16. Dormitory/Dwelling Units
 - Clear floor space
 - Furniture layout (fixed and movable)
17. Laboratory Equipment and Features
 - Emergency eyewash, sinks, fume hoods, etc.
18. Classroom Accommodations and Features
 - Furniture layout (fixed and movable)
 - Lecturns
 - AV equipment
19. Business and Office spaces
 - Furniture
 - Clear aisleways
 - Fixed and movable furniture and equipment clearances
 - Path of travel & aisleways
 - Door and fixture clearances

END OF DOCUMENT

1. Introduction

Audio-visual systems and equipment play a fundamental role in space design at Princeton University. Designers must be aware of the technological requirements of the educational spaces they are working in, and must consider legacy and future technology needs as well. This document introduces some of the issues a Designer must consider in projects at Princeton. Audio-visual requirements for projects may contain spaces such as classrooms (Registrar and non-Registrar), meeting and conference rooms, public spaces (lobbies and lounges) and seminar rooms.

The Committee on Classroom Design at Princeton University has identified five macro-level trends in classroom design: (1) Learner-centered pedagogy; (2) natural systems (ambiance); (3) spaces outside of the classroom; (4) flexibility; and (5) technology.

Properly designed AV systems carefully integrate tele/data systems, room acoustics, lighting, shading, floor, wall, ceiling, structural and architectural elements, seating configurations and sight lines, instructor and student interactivity, the established campus AV standards, and ADA and local code requirements. As such, AV system design should be considered a building system with the same level of planning and preparation of infrastructure as, for example, an HVAC system.

As with other major building systems, programming during the pre-schematic and schematic design phases will inform the project budget, user performance expectations, and the architectural room design. Because the installed costs of AV systems are significant (sometimes as high as 5% of the total construction budget), it is critical that an AV systems program and budget estimate be provided during the initial project budgeting phase.

If the program calls for video-conferencing, “Rich Media” streaming equipment or video recording, many aspects of the room design will be significantly affected, including room acoustics, lighting design, tele/data specifications, seating, surface colors and finishes.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. University AV/Classroom Planner see Project Manager
- C. Associate Director Instructional Technology Services 87 Prospect, 609-258-9945
- D. A/V Consultant see Project Manager
- E. Manager, OIT Network Installation 171 Broadmead, 609-258-6015
- F. McGraw Center for Teaching and Learning see Project Manager

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

- A. Princeton University, Media Equipped Rooms
<https://registrar.princeton.edu/classroom-information/>

- B. Princeton University, Broadcast Center website: <http://www.princeton.edu/bc/>
- C. Princeton University, Media Services website: <http://www.princeton.edu/mediaservices/>
- D. **Audio Visual Equipment** Appendix 2.2-1
- E. **Typical classroom media equipment cabinet and lectern** Appendix 2.3-2
- F. Audio Visual Touch Panel Layout Appendix 2.2-2
- G. A/V Master List Spreadsheet Appendix 2.2-3
- H. Audio Visual As-Built Requirements Appendix 2.2-4
- I. Recording System Standardization
for Campus Lecture Halls Appendix 2.2-4
- J. **Video Conferencing Standards** Appendix 2.2-5
- K. AV Programming Document Appendix 2.2-6
- L. **AV Programming Checklist** Appendix 2.2-7

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [NJ Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities “Tech Teams”, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions may be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The role

of the Tech Team review process is to confirm compliance with the current version of the Facilities Design Standards Manual and each respective section and associated appendices.

6. Procedural Guidelines

In consultation with **Instructional Technology Services, University AV/Classroom Planner** and the Project Manager, a decision must be made about the level of AV and IT technology desired in the classroom/lecture facilities and in the building itself.

The A/V program should be initiated and developed during schematic design of the building or renovation project in the form of a Design Intent document. A needs assessment should be performed with the Project Manager, and an evaluation of the effects those needs will have in terms of space requirements and infrastructure demands. In this phase, the Project Manager acts as the primary 'client' and source of information, with support from the **Associate Director Instructional Technology Services, AV/Classroom Planner and Registrar as required**. Depending on the level of connectivity, additional planning support may be provided by Office of Information Technology, OIT.

In developing the program, compile a set of display parameters for the project. The parameters should address room layout, optimal seating arrangement, lighting considerations, A/V display and control standards, IT connectivity and methods for mounting, storing and securing all equipment.

An AV Programming **Checklist** and Document is to be created (see **Appendix 2.2-6 & 2.2-7**) listing the following at a minimum – per room

1. Owned by
2. Maintained by
3. Classroom Tier (if applicable)
4. Video Capabilities
5. Room Features
6. Ongoing maintenance, warranty and licensing requirements

This document is to be reviewed with the Project Manager, University AV/Classroom Planner, **Instructional Technology Services**, Architectural Engineer, Standards. It is also important to review the document with the user/department so they are aware of which spaces where ownership/maintenance will be their responsibility.

7. Guidelines and Requirements for Documentation

Along with the design documents, the Designer is to produce sufficient documentation to allow for code review of the project and for contract bidding of the work. A/V system information will have to be incorporated into the code review sets to an extent that allows the code review agencies to ascertain that the proposed work meets code requirements, where they apply. This typically will include all line voltage wiring and outlets, and diagrammatic layouts of any low voltage power and signal wiring and raceway that falls under the purview of the National Electric Code. Generally, the A/V consultant will provide the Electrical Engineer with this information, which is then included in the electrical drawings prepared for review and pricing.

See Section 1.4 (Regulatory Agencies) for requirements for code review and permits.

The A/V consultant will be expected to advise the A/E team on equipment and seating layout,

site lines and floor slopes for optimizing viewing; screen location, elevation, size, and orientation; configuration of the projection booth, if one is to be included; and the interconnection of equipment and control locations. Coordination of the equipment with the structure and infrastructure is critical in producing a successful, sophisticated teaching facility. For clarity's sake, separate documentation should be included in the construction documents for the A/V work. The equipment locations and power/control wiring, rack elevations, patch panel details, connector plate details and mounting requirements, control diagrams, etc. should all be shown on the A/V drawings. The A/V consultant will submit all conduit runs and sizes, floor- and wall-box locations and sizes, grounding requirements and details, and power requirements to the consulting Electrical Engineer for inclusion in the electrical construction documents in the general construction bid set.

Any information on the necessary separation of power and A/V line wiring runs should be included on both the A/V and electrical contract documents.

Clear information regarding responsibility for A/V system wiring and responsibility for installation of raceways and line voltage systems is critical. Electrical contract drawings and A/V contract drawings must be carefully coordinated by the consulting Electrical Engineer, the A/V consultant, and the lead design consultant.

Requirements for specific areas of documentation are as follows:

Documentation	SD	DD	50% CD	85% CD
AV Design Intent	X			
AV Programming Document		X	X	X
AV Basis of Design		X		
Space Requirements		X	X	X
AV Functional Diagram			X	X
AV Plans – <i>Include notes, symbols, finishes for the following: Equipment Rack, Media Equipment, Projection Screens, Data/Video Projector, Instructor Location Receptacles, Stereo Loudspeaker, Overhead Projector, Other (Rich Media, Video recording, Cameras, etc.), Floor Boxes, Lectern, Media Equipment Cabinet, AV Touch panel Layout</i>			X	X
Coordination – <i>Coordinate AV Plans with the following: Lighting, HVAC, Acoustics, Security, Signage, Door Hardware</i>				X
Details				X
Outline Specifications		X		
Full-Length Specifications			X	X

8. Guidelines for Audio-Visual Equipment

A. General

1. Provide each A/V station (equipment rack, media cabinet, etc.) with a standard OIT wiring bundle – connections vary depending on tier **and optional equipment selected** (1-1/4” conduit, quad AC and 2 gang to OIT only). Floor box to be approved by **Instructional Technology Services**, OIT, Project Manager, AV/Classroom Planner and AV Consultant.
2. Provide dedicated power circuits for A/V equipment. All AV power circuits including in floor boxes, at equipment racks, video projectors and flat-panel displays to be wired on SAME PHASE at the electrical panel serving the space. If requested by the AV consultant or **Instructional Technology Services**, provide isolated grounding of AV circuits. Power circuits are to be 120VAC and 20A, minimum.
3. In small classroom/seminar configurations where data/video projection/**display** is provided, install desktop connections for A/V signal and control (AC power, data, laptop display and audio and AV control connections). The location will depend on the room configuration, the furniture size and layout, etc., which underscores the need for early planning of the A/V and furniture systems

4. All media equipment is to be locked in place. All equipment cabinets and lecterns are to be keyed with the *media module / national (915)* key. All production booths are to have SALTO keyless locks and main entry.
5. Secure storage in room or close by is to be provided for all portable equipment (i.e. assistive listening, cart mounted equipment).
6. All spaces AV requirements need to be reviewed and is not limited to classrooms and conference rooms. While the tiered requirements below speak to specific tiered classroom requirements there is a benefit to pairing non-registrar spaces with these tiers for future events/support.

B. Requirements for equipment

General tiered room requirements are as follows:

Equipment Tier*	Tier*		
	1	2	3
Flat Panel or Projector / Screen	X		
Single or Multiple Projection / Screens		X	X
VGA/Audio/HDMI/USB Connections (for user laptop)	X	X	X
Program and Speech Mounted Speakers (where applicable)	O	X	X
Assistive Listening (where applicable)	O	X	X
Room Computer	O	X	X
Microphones	O	O	X
Lectern		X	X
Production Booth/Boothette			X
Optional Services **			
Control System	O	X	X
Lecture Capture		O	O
Media Players	O	X	X
Simulcast Receiving	O	O	O
Video Conferencing and Recording	O	O	O
Video Streaming		O	O
Cameras	O	O	O
Wireless Connectivity (i.e. Apple TV)	O	O	O
Web Conferencing	O	O	O
Press Connection		O	O
Misc. Room Equipment – where applicable (i.e. document cameras, cart mounted equip.)	O	O	O

*Additional Specialty Tier rooms will have specific program requirements in addition to those listed above (i.e. performance, film spaces, active learning (flex, entrepreneurial, breakout), etc.)

**Optional Services to be determined during programming.

NOTE: Additional tier specific equipment information is below.

Media equipment should generally be:

1. Simplified AV Classroom (Tier 1)

The simplified AV classroom system is required where only laptop and occasional portable video equipment display is required:

- a. Ceiling-mounted data/video projector with security cable
 - i. Review requirement for tv tuner
 - ii. Or a flat panel television (review requirement for video conference ability **and interactive display requirements**)
- b. Motorized video projection screen (where applicable)
- c. Program and speech mounted speakers/sound bars (where applicable)
- d. Wall or floor box receptacles, conveniently located for:
 - i. Laptop (VGA) and composite video (HDMI) and audio connection to the video projector
 - ii. Laptop Ethernet connection to Princeton LAN (OIT) at instructor location
 - iii. Quad receptacle for laptop power via cable cubby
 - iv. Floor box, if required, for OIT, laptop interface and quad AC
- e. Wall switch plate with projector and volume controls.
- f. Additional OIT outlet at rear of room – to be reviewed
- g. AV control system connection to Media Service RoomView and eControl remote management systems.
- h. Wall mounted atomic clock(s)
- i. Optional Equipment:
 - i. Princeton-provided PC, mouse and keyboard (keyboard drawer required) with a secure mounted screen at lectern or counter– computer and screen furnished by owner.
 - ii. Quad power receptacle at PC location
 - iii. FSR floor box as required for program (quad power at all floor boxes)
 - iv. Height adjustable lectern
 - v. Speech System (microphones)

2. Standard AV Classroom (Tier 2)

The standard AV classroom system is required where permanent source equipment is required in addition to laptop and occasional portable video equipment display:

- a. One or more ceiling or cabinet mounted data/video projector with security cable
- b. Motorized video projection screen. Quantity, size and spacing of screens to be coordinated with the University.
- c. Program and speech mounted speakers (where applicable)
- d. Millwork media equipment cabinet housing:
 - i. AV equipment rack with storage drawer and AC surge protection

- ii. Stereo audio amplifier
- iii. AV control system/video router
- iv. Security rack covers (i.e. program amp, AC surge protection)
- v. Auxiliary RGB
- vi. Networkable AC surge protection
- vii. AV signal input/output plate
- viii. Flash recorder
 - i. Quad power receptacle
- e. Instructor location receptacles, conveniently located for:
 - i. Laptop (VGA) and two composite video (HDMI) and audio connection to the video projector
 - ii. Laptop Ethernet connection to Princeton LAN (OIT)
 - iii. Quad power receptacle for laptop power
 - iv. AV control system with small touch panel, programmed to conform to Princeton layout standard.
 - v. AV control system connection to Media Service RoomView and eControl remote management systems.
 - vi. Floor box for OIT, laptop interface and quad AC
 - i. Princeton-provided PC, mouse and keyboard (keyboard drawer required) with a secure mounted screen at lectern or counter– computer and screen furnished by owner.
 - vii. Height adjustable lectern, if applicable
- f. Speech support sound system including wired and wireless microphones, distributed loudspeakers flush-mounted in the ceiling. Under-balcony loudspeakers may be required in some venues. Wireless microphones must include at least two handheld and two lapel/belt pack microphone combos on separate channels.
- g. ADA-compliant assistive listening system, infrared type with full coverage to entire audience area with transmitters for 4% of seat count, minimum.
- h. Back of room connections:
 - i. Duplex receptacle for laptop power
 - ii. AV control system with small touch panel, programmed to conform to Princeton layout standard.
 - iii. AV control system connection to Media Service RoomView and eControl remote management systems
- i. 1 wall mounted clock
- j. Optional, if requested or appropriate:
 - i. Portable equipment (i.e. cart mounted screens, cameras, computers) to supplement.
 - ii. FSR floor box as required for program (quad power at all floor boxes)

3. Lecture Hall (Tier 3)

A lecture hall AV system is required where speech support sound system is required. Reference appendix 2.2-4: Recording System Standardization for Campus Lecture Hall for more detailed information. A lecture hall configuration may include:

- a. Lockable, sound-isolated projection booth with:
 - i. Independent HVAC zone and in-booth controls
 - ii. Dimmable track lighting over the counter
 - iii. Unobstructed sightlines to audience seating, front wall and teaching areas.
 - iv. Unobstructed sightlines for counter and ceiling-mounted projection equipment with 6' standing clearance in front of booth.
- b. Audio visual equipment at front of room location (rack or lectern).
- c. Programmable light dimming system with multiple preset scenes and luminaire zones coordinated with various front-wall projection screen and writing board configurations. With owner (local) control/programming capacity of presets.
 - i. Classroom lighting requirements
 - ii. Broadcast Center lighting requirements
- d. One or more data/Video projectors ceiling-mounted within the projection booth. The brightness and resolution of the display(s) are to be determined by the AV consultant or by specific request by the users.
- e. Motorized video projection screen(s) flush-mounted in the ceiling. Quantity, size and spacing of screens to be coordinated with the University. Wall-mounted high-performance stereo loudspeakers
- f. Video recording (lecture capture), streaming and conferencing capability (See appendix 2.2-4 and 2.2-6 for lighting, speakers, ceiling microphones and additional Video Conferencing and Recording System Standardization items.)
- g. Speech support sound system including wired and wireless microphones, distributed loudspeakers flush-mounted in the ceiling. Under-balcony loudspeakers may be required in some venues. Wireless microphones must include at least two handheld and two lapel/belt pack microphone combos on separate channels. Wireless microphones to be reviewed. Wired microphones inputs a center stage floor box locations – to be coordinated with University.
- h. ADA-compliant assistive listening system, infrared type with full coverage to entire audience area with transmitters for 4% of seat count, minimum.
- i. Rear-wall power, data, and audio output receptacle (press feed), speech and speech program mix
- j. Height adjustable millwork lectern configured to accommodate:
 - ii. Wired gooseneck microphone
 - iii. Princeton-provided computer, mouse and keyboard (keyboard drawer required)
 - iv. Laptop audio and video connections and USB cable from booth (one VGA and two HDMI connections,) to the display system

- v. Cable cubby to accommodate quad power and data connections to the Princeton LAN (OIT), and a USB hub
 - vi. Intercom phone to the projection booth
 - vii. Reading lamp
 - viii. Clock/timer
 - ix. AV control system touch panel
 - x. FSR floor box(es) with connections as required for lectern connection to AV system (quad power at all floor boxes)
 - xi. Wireless microphones, with designated storage location
 - xii. Space to accommodate user laptop, notes
- k. AV equipment racks, housing:
- i. Blu-Ray/DVD player
 - ii. CD Player
 - iii. Digital audio recorder (flash recorder)
 - iv. NTSC HD TV tuner (TBD)
 - v. Stereo and speech audio amplifier(s)
 - vi. AV control system hardware
 - vii. AV Bridge to be reviewed
 - viii. Video amplification, routing, and processing equipment
 - ix. Telephone hybrid (DSP and switchers)
 - x. Rack plate (and patching if requested)
 - Video
 - a. Composite video in/out (BNC connectors)
 - b. Component video in/out (BNC connectors)
 - c. VGA input (VGA female)
 - d. VGA output (VGA male)
 - e. HDMI in/out
 - Audio
 - a. All connectors XLR unless noted
 - b. Inputs (female)/Outputs (male)
 - c. 1 microphone input
 - Line level program audio stereo – inputs/outputs
 - Speech stereo line level output – speech only
 - Stereo speech/program mix output
 - VGA input/output stereo mini
 - xi. Storage drawers
 - xii. Networkable AC surge protection
 - xiii. Wire management hardware
 - xiv. Blu-ray DVD player
 - xv. UPS
- l. AV control system with one or more large touch panels, programmed to conform to Princeton layout and graphic standards. In addition to the AV controls indicated in the Princeton standard, touch panels may require:
- i. Video preview capability
 - ii. Computer viewing capability

- iii. Control of lighting presets, motorized projection screens, drapery, shades and writing boards, as determined by the Princeton project manager. University AV/Classroom Planner, Media Services and the Broadcast Center.
- m. AV control system connection to Media Service Room View and eControl remote management systems.
- n. 2 wall mounted clocks
- o. Analog line
- p. Optional, if requested or appropriate:
 - i. Subwoofer and/or surround sound loudspeakers
 - ii. Digital document camera
 - iii. Ceiling-mounted camera located in the ceiling above lab benches
 - iv. Rich Media web recording and distribution system and associate a/v outputs
 - v. Rear wall confidence monitors
 - vi. Auxiliary laptop, video, audio and AV control system connection locations'
 - vii. FSR floor box as required for program (quad power at all floor boxes)
 - viii. 4 SHURE SM58 microphones, 4 stands and four XLR cables
 - ix. Refer to appendix 2.2-5: Recording System Standardization for Campus Lecture Hall for more detailed information for video conference, recording, streaming and associated camera requirements
 - x. Portable equipment (i.e. cart mounted screens, cameras, computers) to supplement.

4. Specialty Rooms

Specialty AV rooms include spaces that do not fall into the types outlined above. These spaces may be public event spaces, performance spaces, music spaces, active learning environments (i.e. flex and entrepreneurial) as well as simplified public break out zones. Planning of these spaces during the AV programming exercises is key to their success. Some of these spaces will have simplified AV systems while some of these spaces may include Tier 3 requirements in addition to:

- a. Sound systems for theatrical or musical performance, background music, sound masking, paging, intercom, or other specialized applications.
- b. Display and sound systems for video conferencing, immersive or 3D visualization, security monitoring, portable use, outdoor events, and digital signage or recreational displays for student lounges, cafes, common areas, etc.

Specialty systems may have significant impact on the physical and architectural design as well as the structural and electrical infrastructure and acoustical attributes of the space (and building) and will require significant planning and design coordination between the architect, structural, electrical, mechanical and audiovisual systems engineers. To avoid unnecessary architectural redesign expenses, these systems must be evaluated, programmed and budgeted during the schematic design phase.

5. Legacy Equipment

Infrastructure for legacy equipment (rack space, audio/video interfacing and routing, power, conduit, junction boxes, and receptacles) must be provided where requested. This includes:

- a. 16mm and 35mm film projection
- b. 35mm slide projection
- c. Transparency overhead projection
- d. Multi-region or NTSC VHS videotape display
- e. Audio cassette playback

Designers can inquire about the availability of legacy devices and support with the Princeton **Instructional Technology Services**, Department at (609) 258-3196.

6. Portable Equipment:

Portable equipment systems dedicated to a facility such as cart-based projection and sound systems are discouraged. Portable equipment requires secure storage, is prone to theft and abuse, and requires user expertise or technical support to operate. As such, portable equipment may fall into disuse and is a generally poor investment.

Where no alternative exists, the Princeton Project Manager must assure that support personnel are available to deliver, remove, manage and maintain the equipment as needed by the users.

C. Production Booths (Tier 3/Specialty where applicable)

During Schematic Design the layout of any production booths should begin. As the project scope is developed, A/V equipment should be planned and enumerated, and the production booth developed as well.

Except where room configuration prevents adequate space allotment to a projection area, standard (front) projection is preferred to a rear projection system. The production booth should have direct access to the room it serves. Coordinate recording booth requirements with the users. The recording booth may become a separate space from the production booth depending on program requirements.

Production booths become the operational center of a lecture facility, and virtually all controls for systems should be in (or duplicated in) the production booth. Critical controls must be near at hand to the operator/technician. The production booth should include the following systems and characteristics:

1. Lighting and controls

- a. The projection room itself is to have two separate lighting systems, an ambient system (lighting levels at floor level per IES and PU Standards) for work in the room, and a dimmable system for use during projection. The dimmable system is typically a track lighting system for maximum flexibility. Controls for this system need to be near the operator/technician work position.

- b. The main dimming controls for the tier 3/Specialty room need to be in the production booth, again near to the operator/technicians work position. The University standard for tier 3/Specialty dimming controls is **Lutron's GraphicEye** system.

The dimming panel itself need not be in the production booth and in fact will add to the space required for the room and to the heat load in the room. If the dimming panel *is* installed in the production booth, code-required clearances must be provided, without impinging on space required for projection equipment.

Additional locations for tier 3/Specialty room dimming controls are near the lectern where pre-set scenes and an on/off control should be provided, and at all entrances to the room, where on/off controls should be installed. The preset scenes are to agreed upon by the user, University AV/Classroom Planner, **Instructional Technology Services** and be coordinated with room layout as well as AV layout.

The need for an emergency override switch for the lecture room system should be reviewed with the University's code analyst; one location for such an emergency switch should be at the projectionist's work station.

2. HVAC and controls

The projection room needs adequate ventilation and cooling, both for the equipment and for the operator. If feasible, the room should be on its own zone, with its own controls. Cooling load calculations should include all equipment, panels, and controls, and allowance for two to four operators.

3. Electrical provisions

All conduit and raceways for power and line/data/signal necessary for the A/V system are to be provided and installed by the electrical subcontractor as part of the general construction for the project.

Circuiting for projection room and equipment should be dedicated to that purpose. A separate power panel for the room, placed in the room, should be considered. Circuits should be provided with isolated ground to avoid the possibility of interference from any other source in building.

The projection counter should be outfitted for its full length with plugmold, either mounted above the counter or below with grommets or slots for equipment cords.

Controls for lighting, screen, any masking, and any window shades or draperies should have manual overrides, both in booth and at speaker's position.

If occupancy sensors are included, they should be designed to coordinate with room use.

4. Connectivity (dependant on the equipment specified)

- a. Ethernet connections to include, two at each equipment rack (verify counts – may need more than two), two at the counter and two at the lectern.
- b. Campus TV connection for each TV tuner in projection room (Tier 3/Specialty).
- c. Campus telephone in projection room, near operating controls.

5. Glazing

Standard plate glass is to be used for projection room wall, sized to accommodate all equipment in a side-by-side configuration. Tinted or laminated glazing should not be used, due to complications with color rendition of projected images. Glazing should be sloped to prevent reflection back to projectionist, without causing undue refraction (approximately five degree slope toward projector). Cameras are never to be placed behind glazing.

6. Finishes

- a. Flooring: rubber tile is preferred; carpet is not an appropriate finish.
- b. Ceiling: acoustic tile is preferred. Color may be muted, but not black. Lighting used during projection should be positioned to avoid affecting the projected image or the lecture space, and so reflection from the projection room is minimized (reducing the need for dark colors in the projection room).
- c. Walls: as with the ceiling, color may be muted, but not black. Light reflection should be controlled during projection. It should be remembered that additional time in a projection room will be spent in setting up equipment and presentation material, in maintaining equipment and in supporting recording production, so it is important that the room function well as a work space as well as a projection space.
- d. Counters: counters should be wide enough to accommodate all planned equipment set up side-by-side. Consideration should be given to the need for additional equipment in the future. Counters must be deep enough to accommodate the equipment installed on them, with additional depth to allow for power plug configurations and any A/V connections and wire runs. Counters should have provisions incorporated for wire management, including grommets for wire penetrations, or finished wireway slots.

Counters *must* be strong enough to support equipment, and should be durable enough to support those who might lean on it during equipment installation and wire-up. Counter must be strong enough to prevent any shaking of image on screen during projection.

Provide open storage under counter; provide adequate storage at or near counter for equipment operating manuals.

Chairs in the space should match the situation (office/projection). Chairs of the appropriate height with built in adjustability are preferred.

7. Equipment rack

Provide equipment racks to hold all AV equipment, routing and distribution, patch panels, monitoring, storage drawers, etc. OSHA clearance of 30" behind stationary racks to allow access for service and maintenance is required.

8. Miscellaneous features

- a. Monitor speaker (sufficient to be heard over projector fan noise) so projectionist can monitor sound quality in lecture room; speaker should be driven by ceiling microphones, speech and program sources.
- b. Coordinate equipment security with Media Services including specific lock and keying requirements.
- c. Audience microphones shall be controlled separately from podium microphones.

D. Lecterns

1. Sufficient area for open three-ring binder / or laptop, microphone, lighting controls (if not wall mounted), A/V and projection controls or velcro-mounted remote, laser pointer, aimable lectern light and dimmer, clock timer, water glass or bottle. A duplex power outlet should be mounted on the lectern, with a grommetted opening on the lectern top to allow access to the outlet if it is mounted below.
2. Connectors for all accessories including designated storage locations.
3. Provisions for lectern computing (OFE) where room has A/V control system.

E. Power, A/V, and data boxes

Floor boxes are typically used to provide power and A/V connection to free-standing furnishings such as lecterns and conference/discussion tables. To provide maximum flexibility, several floor boxes are often provided to allow a variety of presentation configurations at the front of a lecture facility.

Because of the need to separate line voltage outlets from low voltage and signal wiring, and because of the need for maximum flexibility, the floor boxes are often quite large. Space must be allowed within the box for the various plugs and connectors for power, A/V, and data; A/V connections will be terminated in the floor box. The box must be deep enough to allow the cover to close over the connectors and the necessary strain-relief fittings needed on wires leaving the floor box. The requirements for services to the floor boxes should be reviewed with Media Services, OIT, and Facilities Engineering to insure that the correct type of box and the configuration is specified and shown on electrical contract drawings.

The Designer must also review the need for physical separation of line and voice wiring conduit runs from those for power or devices that might cause interference across the lines. This separation requirement, and the proper floor box configuration and location, must be coordinated in design and construction, to guarantee proper system operation at occupancy.

F. Connectivity

The Designer should also be aware of, and should consult with the Project Manager on, the need for providing power, data, and A/V connections at the various locations depending on layout. Because of the complexity of the A/V requirements for lecture facilities and projection rooms, it is mandatory that a coordination meeting be held with all trades at construction kickoff to review the projection room layout and floor box

locations. The meeting will be set up by the construction manager, and attended by general construction, HVAC, and electrical job superintendents, with the University's Project Manager, and representatives of the Architect, the Design Engineer, and the A/V consultant.

The trades will produce coordination drawings (including camera locations) for the projection room and the presentation end of the room, under the construction manager's oversight. A second meeting will be held just prior to the start of rough-in for the systems, with the same parties in attendance.

9. Warranty and Licensing

Warranty and licensing requirements to be discussed with University AV/Classroom Planner, Media Services, Broadcast Center and the Users. All Information to be completed on the AV Programming Document (See Appendix 2.2-6)

10. Requirements for Testing and Personnel Instruction

The AV Consultant is to submit the AV Master List Spread Sheet prior to testing (see appendix 2.2-3)

A final acceptance test will be conducted by the A/V consultant, with the installer and a representative of Media Services and Broadcast Center present during testing.

Initial training of personnel in the operation of A/V equipment and systems will be conducted by a qualified representative of the installer; subsequent training will be provided by Media Services. The installer is also to provide user instruction templates in both digital and print form (printed instructions to live in the room). Discuss any requirements for video recording of the training to be turned over to the owner.

11. Requirements for As-Built Drawings and Project Closeout

The A/V consultant is responsible for checking the accuracy of as-built drawings prepared by the systems installer, the Electrical Subcontractor, and the Construction Contractor.

The A/V consultant is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the A/V installer, the Construction Contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. The A/V consultant will verify during these regular meetings that the contractor is maintaining record drawings to convert to as-builts.

See Appendix 2.2-1 and Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

1. Introduction

Classrooms, meeting rooms, seminar rooms' performance and public spaces are the heart of Princeton University's mission. The Designer must be aware of the needs of the particular users, the ways the room will and might be used, and the technical needs of the department involved and the technical requirements of the space itself.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance Department, or as applicable).
- B. University AV/Classroom Planner see Project Manager
- C. **Associate Director Instructional Technology Services** **87 Prospect, 609-258-9945**
- D. Chair, Faculty Committee on Classrooms and Schedule (through Project Manager)
- E. Manager, OIT Network Installation 171 Broadmead, 609-258-6015
- A. **McGraw Center for Teaching and Learning** see Project Manager

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

- A. Illuminating Engineers Society of North America, website www.iesna.org
- B. Princeton University, media Equipped rooms <http://registrar.princeton.edu/classroom-information/>
- C. **Typical Classroom / Conference Room Layout Samples** **Appendix 2.3-1**
- D. **Typical classroom media equipment cabinet and lectern** **Appendix 2.3-2**
- E. Audio Visual Touch Panel Layout Appendix 2.2-2
- F. A/V Master List Spreadsheet Appendix 2.2-3
- G. Audio Visual As-Built Requirements Appendix 2.2-4
- H. Recording System Standardization for Campus Lecture Halls Appendix 2.2-4
- I. **Video Conferencing Standards** **Appendix 2.2-5**
- J. AV Programming Document Appendix 2.2-6
- K. **AV Programming Checklist** **Appendix 2.2-7**

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)

- B. [NJ Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. During the Programming Phase
- B. Completion of Schematic Design;
- C. Completion of Design Development
- D. At 50% completion of construction documents;
- E. At 85% completion of construction documents;
- F. At 100% completion of construction documents, if required, at the discretion of the Tech Team

Note that at 85% completion the Designer should submit representative lighting calculations for review, including horizontal calculations for instructional rooms, and vertical readings for chalkboards, etc.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented.

The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

Early in the programming phase of the project, the Project Manager will review the proposed project with the Provost Office, University Registrar or the academic/administrative department/end user. In most cases the “end user” group may have additional requirements over and above those of the Registrar and other academic/administrative departments.

The “end user” group may be comprised of one or more of the following groups on campus:

- University Services(Conference and Event Services, Campus Venue Services),
- OIT (Hardware Support, Media Services),
- McGraw Center (Teaching and Learning, Broadcast Center),
- Council for Science and Technology

The Registrar will determine how many Registrar classrooms will be needed, the sizes, and the types. The Faculty Committee on Classrooms and Schedule, working through the Provost's Office, has University-wide responsibility for classroom space on campus, and will provide oversight in the programming phase. The Project Manager, with the Designer, should meet with the Registrar, University AV/Classroom Planner, academic/administrative departments and any end users to confirm the requirements for classroom space in preliminary programming.

The Project Manager, with the Designer University AV/Classroom Planner, academic/administrative departments and any end users should also ascertain the Department/building's non-Registrar space requirements.

The Project Manager remains the Designer's primary contact and source of information. The Project Manager will involve other University sources in the project, including the University AV/Classroom Planner in the Office of Design and Construction, the project representatives for the Facilities Engineering Department, and Media Services and OIT personnel.

Meetings with the academic department/end user, Registrar, **Instructional Technology Services** and the University AV/Classroom Planner for the project will be arranged by the Project Manager.

7. Guidelines and Requirements for Documentation

Along with the Design Drawings, the Designer is to produce sufficient documentation to allow for code review of the project and for contract bidding of the work. See Section 1.4 (Regulatory Agencies) for requirements for code review and permits.

In addition to the documentation required for the permitting and construction of the project, the Designer will (if specified in the contract for services) provide bidding documents for fixed furniture and for the audio-visual systems in the building. These should be separate documents prepared with the furniture and A/V consultants and coordinated with the electrical contract documents (for conduit runs, junction and floor box selection and placement, lighting, power, etc.). See Sections 2.2 (Audio-Visual Standards) and 2.5 (Furnishings, Fixtures, and Equipment) for additional information.

Requirements for specific areas of documentation are as follows:

Documentation	SD	DD	50% CD	85% CD
Class/Conf Rm Design Intent	X			
Class/Conf Rm Basis of Design		X		
Space Requirements		X	X	X
AV Programming Document		X	X	X
Projection Booth - Coordinate requirements early	X	X	X	X
Class/Conf Rm Plans – Include notes, symbols, finishes for the following: Furnishing, Chalkboards/Whiteboards, Lighting, Floor/Wall Boxes (Elec/IT/AV), Lectern, AV Equip. (Equipment Rack, Screens, Microphones, Speakers, Media Equipment) Cabinet.		X	X	X
Coordination - Coord. Plans with the following: Lighting, HVAC, Acoustics, Security, Signage, Door Hardware, Furniture, Lecturns, IT (coord with # of drops/package)			X	X
Details				X
Outline Specifications		X		
Full-Length Specifications			X	X

8. Guidelines for Classroom and Conference Room Design

A. General Approach

Classrooms in the project should be the primary focal point of the Designer. Meeting the educational goals of the academic department and those for the project should be the guiding principle for the Designer. There are three types of classrooms on campus: Registrar controlled rooms, Department controlled rooms, and University Services controlled rooms.

Rooms discussed under this section will be typical instructional and lecture spaces as well as meeting and breakout spaces. The University anticipates an increasing use of multi-functional space accommodating various room types and layouts. Specialized facilities, such as laboratory, classrooms, performance, **maker, entrepreneurship, active learning** spaces, should be reviewed with the Project Manager and the academic department/client to determine programmatic and staffing needs and parameters.

There are different requirements for rooms depending on whether seating is to be fixed or movable, and also depending on the educational and/or departmental approach to be used in the room. Detail is extremely important to the success of a space; it is incumbent upon the Designer to ascertain the needs of the various room types in a project, to thoroughly

understand the requirements for the systems to be incorporated into the rooms, and to detail the space around those needs and requirements.

Area requirements are affected by the teaching style anticipated for the room; the Designer must ascertain and understand the users' needs. Is the room to be used in a straight-on instructional style?; is it to be an interactive classroom?; is it to be a collaborative arrangement?; are preceptorials held in the space?

B. Space Requirements

1. Area/Volume

As a rule of thumb, if an instructional space is to have fixed seating it will require 15 square feet of space per student (not including space required for A/V or other specialized equipment). If a classroom is to be provided with moveable seating the minimum area allowance per student rises to between 20 and 25 square feet for typical instructional space and between 25 and 30 square feet for seminar or preceptorial use. (In preliminary design it may prove useful to establish *target* standards of 25 to 30 square feet per student in typical classrooms and to aim as high as 50 square feet per student in media-rich facilities.)

If possible, instructional rooms should have a minimum ceiling height of 10'-6". This will allow inclusion of indirect lighting in the space, with proper throw for the fixture and clearance from the floor. Larger rooms should allow for proper proportioning of rooms for acoustic as well as aesthetic considerations.

2. Layout

- a) Instructive: generally designed with seating facing a podium, lectern, or instructor's desk;
- b) Collaborative: laid out in an open circular, elliptical, rectangular, or U-shaped fashion;
- c) Interactive: laid out in a variety of shapes, with groupings of two or more seats at a common workstation.
- d) Flexible: may include the above types of layouts but may occur in non-traditional spaces such as open areas, corridors, exterior spaces, etc.

Allow adequate space in each room for the instructor/presenter in multiple room configurations.

3. Location/Orientation

Classrooms should not be isolated in a building but should be near or on public spaces such as lobbies and major hallways. Amenities such as bathrooms should be nearby.

Classrooms should be oriented to take advantage of natural lighting (with consideration for controlling sunlight and glare). Operable windows are desirable but must be in conformance with the intent of the project and space, and must be accounted for in the HVAC design.

It is preferred to have room entrances located away from the front of classrooms; students arriving late should be able to sit down without disrupting class in progress. In large lecture halls, the use of an entry vestibule is desirable to control external noises and light.

C. Finishes

Acoustic considerations, **closely followed by durability** should be the primary concern in finishes for classrooms. Acoustic control between classrooms is also important, so that sound transmission classification (STC) ratings of structural components and finishes should be taken into account when selecting materials and systems.

1. Walls and Doors

There is no 'standard' wall material or finish, but the Designer must remember that the facility needs to be finished in a way that allows for normal cleaning, upkeep, and maintenance. See Section 4.9 (Painting) for additional information. Chair rail trim is encouraged where moveable tablet-arm chairs are to be used, or where stacking chairs provide extra seating in a room.

The Designer should attempt to incorporate breaks, reveals, or other architectural details to divide large expanses of painted surface, particularly in the vertical direction. This is especially true in high traffic areas, areas using high pigment paints, or locations that are especially subject to abuse.

Doors into classrooms should be provided with vision panels to allow students to see if room is in use.

2. Floors

It is common to use vinyl composition tile, linoleum, or carpet. Proximity to the building entrance and out-of-doors may affect the choice between carpet or tile. Carpet is common in lecture rooms; the Designer must detail material interfaces where carpet meets floor, where carpet runs to or under seating, and at fixed equipment such as lecterns (with A/V and power outlet receptacles), etc. The Designer must make an informed decision based on the use of the space, anticipated traffic patterns, type of substrate, frequency of cleaning and maintenance and ease of replacement; all these factors must be taken into consideration.

In larger spaces, detail the location of carpet seams carefully to avoid the possibility of ragged edges and subsequent problems with upkeep and excessive wear. If a section of the carpet must be replaced, the seaming should not be immediately obvious.

3. Ceilings

Concern for proper acoustics should prevail in selection of ceiling materials. For acoustic tile ceilings, the overwhelming preference is for suspended lay-in ceilings, 2x2 or 2x4. Concealed-spline ceilings should not be specified, unless there is a special condition that must be accounted for; review with the Project Manager and the Director of Maintenance before including concealed-spline ceilings in a project. Generally, concealed spline ceilings are appropriate only in locations without ceiling access requirements.

With the increasing importance of A/V and data systems in classrooms (and the emergent nature of the technologies involved), the Designer is encouraged to create terminal points that are as flexible as possible. Serious consideration should be given to under-floor access for boxes serving A/V, data, and power at locations such as lecterns. If the classroom is above grade level, this access can be provided from the ceiling below, provided the ceiling is not constructed with fine finishes which cannot be disturbed.

D. Furnishings

1. Seating

Seating should be relatively comfortable, should be durable and easily maintained, and should be replaceable, without extraordinary effort.

Classrooms will typically be fitted with tablet arms; the tablets should be oversized. Seminar/**conference room** seating may be armchairs or be armless, depending on space constraints and registrar and/or departmental preference. Fixed lecture seating will typically include retractable tablet arms, preferably oversized. Laminate facing is preferred on the tablets (not veneer), and painted edges to exposed plywood. ***At least 10% of tablets should be positioned for left-hand use.***

In all rooms, include required spacing **and furniture** provisions **to meet state and federal accessibility requirements**. Leave spaces, with companion seats, to meet the requirements of New Jersey's barrier-free subcode, and comply with federal ADA requirements. ***Provide 5% "Attic stock" for tablets, brackets, seat springs, etc.***

2. Tables

Tables may be fixed or movable **and need to be coordinated with** required power or data connections. Tables that integrate power, data, **and AV** must be thoroughly reviewed by the **University**. Method of delivering power and data to tables, and the distribution details involved, must also be reviewed with OIT. Tables that include infrastructure wiring (i.e.: instructors table) must be mounted to the floor.

For seminar or conference use, provide a minimum of twenty-seven to thirty inches of table length per person. Typically a residential college seminar room requires seating capacity for 15 students plus one instructor (at head of table).

3. Lectern and Equipment Cabinets

While the lectern may be seen by the Designer as a focal point in a small lecture facility and as an interesting design opportunity, first and foremost the lectern must serve its function. Likewise, the projection booth for a lecture facility, and the equipment cabinet provided many classrooms must operate properly. **The weight of the equipment and the cabinet itself must be taken into account to properly support all applied loads as well as people leaning on the cabinets.** See Drawings for lectern, and for equipment cabinet, Appendices 2.3-1 and 2.3-2. See Section 2.2 (Audio-Visual Standards) for additional information.

If applicable, make sure the lectern/equipment cabinet accommodates the wiring and ventilation requirements of all equipment being housed within. Coordination of all

cutout within the lectern or equipment cabinet is important. Coordinate with **Instructional Technology Services** as well as the AV Consultant during design as well as shop drawing phases of the project.

4. Chalkboards, marker boards, display boards

Requirements for instructional boards should be reviewed with the Project Manager, the Architect/Planner for Classrooms, and with the academic department or Registrar's Office. The Designer must coordinate the locations and installation of chalkboards with any projection screens planned for the project. Installation of chalkboards is the standard practice in classrooms, seminar rooms, and lecture halls. Markerboards cannot be properly maintained by the Registrar's Office, and thus are generally not used. **However, they are typical in departmental seminar rooms as well as conference rooms.**

A typical coordination sketch should be prepared, including switch locations for lighting and screens, and any A/V controls and data and communications outlets.

Fixed boards are a non-proprietary product. Sliding chalkboards are to combine a fixed board and a single slider (unless otherwise directed by the Project Manager.

Black or charcoal color is standard; provision of map rail is to be at direction of Project Manager.

Coordination of all presentation and display boards as well as any specialty solutions (marker/glass furniture and/or walls) shall be done with the Project Manager.

5. Projection screens

Screens for video, data, slide, and film projection should be specified by the Audio/Visual consultant, but should be included in general construction specifications for installation by the builder. Screen location, quantity and size must be coordinated with chalkboards and pendant light fixture mounting heights.

6. Window treatment

Review requirements for sunlight filtering in classrooms, and for room darkening for projection. Standard room darkening shades are produced by Mecho Shade or equal, and may be manual or motorized; if motorized, coordinate controls with A/V equipment locations and instructor's furnishings.

E. Lighting

1. General

Lighting should be even across the room, with a maintained light level per IES and PU Standards on the work surface. A combination of lighting zones, dimmable fixtures, and controlled daylight in the room is ideal. Fixtures should control glare and should not produce veiled reflection in the room or on equipment. Indirect/direct fixtures are favored.

If a room is multi-functional, take into account in the lighting design the various tasks that are to occur in the different sectors of the room.

If a space has a ceiling above 12' in height, the project team shall review all access requirements for light fixture maintenance and incorporate any fixed requirements such as access panels, cat walks, etc. into the documents.

Emergency lighting shall be installed in each classroom with occupancy of more than 50 people.

If a classroom has multiple entrances, provide switches (and occupancy sensors, if applicable) for ease of access at each entrance.

Lighting should be **on an occupancy sensor (with a long delay)** in the vestibules adjacent to larger classrooms.

2. Chalkboards

Chalkboards should be lit to produce lighting levels per IES and PU Standard, across the board, without glare or bounce.

3. Special Features

Much of the public space lighting on the University campus is controlled by occupancy sensors. The occupancy sensor is to be wired so that it can be bypassed with a conventional light switch. If occupancy sensors are to be included in a project, the operation should be carefully coordinated with the room use.

Review the need for daylight control and for blackout capability in classrooms.

4. Lighting Types

For instructional spaces (as with interior lighting in general) energy efficient lighting is standard for Princeton. Indirect/direct lighting is preferred for its even quality. For any needed downlighting or highlighting, LED fixtures are preferred.

To minimize the need for storing a large variety of replacement tubes and bulbs, Designers should attempt to use two- and four-foot tubes as a standard, and PL tubes with a common base configuration throughout a project.

If tubes are selected, consider similar lamp types and bases. Programmable start electric ballasts are standard and, where applicable, should be dimmable to 10% without flickering.

5. Lighting Controls

In general, the Designer should attempt to provide for separately-controlled lighting over the seating area of a classroom or lecture room, over the display end of the room, and for presentation areas such as lecterns, podiums, daises, etc. Lighting at the display end should be zoned for multi-media presentations allowing for a variety of chalkboard and projection scenarios. Consider room flexibility when creating lighting scenes.

Adequate lighting for safety should be controlled at entrances to rooms, with system controls at the instructor's position and at the A/V operator's position, if the room is provided with fixed equipment. Lighting should be zoned, where applicable for

increased media sophistication. Lighting over seating should be sufficient for taking notes during media presentations.

The Designer should review the need for lighting control with the Project Manager; the standard control is a Lutron GraphicEye, typically providing four preset lighting scenes.

F. Power

The design team is to provide adequate power for general use and for audio/visual equipment needs in classrooms. The Designer should also be aware of, and should consult with the Project Manager on, the need for providing power and data outlets at each fixed seat in new and renovated lecture facilities and to classroom furniture such as seminar tables.

G. Equipment

Audio/Visual equipment should be specified by the Audio/Visual consultant; the Designer must coordinate construction Drawings - Architectural, Electrical, and HVAC in particular - to provide the necessary and proper shell and support for the physical installation of equipment. Special care should be taken to provide adequate and ‘clean’ power for equipment, flexible and effective raceway and conduit for A/V, data, and communication lines throughout the facility, code-required clearances and proper operating areas for equipment, and adequate cooling and ventilation for equipment and operator loads.

Control of lighting and any light control features within the classroom is also important; see Section 2.2 (Audio-Visual Standards) for information.

H. HVAC

The design team must provide adequate heating, cooling, and fresh air to classroom lecture spaces and production booths, and must do so without intruding on the classroom mission. Careful selection and placement of equipment, and attention to the design of delivery systems are important to the success of instructional spaces.

I. Acoustics

Design team should use ANSI standard S12.60-2002 titled “Acoustical Performance Criteria, Design Requirement, and Guidelines for Schools” as a guideline. This benchmark for acoustical performance is as follows:

CLASSROOMS	Background Noise Level	Reverberation Time at 500 Hz, 1 kHz, and 2 kHz
Less than 10,000 ft ³	Less than 35 dBA	Less than 0.6 seconds
Between 10,000 And 20,000 ft ³	Less than 35 dBA	Less than 0.7 seconds
Greater than 20,000 ft ³	Less than 35 dBA	Not applicable

Regarding background noise levels, the following limits should be adhered to:
 < L35 dBA new classrooms, NC 30. 35-42 dBA

Renovated classrooms, NC 30

J. Security

Review the need for security control of classrooms with Project Manager. The University employs access control, as part of a campus-wide system, at the entrances of many of its buildings, and to some interior spaces as well. Consider A/V equipment requirements when reviewing classroom security.

K. Signage

Determine the signage requirements for the space. Note the University has a no eating / drinking policy for its classrooms and should be taken into account for the signage package.

9. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the construction contractor and any systems installer.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

1. Introduction

Princeton University has over forty undergraduate dormitory buildings, built between 1886 and the present in a wide variety of Architectural styles and configurations. There are six residential colleges on campus, designed for freshman and sophomore housing and social accommodations. The residential colleges account for more than half the undergraduate population, with over three thousand bed spaces in thirty-four dormitories. Upperclass housing accounts for the balance of the undergraduate dorms, with approximately two thousand bed spaces in twelve dormitories.

Graduate student housing consists of approximately one hundred eighty seven bed spaces within the original Graduate College. The complex known as the New Grad College houses an additional two hundred thirty- six students. There are also a number of wood-frame housing annexes for approximately eighty-eight graduate students and thirty upperclass students.

The Designer should be aware that undergraduate dormitories are occupied by students nine months of the year, while graduate dormitories are occupied year-round. Undergraduate dormitories also provide housing for summer events and sports camps, so access for survey and planning purposes must be coordinated with the Housing and Real Estate Services and Conference and Event Services during summer months.

(Note that italics will be used to indicate statements that apply only to dormitory renewal design work.)

2. Contacts

- | | |
|--|----------------------------------|
| A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable). | |
| B. University Code Analyst | MacMillan Building, 609-258-6706 |
| C. Director of Housing | New South Building, 609-258-1908 |
| D. Associate Director for Student Housing | New South Building, 609-258-2517 |
| E. University Architect | MacMillan Building, 609-258-3356 |
| F. Director of Facilities Engineering | MacMillan Building, 609-258-5472 |
| G. Associate Director of Grounds and Building Maintenance | MacMillan Building, 609-258-3591 |
| H. University Fire Marshall | 200 Elm Drive, 609-258-6805 |

3. Index of References

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| A. Existing Conditions Reports | Consult Program Manager | |
| B. Standard 36 Month “PERC” Schedule, Office of Design and Construction | Appendix 2.4-2 | |
| C. Master Fire Alarm Technical Specification | Appendix 3.4-1 | |

D. Memo: Standard Dormitory Paint Colors	Appendix 2.4-3	
E. Fire Alarm/Signage Nomenclature Spreadsheet Sample, Princeton University	Appendix 3.4-3	
F. Plan of Minimum 4-person suite size for a University Dormitory	Appendix 2.4-4	Appendix 2.4-4
G. Shower Base Installation Detail	Appendix 4.13-3	Appendix 4.13-3
H. Typical Full Service Graduate Student Suite Kitchenette	Appendix 2.4-5	Appendix 2.4-5
I. Standard Dorm Furniture	Appendix 2.4-6	
J. PU Fire Extinguisher Use Matrix	Appendix 3.8-2	

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. International Building Code (in edition adopted and modified by NJUCC); dormitories are typically R-2 use group
- E. NFPA 101 - Life Safety Handbook
- F. NFPA 13, 13R - Sprinkler System Installation Guidelines
- G. NFPA 72 - National Fire Alarm Code
- H. See 1.4 (Regulatory Agencies) for additional information

5. Review Guidelines – General

Initial planning and preliminary design will be conducted thru the Office of Design & Construction with the Housing and Real Estate Services. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards.

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For dormitory renewal projects, planning begins at least two years in advance of construction. Planning for new construction may take a similar course. As the project moves toward the construction documentation and code review phases, it becomes important that the project be reviewed with the Housing and Real Estate Services, the Engineering Department, the Grounds and Building Maintenance Department, the Office of Design and Construction, Office of the University Architect, Conference Services, the Department of Public Safety and to any department affected by the work.

For new dormitory projects, and for the dorm renewal program, each project has a specific review committee. The committee is made up of representatives from the Office of the University Architect, Office of Design and Construction, the Facilities Engineering Department, Grounds and Building Maintenance, the Housing and Real Estate Services, and the office of the Vice President for Facilities. Additionally, committee members come from the Office of the

Dean of Undergraduate Student Life and from the Office of the Vice President and General Counsel for the University.

Meetings are held regularly during the pre-construction phase of a dormitory design project. All decisions regarding programming and design require a consensus of the full representation of the review committee.

After preliminary design is complete, additional departments may be brought into the design development and construction planning phases. Departments such as Public Safety, Dining Services, and Building Services may be included in the review process, and may act as in-house consultants for specific aspects of the project.

During this pre-construction phase mockups are constructed (and may include complete full-scale models of rooms) to aid the review committee in selecting room finishes and accessories, window types, light fixtures, heating units, piping enclosures, etc. Every visible finish and system component is designed, constructed, tested, and reviewed. Mockups are also used to test the effectiveness of cleaning methods on building stone and other finishes to remain in place. A significant amount of effort is necessarily put into the design and documentation of mockups, for they are the tools that lead to final design decisions and to the aesthetic that ultimately forms the project. Mockups are typically constructed during the summer of the year prior to the project's construction start date, and lead into final construction documentation for the project.

During the process of design, plans are to be submitted for review by Facilities departments at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, Housing, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Considerations for Dormitory Design

A. General Approach

1. In new construction and in dormitory renewal projects, providing opportunities for interaction between students and facilitating the development of a feeling of collegial unity is encouraged. However, the mix of social spaces with living spaces, the density of bed spaces in living spaces, the inclusion of educational spaces in a dormitory, and

the type and number of support/utility spaces in a dorm, along with other design considerations, is highly dependent upon the purpose the dormitory serves.

In residential colleges, the density within units is typically higher; a higher percentage of space may be given over to social and educational programs within the building; and service-type spaces may be shared among a group of buildings. Consideration is given to the provision in each college of communal study space, lounge, kitchenette, game and vending room, and a variety of arts-related rooms such as theater, music rooms. The design review committee will provide direction for the Designer regarding the mix of spaces.

In upperclass dormitories the individual's living space is typically larger (in terms of square feet per occupant) than in the residential colleges, and providing a variety of living arrangements is a desirable goal. Single-occupancy rooms are popular, with two-room doubles and three-room quads sought after as well. Students are typically self-directed in their studies at this point and, for some, privacy for work is an overriding concern. Along with providing a wide choice of living arrangements, each upperclass dormitory will typically contain a full complement of service and support spaces such as laundry, kitchen, and lounge.

The Graduate College dormitory buildings at Princeton serve much the same function as the residential college dorms, although the independence and relative maturity of graduate students affect design considerations.

2. The initial step in a dormitory renewal project is to determine a preliminary scope of work and to conduct a full-scale survey of the building. This survey should be performed after discussions with the Project Manager and the University's Grounds and Building Maintenance Department, to assemble available information on systems in the building, and to gain insight on any known defects in a building. In interviews prior to surveying a building, the Designer can be advised of any environmental issues that might affect the project; see section 10 below for additional information on this subject. A report on existing conditions is produced from the survey, including information on the building finishes, envelope, and systems. The report will be presented to the review committee, which may make suggestions for revisions or modifications before a final version of the report is produced.

The report is used as a tool to develop the building program and to guide the professional in the schematic design process. Input from the design review committee is critical at this point in the process. The committee will prescribe the desired bed count, the mix of singles, doubles, and quads, the bathroom fixture ratio, etc. Additional survey work may be needed to measure critical areas after initial planning and design is completed. Some core samples of building systems may be required to ascertain existing construction, and investigative demolition might be carried out in this effort.

Because space is at a premium in dormitories, it is important during the early phases of design that thought is given to "capturing" underutilized space in the building -- basement or attic space that can be economically converted to living or social spaces without the cost of constructing foundation and shell.

3. After schematic plans are approved by the review committee, the Designer is to provide a furniture layout plan, which will be used to develop the design of electrical and mechanical systems in the dorm rooms. This step is important in developing plans for new construction as well as in dormitory renewal.

As electrical and mechanical systems are developed for the building (with the chases, duct shafts, etc. that these systems require), the Designer will need to coordinate the mechanical systems with the furniture layout. The intent is to produce a plan that integrates building systems into the overall layout, without sacrificing utility and comfort to aesthetics, or vice versa. The review committee will be presented with the final building layout and furniture plan for approval before the project is carried into the Construction Documentation Phase.

4. Room Numbering Requirements

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It is the intent of all projects to have permanent room numbers assigned during the Design Development Phase. It is the responsibility of the Designer to initiate and complete this process, and the Project Manager's responsibility to gather required approvals. All Drawings shall reference the University approved final room number system.

See Appendix 2.8-2 for a sample spreadsheet for coordinating this process and Appendix 1.5-3 for room/space numbering system guidelines.

B. Exterior

1. Accessibility

Some of Princeton's dormitories were originally designed in ways that make it nearly impossible to provide barrier-free access to all parts of a building. Nevertheless, one of the goals of the dorm renewal projects is to create accessible routes to as many dormitory spaces as is reasonably possible, and to create accessible social and support spaces. (See Accessibility Section 2.1)

The project review committee will advise the Designer on the level of accessibility desired in the project, based on options presented by the Designer and influenced by campus-wide accessibility needs.

Code minimums must be met for accessible and adaptable units within a dormitory, code requirements for mounting heights of switches and controls are to be met by the design, and placement of special devices such as audible-base detectors and strobe alarms are to be carefully planned. For more technical information see Section 3.4 (Fire Alarms).

2. Safety/Security

Consideration for both vehicular and foot traffic is to be given to the routes into and along buildings, so that cul-de-sacs and dead-ends are eliminated. (The same considerations should apply to interior circulation.)

Exterior lighting should be sufficient to provide safety and security to passers-by and to building occupants. NJUCC/ICC code requires emergency lighting of egress paths on the exterior of dormitories. **For existing buildings refer to Outdoor Lighting Master**

Plan (Appendix 2.9-15) for lighting design guidelines.

In addition, handrails are to be installed at site stairs, where required.

Refer to procedures within Section 2.7, Security for the Security Programming Document.

3. Site Accessories

Card access shall be installed at dormitory entries. See Section 3.1 (Access Control Standards). The Designer is to consult with the Project Manager and Site Protection to assess the need for exterior emergency phones/broadcast towers.

Consideration should be given to site furnishings, particularly bike racks, picnic tables, benches, shuttle stops, bollards, etc.

4. Finishes

Exterior finishes are of paramount importance in the perception of the quality of buildings at Princeton University. *The exterior envelope of the dorm should be studied carefully during the building survey, and the existing conditions report should concisely describe the findings of the survey.*

Envelope components that must be considered in the study include walls, copings, parapets, chimneys, and decorative and trim masonry; flashings, gutters, leaders, leader boxes and roof; windows, louvers and vents, doors, door accessories, entry steps, handrails, and paving.

5. Site Utilities

When a building is a candidate for renewal, the Facilities Engineering Department may decide to take the opportunity to replace services into the building or site utilities near the building. New buildings also require extensive investigation for utility work. The Designer will be asked to enumerate and evaluate the utility loads for heating, cooling, electrical, and similar systems in new and renewal work, as well as the effects on water supply, sanitary, and storm lines on and around the site. The Designer will need to coordinate the efforts required for documentation, review and construction of this work, and may be requested by the Engineering Department to provide design services for the utility work. See Section 3.6 (Utilities Guidelines).

C. Interior Circulation

Interior circulation must provide reasonable access to all areas of the dorm.

1. Entries

Entries must be carefully and skillfully treated to enhance the Designer's intent.

The Designer should integrate a number of standard elements into the design for each entry. These include:

- a) Card access on entry doors (see Section 3.1 Access Control Standards and Section 4.4 Door Hardware).
- b) Scrub mats or walk-off mats at the entrance, in a durable, cleanable, easily maintained material; the design should feature mats which can be easily replaced

and slip resistant.

- c) Message boards, such as tackboards (meeting code requirements for finishes); a variation on the standard types may be developed, either metal-framed or trimmed in wood.
- d) Specify durable, cleanable wall and floor finishes.

2. Stairs

- a) There is no “standard” stair material. The Designer may choose a durable and inherently safe material from wood to stone, to reflect the building aesthetic.
- b) Doors and hardware must meet code requirements for size, operation, fire rating, and temperature rise. Doors and frames should be of a durable construction to withstand the wear and tear of daily use by students and custodial staff. Smoke detector-activated hold-open devices are often used on stair/corridor doors to reduce wear and tear, and to create a more open appearance.

Refer to Section 4.4 (Door Hardware) for additional details.

- c) Guards, balusters, and handrails should be designed consistent with safety codes to enhance the finished appearance of the stairway.
- d) Specify durable wall and floor finishes that are easily maintained.
- e) Meet minimum lighting requirements, including exit and emergency lighting (for required distance – area to refuge); use lighting to enhance design.
- f) *Dry standpipes are preferred as a fire safety feature but may not be required in all cases. In a dormitory renewal project, a Designer should assume that, if standpipes existed in the building prior to the renewal project, standpipes will be required as part of the renewal work.*

If including a standpipe in the building presents a major problem (due to space constraints, e.g.) the University may appeal to the State to remove the standpipe. The decision to file an appeal requires the approval of the AVP for Facilities, Design and Construction and the AVP for Facilities, Operations.

Those buildings that do not have a pre-existing standpipe can be evaluated on a case-by-case basis. The AVP for Facilities, Design and Construction and the AVP for Facilities, Operations will make the final decision on the inclusion of standpipes in such a case.

All dormitory standpipes will be dry systems charged using a post-indicator valve located near the fire department connection outside the building.

- g) Fire Extinguishers – The design of the fire extinguisher in hallways/corridors shall be incorporated with the overall stair design and enclosed in a fire-rated cabinet as required. See Appendix 3.8-2

3. Hallways/corridors

- a) Specify durable wall and floor finishes; research requirements for fire ratings in corridors, provide listed assemblies where needed. At a minimum, use reinforced gypsum board for walls, with skim-coat finish. (Gypsum board walls with taped

finishes are not to be used in dormitory halls.)

The project design review committee will advise the Designer on the use of appropriate finishes in corridors.

There should be some form of base in corridors for housekeeping purposes, compatible with floor finish; tile, stone, wood, rubber. **Bamboo and carpet floor finishes are to be avoided**, review with Project Manager.

Princeton University employs a range of standard colors for use in dormitories; consult with the Project Manager.

The Designer should attempt to incorporate breaks, reveals, or other architectural details to divide large expanses of painted surface, particularly in the vertical direction. This is especially true in high traffic areas, areas using high pigment paints, or locations that are especially subject to abuse.

Fire Extinguisher – The design of the fire extinguisher in corridors shall be incorporated with the overall design and enclosed in a fire-rated cabinet as required. See Appendix 3.8-2.

- b) In rated corridors, doors and hardware must meet requirements for fire assembly and accessibility. Princeton University employs a standard dorm room-to-corridor cylindrical lockset, a storeroom function lever-handle lockset, as well as standard hinges, closers, etc. See Section 4.4 (Door Hardware). The lockset is a Salto keyless lock (with prox reader and keypad for dual validation). Confirm use of Salto lockset is appropriate for the project with the Project Manager and Site Protection. In dormitories the Salto system is being installed to function on an independent wireless network. For corridor doors leading to public or social spaces, consider using smoke detector-activated hold opens.
- c) Ceilings: consider routing of utilities early in design; if corridor ceilings are to be used for utilities, ceilings must be accessible. Minimizing MEP systems above ceilings is desirable. Appearance is important, and utility runs must be thoroughly planned and documented to minimize the need for multiple access doors in hard-finished ceilings. See Section 4.2 (Corridors).
- d) Lighting: must meet Code mandated minimum levels, and must meet University standard levels. Hallways should have lights that are lit 24/7/365 **controlled by an occupancy sensor to maintain a minimum light level of one foot candle**, and may be lighted with ceiling lights, wall sconces, or a combination of both. The type of lighting may be dependent on the style of the building. The Designer is responsible for insuring that all components of lighting - lenses, lamps, ballasts, wiring connections, etc. - are readily accessible for maintenance of fixtures. All fixtures should also be easily procurable, should the University need to get replacements. See Section 3.5 (Lighting Design). **Code minimums for emergency egress lighting levels must be met for the entire egress pathway.**

Any surface mounted exit sign mounted on edge below 9'-0" requires redundant support along a second edge or side, preferably located at a wall/ceiling intersection.

- e) Sprinklers: sprinkler heads are to be concealed in corridors if possible; if sidewall sprinklers are to be used, ONLY concealed type are to be used.
- f) Accessories – **framed** message boards **integrated with room signage**.
- g) Security and safety concerns - dead-ends, remote areas, emergency phone location
- h) Air handlers and other mechanical equipment placed in eave spaces off corridors require sound insulation, vibrant isolation and low db rating.
- i) Trash Collection – The Designer shall evaluate locations and methods for trash collection and/or removal from each hallway. This includes possible design of trash chutes or permanent Trash Room.
- j) Electrical Outlets – Maximum 25’ on center dedicated 20 Amp circuit per corridor or stair.
- k) Drinking fountains comply with code for quantity and accessibility requirements. In addition provide University standard Insta-hot water dispenser, or bottle filler spigot at each location. Consideration should be given to protection of finishes in locations where drinking fountains are designed.

D. Bathrooms

1. Fixture Requirements

Princeton University has dormitories with multiple-fixture bathrooms serving entire floors or areas of dorms, and also has dormitories that have private or semi-private shared single-fixture bathrooms. This section deals primarily with multiple-fixture bathrooms. The project team shall also review gender-neutral toilet and shower requirements for new dormitory construction projects.

At a minimum, requirements of NJUCC and National Standard Plumbing Code must be met for number of fixtures (including drinking fountains); however, Princeton University Housing and Real Estate Services has developed the following ratios as a desirable minimum goal in dormitories:

- a) students per shower: 5.5/1
- b) students per toilet: 5.5/1
- c) students per lavatory: 4.5/1

Bathtubs are generally not installed in dorms at Princeton. Individual precast terrazzo shower bases are typically specified for both gang and private baths. **Tiled shower floors shall be discussed with Housing as an alternative to precast shower bases.** The Designer is to be conscious of waterproofing requirements for these bases at all wall, floor and drain locations, especially where occupied spaces may be below the showers.

At least one floor drain should be installed in each bathroom, more if layout dictates.

Floor drains should be installed in each barrier-free shower and directly outside of the hc shower compartments. **Consider using linear floor drains at hc shower compartments.** Use only University approved integrated drainers and tailpieces per Section 3.11 (Plumbing Systems Design). Pitch tile towards drain.

In bathrooms that are not adjacent to a janitor's closet with a service sink, hot and cold hose bibbs should be installed for custodial use. The hose bibbs should have key stops rather than handles. The preferred location is under a lavatory, approximately 18" above the finish floor.

Generally floor mounted toilets are preferred in concrete or steel construction. This approach is preferred for both new and renovation construction.

2. ADA and Adaptability Requirements

The Designer must become familiar with the barrier-free requirements in the NJUCC and the sub-code ICC /ANSI A117.1. *In renovations, the University's goal is to have accessible bathrooms in areas served by accessible entries and along accessible routes. The project design review committee will review the proposed location and layout of accessible baths on a case-by-case basis, for continuity with the University's Accessibility Standards per Section 2.1*

3. Security

Bathroom entry doors are equipped with combination-lock hardware to provide a measure of security within the dorms. See Section 4.4 (Door Hardware).

4. Finishes

Provide washable finishes; floors are typically ceramic tile or stone with colored grout, as are walls to at least the height of mirrors.

Materials must be water-resistant; at a minimum, use water-resistant gypsum board for walls and ceilings. A smooth plaster finish is preferred. Plan carefully for access doors that are often needed in bathroom walls or ceilings; minimum 12" square doors are standard, with screwdriver operation unless below 8'-0" above finished floor, in which case Best cylinder locks are to be installed.

For renovations in wood framed structures particular attention should be paid to waterproofing in all bathrooms (See Section 4.11 Toilet Rooms for waterproofing).

5. Lighting and Power

Provide area lighting for the room, and (generally) a light at each fixture or compartment. Motion detectors may be used for control of selected light fixtures, with at least one unswitched fixture per room on an emergency circuit, preferably over lavatories/ mirror. Provide ground-fault-interrupted receptacles at lavatories, one centered between every two lavatories, or at individual fixtures. Provide back-box and power for electric hand dryers in the vicinity of the lavatories, where towel dispensers are to be located.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conductor equipment.

6. Partitions

Provide toilet partitions with doors, shower stalls with curtains or doors, and a drying area which is, at a minimum, screened. Princeton traditionally used marble for partitions, but most recently has used the Solid Color Reinforced Composite (SCRC)

and stainless steel type. Other metal partitions have been found to be too susceptible to damage and corrosion and are generally not used.

7. Accessories

- a) Vendors for Building Services provide many of the accessories used in Princeton's dormitories, including soap and paper towel dispensers and large-roll toilet tissue dispensers. Building Services provides shower curtains for the dorm bathrooms. Consult Project Manager and Building Services for current information.
- b) The following need to be specified by the Designer: robe and towel hooks; large volume trash disposal units; feminine napkin disposal units; surface mounted soap dishes for shower stalls; mirrors (typically standard units, individually framed for ease of replacement, often with attached stainless steel shelves).
- c) Hot and cold hose bibbs may be required, as noted above.
- d) The University may install electric hand dryers in multiple-fixture bathrooms in lieu of paper towel dispensers. Paper towel dispensers may be temporarily installed over dryer outlets, until the decision on hand dryers is finalized.

E. Social spaces/"public" common rooms

The mix of social spaces in a dormitory often depends on whether it is in a residential college or if it is an upper-class dorm, whether some similar spaces are provided nearby, etc., and should be determined in the preliminary design phase in consultation with the review committee for the dormitory.

If a social space is proposed above or near a dormitory room, specific approval for the location is required from the review committee.

Some comments on typically provided amenities follow.

1. Lounges

- a) The size, shape, and number of lounges should be planned carefully. A lounge should be provided with a kitchen or kitchenette if possible. The Project Design Review Committee will determine whether a kitchen or kitchenette is to be included in a project.
- b) When approved by the design review committee, a flat screen television is to be installed in lounges. The TV location is to be supplied with an OIT wiring bundle and is to be equipped with an alarm.
- c) Provision should also be made for wired and wireless data communications.
- d) Vending area is to be provided with an OIT wiring bundle.

Designer is to consider heat produced by vending machines in calculating the HVAC requirements for lounge areas.
- e) Social spaces are considered special areas, and the normal constraints on paint colors do not necessarily apply to these spaces. Consult with the Project Manager.
- f) All items manufactured with foam/fabric shall be submitted for CAL 133 testing.

2. Kitchens/Kitchenettes

- a) Snack kitchenettes are installed in dormitories for the purpose of providing students unrestricted access to limited kitchenette facilities.

Snack kitchenettes are to be designed around standard appliances such as a full- or half-sized refrigerator provided by the Housing and Real Estate Services (with project funding). A stove or cooking surface shall not be installed in snack kitchenettes. A microwave oven should be installed. Cabinets and countertops should be included. An instant hot water dispenser with sink fixture should be included. Consult with Housing for current standard appliances.

- b) The full-service kitchenettes may be installed in residential college dormitories. They would be installed for the purpose of providing undergraduate students limited access to full-service kitchenette facilities. These kitchenettes may be located adjacent to spaces that could be used for meal seating.

The full-service kitchenettes will contain the following items:

- Freestanding electric range with four burners and an integral oven – control knobs to be on front of range (no reaching over burners);
- Hood suspended above the range with an integral recirculating fan. Although direct venting to the building exterior is preferable, this requirement shall be reviewed by the Tech Team on a project-specific basis. Designer shall take note to locate any required Fire Alarm Smoke Detectors as far away from this location as allowed by code.
- Microwave oven (not a combination range hood unit), countertop or shelf mounted
- Sink with a bin, or bins, that is sufficiently sized for cleaning cooking utensils and equipment;
- Kitchen faucet;
- Bottle filler mounted at sink
- Instant hot water dispenser installed on the sink;
- Freestanding full-size refrigerator and freezer unit, without an automatic ice-maker/dispenser;
- Overhead and under-counter cabinets, flush panel doors preferred with minimal hardware;
- Cubbies for storage; and
- Garbage disposals will not be installed.

The full-service kitchenettes will be located in secured rooms. The kitchen facilities will be secured by lockable doors or integral appliance keyed control device. Consult with Housing for appliance information.

- c) Full-service kitchens located in Upper-class Student Dormitories; commonly known as “co-op kitchens. These full-service kitchens are located in unaffiliated upper-class dormitories. They are used for daily preparation of meals for upper-class students that do not have a meal contract.

Dormitory food preparation areas require discussion of the requirements for hood suppression at cooking sources. Generally, the hood suppression requirement is a function of the type of usages programmed for the dormitory considered. This discussion must occur in conjunction with the Housing and Real Estate Services and University Code Analyst. Generally, direct-vented hoods over ranges are required in addition to a residential-grade hood suppression system.

Storage cubbies should be planned into the cabinetry, for storage use by individuals in the kitchen. Cubbies should have doors with standard “Best” 5L7RD2 locks (see Section 4.4: Door Hardware). If space allows, an eating area should be planned as part of the kitchen function.

- d) Full-service Graduate Student Suite Kitchenettes. These full-service kitchenettes are installed in graduate student suites located within residential college dormitories. They are installed for the purpose of providing graduate students kitchenette facilities that would be used for daily meal preparation.

The Graduate Student Full-service Kitchenette will contain the following items:

- Freestanding electric range with four burners and an integral oven;
- Hood suspended above the range with an integral recirculation fan. The designer shall take note to locate any required Fire Alarm Smoke Detectors as far away from this location as allowed by code.
- Microwave oven (not a combination range hood unit), shelf mounted If possible
- Sink with bin, or bins, that is sufficiently sized for cleaning cooking utensils and equipment;
- Kitchen faucet;
- Instant hot water dispenser installed on the sink;
- Freestanding full-size refrigerator and freezer unit, without an automatic ice-maker/dispenser;
- Overhead and under-counter cabinets, flush panel doors preferred with minimal hardware;
- Garbage disposals will not be installed; and;
- Counter Space: refer to Appendix 2.4-5 for university minimum standard.

See Housing and Real Estate Services for supply current appliance information.

3. Laundries

Laundry facilities are to be included in each dormitory. Access to the laundry room is to be through the interior of the building. Particular attention must be paid to the “nuisance factor” of a laundry room - the effect of noise and heat on nearby rooms.

See Section 4.7 (Laundry Rooms).

Laundry rooms are to have easily maintained and durable floor finishes and need to include a floor drain.

Typically, laundry rooms will contain the following:

- a) Heavy-duty washers, not coin operated. Consult Building Services for current model.
- b) Stacking electric dryers, not coin operated, with individual vents running to a plenum located at the discharge point. Generally, the individual vents consist of 4" diameter sheet metal duct. The Designer shall take care to assure lint build-up and removal within these vents in addressed in the design. (Steam dryers are preferable to electric if steam is available and space allows for the larger machines and access area.) Plan to install one dryer for each washer in the laundry room. Consult Building Services for current model, and for clearance requirements for maintenance of units; see Section 4.7 (Laundry Rooms) and Appendix 4.7-3.
- c) Motion sensor-activated light fixtures for general lighting (with an unswitched light in each area).
- d) A fixed table or counter with hanging rod for folding, with built-ins for bins.
- e) Large-volume trash receptacles.
- f) An adjacent waiting/study area is desirable; visual connection with adjacent space or corridor is desirable.
- g) Room ventilation system is necessary.
- h) An emergency phone should be installed in the laundry area. (A panic button may be necessary for remote location.)
- i) For design purposes plan 1 washer for every 25 students and 1 dryer (stacked) for every one washer.
- j) Floor mounted laundry sink with a hose bib for janitorial purposes.
- k) Coordinate installation of "Laundry View" laundry monitoring system with OIT
- l) White board
- m) Standard signage with customer service information

F. Living Units

1. Living/study/common rooms

a) Space Requirements

Area: quad, 400 square feet minimum in a renewal project, and 450 square feet minimum in new dormitories. Approximately 180-200 square feet should be devoted to the common room of quads. Refer to Appendix 2.4-4.

b) Layout

Based on positioning of standard University furniture (e.g. desks, bookshelves) with consideration for student-provided couch, chairs, entertainment units, etc.

The option of having all beds un-bunked with two desks along one side of the common room (or) the option of all desks in the bedrooms with the beds bunked shall be considered.

c) Location/Orientation

Provide entry to common room off corridor; common room is to provide main access to living unit (entry to suite is not to be through bedroom)

d) Finishes

- 1) Walls: durable finish; skim-coated impact resistant gypsum board or plaster on gypsum lath.
- 2) Floors: durable finish such as, wood strip flooring, vinyl tile or approved equal. For wood flooring, finishes must meet New Jersey requirements for volatile organic compounds (VOC). (4-coat) water-based finishes have proven suitable for private rooms.
- 3) Ceilings: typically gypsum board or plaster; if utilities are run in ceilings or in soffits in rooms, carefully planned access panels may be required for valves, junction boxes, etc. Refer to Section 4.4 for specifics regarding access panel requirements.

e) Doors and hardware: rated doors and hardware may be required for corridors; unrated doors may be used for doors interior to living units. Best Lock cylindrical sets are standard. Door viewers shall be installed at all corridor doors.

f) Windows: dormitory renewal projects often include the reconstruction or replacement of windows original to the building. During the building investigation enough information should be gathered on the condition of windows to determine whether rehabilitation/reconstruction is a viable option, based on cost/life cycle.

New buildings should incorporate new window technology for energy performance and for ease of maintenance. Within these basic guidelines, a wide variety of types and designs are available.

Regardless of building type, the following requirements apply:

- 1) Ventilating sash: habitable rooms require natural ventilation if a mechanical ventilation system is not being installed in the building.
- 2) Screens: all operable sashes require screens, and windows at grade or first floor must be fitted with heavy-duty (.020 wire gage fabric) screens for security. Emergency egress requirements must be met by screens and windows; coordinate with building egress plans. Include positive latch from inside of room only.
- 3) Shades: all windows in living units are to be supplied with shades. Simple spring-loaded roll-up shades are standard on campus. Evaluate window trim and screen operation to avoid conflict with shade operation. Princeton University utilizes a custom shade fabric and color (green for all dorms except

Spelman, which is cream) for its dorms. The shades may be purchased through the University shade shop, or shade fabric may be purchased (via the University supplier) and supplied to any shade vender.

g) Utilities: building systems are typically replaced in dorm renewal. System piping and equipment, ductwork, etc. must be carefully planned and routed to produce an integrated design for the building.

1) Heating/cooling: buildings are typically heated using hot-water radiation driven by the campus steam system. *In older buildings with window seats in common rooms, the heating element is often housed in the window seat. Careful attention should be given to requirements for insulation for piping run in exterior walls (i.e. 2" min. fiberglass).*

Ventilation with heated make-up air is generally provided for bathrooms, laundry rooms, and other spaces with ventilation requirements. Dormitories are not generally air-conditioned.

2) Power: *wiring is typically replaced in dorm renewal projects, with one power circuit per room. Wiring should be totally concealed. The number of duplex power outlets is increased to meet current code levels (≤ 12 feet apart) and the needs of student life.* Outlet location should be carefully coordinated with furniture plans. A quad outlet should be installed at OIT jack locations.

For both new construction and Dormitory renovation consideration should be given to increasing this requirement to one power circuit per student, (i.e. 2 circuits per double occupancy, 4 circuits per Quad, etc.). This decision shall be made in conjunction with Facilities Engineering after determining if localized A/C units may be installed in the Living Unit.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conductor equipment. See Appendix 3.12-9 for acceptable use of MC cable in dormitories.

3) Lighting: wall sconce fixtures are currently used for lighting in the living units in dorms, typically three or four fixtures in a Study Room. One lighting circuit per suite is standard. Review standard fixture with Project Manager to ascertain requirements for backboxes, conduit, switching, etc. Of primary concern for proper light distribution is the mounting height.

For rooms with 8' to 9' ceiling heights, the top of the sconce fixture should be mounted even with the top of door casings, but never less than 18" below the ceiling for best light distribution. For ceiling heights above and below these heights, engineering photometrics should be used in combination with interior elevation studies to achieve the optimal photometric and aesthetic combinations. Avoid placement of these fixtures under soffits, exposed beams, valance heating units, near windows, fireplaces and doors. Mock-ups of typical Student Room lighting schemes are required to confirm final design layout. All fixtures should also be easily procurable, should the University need to get replacements.

- 4) OIT: one two-port data outlet with two phone outlets constitutes a standard OIT outlet. One OIT outlet per room is standard, with adjacent quad power receptacle.
- h) Furnishings: the Housing and Real Estate Services, in concert with the Office of the University Architect, will provide information to the Designer on furniture sizes, manufacturers, etc. Currently furniture is supplied in plywood with a clear finished red oak veneer; furniture may be plywood base or solid wood, but no particle-core board or pressed-board is to be used.

A standard set of furniture includes a desk chair, desk, bed, dresser and a bookcase. Wardrobe units are provided for rooms without closets or built-in wardrobes; wardrobe units are customized only to size appropriate cut-out to accept wall base. Bookcases are provided for rooms without shelving and for rooms not meeting the minimum nominal requirement of six linear feet of built-in shelving. Wardrobes are to be secured to the wall. Bookcases shall consist of a minimum 6' linear feet of shelving to fit on top of chest or desk or on the floor. See [Appendix 2.4-6](#)

Furniture should be specified with felt footpads to prevent scratching of newly-finished floors.

2. Sleeping rooms

- a) Space Requirements
 - 1) Area: single room, 100 – 120 square feet minimum
double, 170 – 200 square feet minimum
quad 400-500 square feet, double occupancy for each sleeping room, independent of built-in closet or wardrobe unit square footage
 - 2) Layout: based on positioning standard University furniture, *without* consideration for using bunkbeds in double-occupancy rooms.
 - 3) Location/Orientation: entry from common room/study.
- b) Finishes: the same considerations listed for common rooms apply to individual sleeping rooms.
- c) Doors and hardware: unrated doors with passage or privacy hardware may typically be used for doors interior to living units. Sleeping rooms entered from a rated corridor will require rated doors, frames, and hardware, including closer.

Bedroom doors in suites are equipped with privacy locks, as are bathrooms within units.

Best Lock cylindrical sets and LCN closers are standard for both rated and unrated doors.

The Designer is advised to review requirements for fire-rated enclosures (and the lessening of requirements) in dormitories with full fire-suppression systems. Door viewers shall be installed at all corridor doors.
- d) Windows: the same considerations for common rooms apply to sleeping rooms.

e) Utilities:

- 1) Heating/cooling: as with common rooms, heating is usually provided by radiators fed by hot water converted from campus steam in the building's utility room. Individual HVAC controls are to be installed in each living unit; programmed temperature sensors are used in public spaces and bathrooms

Placement of student rooms over or near the building's steam-to-hot-water converter can be problematic.

Air conditioning is not typically supplied to the dormitories on campus, although new dormitories may utilize systems that provide air conditioning. *Consider an additional power circuit if localized air conditioning is to be installed in sleeping rooms*

- 2) Power: duplex outlet placement should meet code requirements (≤ 12 feet apart). Coordinate placement with proposed furniture layout; in rooms that are not in accessible areas, outlets should be mounted at 11'' (at renovations only) above floor to avoid possible conflicts with bed frames. For new construction, locate duplex outlets away from typical bed locations wherever possible. Provide quad power outlet at OIT outlet.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conductor equipment. See Appendix 3.12-9 for acceptable use of MC cable in dormitories.

- 3) Lighting: two wall sconce fixtures for each bedroom is typical, although larger bedrooms may warrant additional fixtures. For single and double occupancy rooms, one lighting circuit per four rooms is standard.

For rooms with 8' to 9' ceiling heights, the top of the sconce fixture should be mounted even with the top of door casings, but never less than 18'' below the ceiling for best light distribution. For ceiling heights above and below these heights, engineering photometrics should be used in combination with interior elevation studies to achieve the optimal photometric and aesthetic combinations. Avoid placement of these fixtures under soffits, exposed beams, valance heating units, near windows, fireplaces and doors. Mock-ups of typical Student Room lighting schemes are required to confirm final design layout. All fixtures should also be easily procurable, should the University need to get replacements.

- 4) OIT: one two-port data outlet with two phone outlets constitutes a standard OIT outlet. One OIT outlet per room is standard. The University runs a standard cable bundle to each outlet, including voice, data, cable TV, and fiber optic; see Section 2.6 (Computer Information Technology).
- 5) Smoke detection: locate heads away from possible sources of interference or damage such as doors, wardrobes, ceiling-mounted bike hangers, bunkbeds, light fixtures, etc. Detectors must be 36'' minimum from air supply outlets.
- 6) Fire suppression: concealed heads are preferred, either ceiling-mounted or sidewall type. If a dry standpipe is run adjacent to a room, access doors for

inspection of the standpipe might be required within the room.

- f) Furnishings: as listed above, the standard set of furniture for each occupant is a desk chair, a desk, a bed, dresser; wardrobe and bookcase where not built in.

Each bedroom should have a closet, a built-in wardrobe, or a moveable wardrobe unit that is secured to the wall; the choice is a programmatic decision, and should be made in consultation with the project design review committee.

Because of possible requirements for sprinklers within closets, the Designer should carefully review the issue of closet vs. wardrobe with the Project Manager and the University Code Analyst.

All millwork / furnishings manufactured with foam and or fabric shall be submitted for CAL 133 testing.

7. Signage Requirements

Prior to submitting signage design package the designer shall meet with the project manager to determine required locations and signage types. Generally, interior signage for dormitories shall include:

- A. Emergency Room Evacuation Signage - To be located immediately adjacent to room side of corridor door handle, indicating direction of all legal exits and installed with tamper proof screws.
- B. Room Identification Signage - To be located on corridor side at entrance to each suite. Includes room number, ADA Braille requirements, name slot and message board. Each room I.D. sign shall be designed individual to each project and reviewed with Housing and Real Estate Services. 10% attic stock shall be specified for each type of signage in the project.
- C. Stair Egress Signage - Denotes level and levels down to exit. Assigns a stair number and includes ADA Braille requirements.
- D. Common Area Signage - Includes room name, number and ADA Braille requirements.
- E. Elevator Signage – In accordance with ANSI A17.1 requirements.
- F. Electrical Signage – In accordance with NEC requirements.
- G. Fire Protection Signage – In accordance with NFPA requirements.
- H. **Wayfinding Signage – To be located at main entries and intersections of buildings. Includes location within the building and location in relation to other connected buildings within the college and the public areas of the college (ie. College offices).**

8. Environmental Issues

Prior to undertaking renovation work in an existing dormitory, the University will arrange for a survey of the building to determine the possible presence of hazardous materials. The University will engage a separate consultant for any remedial consultation deemed prudent as the result of this survey, and will attempt to abate any hazardous material prior to the start of construction, using a separate contractor qualified to perform the abatement work.

9. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the construction contractor and any systems installer.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record drawings to convert to as-builts. See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

PDF

- | | |
|--|-------------------------------------|
| A. FF&E Services Checklist Matrix | Appendix 2.5-1 |
| B. NFPA 260, Fabric Specifying Guide | Public Document |
| C. Purchasing General Terms and Conditions | |
| D. CAL 133, California Technical Bulletin, Fabric Open Flame Burn Test | Public Document |
| E. Sample Required Furniture Schedule/Unit Cost Summary | Appendix 2.5-2 |
| F. Standard Dorm Furniture | Appendix 2.4-6 |
| G. Sample FF&E Program Summary | See Interior Design Project Manager |

4. Review Guidelines

Furniture plans are often begun when project planning - and even construction documents - are well along toward completion. (This is not always the case; see comments in Section 2.4 Dormitory Design). The Interior Designer may or may not be a consultant to the principal Project Designer. Review of furnishings for non-dormitory projects will typically begin with a preliminary design, will continue through design development, and culminate in a furniture order a minimum of four months prior to installation.

The Designer is expected to review the proposed design with the University's Project Manager, Interior Design Project Manager, University Architect, the departmental representatives (department chair and department manager, eg.), and any adjunct professionals. In order to properly coordinate with all vested groups, no definitive number of review sessions can be laid down in general terms. The Designer must be prepared to work on a coordinated effort with the other professionals involved in the project, and must respond to the needs and wishes of the client/user while maintaining a clear understanding of schedule and budget. The furnishing project cannot be done on its own schedule, but must be timed to fit with the overall project schedule.

The Designer should be aware of the probable need to provide full-scale samples of furniture for client review. This is particularly true if furniture not in standard use at the University is proposed. Full-scale mockups must be provided during the early construction phase so that purchase decisions can be made without adversely affecting the end date of the project.

The Designer will be expected to participate in coordination efforts during the mock-up phase, to incorporate utilities such as power and data wiring. In addition, the Designer may be requested to provide coordination services to administrate the move of furniture and occupants, and in some cases, arrange an interim move so that existing space can be renovated.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all

these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

Requirements for specific areas of documentation are as follows:

Documentation	SD	DD	50% CD	85% CD
FF&E Program Summary	X	X		
Furniture Plans – <i>Include notes, symbols, (furniture dimensions to be included for user review)</i>		X	X	X
Furniture Product Investigation and Selection		X	X	
Finishes – <i>Finish material, color and samples</i>			X	X
Coordination - <i>Coord. Plans with the following: Lighting, Power, IT, HVAC (thermostats, vents, access), AV</i>			X	X
Life Safety Coord. – <i>Coord. Cal 133 / Atrium and any flammability requirements with material selection</i>				X
Mock Ups – <i>Plans and details</i>			X	X
Draft FF&E Specifications			X	
Final Specifications				X
Furniture Schedule/Unit Cost Summary			X	X

Timeline for delivery of the items listed above may vary depending on the nature of the FF&E package for the project (to be determined by the University Project Manager and the Interiors Project Manager).

5. Design Guidelines

There is no real “standard” office, classroom, or lab at the University although there are furnishing needs common to many uses. Depending on the department or discipline, there may be a greater or lesser need for pieces such as shelving or filing cabinets, work tables or computer stations, etc. Some of the common elements follow.

Attention should be made in supplying users with an ergonomic work environment, including but not limited to considerations for:

- Chair
- Desk
- Computer Workspace (height adjustable; if applicable)
- Lighting

Finishes are dependent on a number of factors - budget, client taste, Designer aesthetic, etc. and may be different for different functions and positions within a department. Public spaces should reflect the nature of the building's architecture, while private spaces may vary from such design constraint and take on a more personalized character.

As part of AE code compliance review all requirements for furnishings based on use group and construction classification should be coordinated with projects interior designer. In residential dormitories, atriums as well as any other areas required for code compliance, Princeton University requires fabric wall decorations, furnishings and millwork with foam and or fabric be tested for CAL 133 compliance. In all buildings, furniture and millwork must be coordinated with accessibility requirements. **For new construction or major renovations the Designer shall discuss the need of warranties for the furnishings with the Project Manager and Interior Design Project Manager.**

A. Work Spaces / Office Spaces

The Designer should consider the following in specifying furniture for work areas:

1. Ergonomic chair – in addition to pneumatic height adjustment, 5-star caster base, swivel; features allowing reclining and tilting forward positions, locking in position, arm rest height and position adjustments, back height and seat depth adjustments, lumbar support and overall chair size variations.
2. Desk, **primary and secondary** work surface, **side returns, etc..**
 - a. of sufficient depth (min 24”) to accommodate computer, multiple monitors where needed: auxiliary equipment such as printer or laptop. Allows for ‘L’ and ‘U’ shaped configurations as needed; acts as appropriate surface for meetings; provides monitor positions that does not expose confidential work;
 - b. wire management system, horizontal and vertical, with properly sized and located grommets or other fittings required for connectivity;
 - c. layout and fit of furniture must not block access to power, data, and HVAC controls and filters and other utilities;
 - d. **Coordinate integrated locations of recessed and surface mounted data power outlets.**
3. Computer accessories:
 - a. ergonomic keyboard with mouse pad;
 - b. monitor stand or support as appropriate (depth of work surface should allow correct placement);
 - c. CPU holder where needed, mobile free standing;
 - d. mobility of components and access to components should be considered;
 - e. laptop docking station, if applicable
 - f. coordination of access to surge suppression and power backup devices.
4. Task lighting should be considered in conjunction with layout and overall lighting design. screw-base socket fixtures must be capable of accepting LED with compatible housing. Distribution concerns may eliminate tubular fixtures. Under shelf lighting,

magnetic or with fasteners, to be LED. Transformer coordination and appropriate wire management required.

5. Shelving or bookcases, freestanding or secured to structure (with provision of architectural wood blocking). Designers should be aware of the need for shelving in University projects; extent and weight capacity of shelving is beyond the industry norm. Designer should also be aware of the restrictions on height of shelving in projects that include sprinkler systems. **See Section 4.13 - Carpentry for shelving material requirements.**
6. Filing, pedestal and storage cabinets, undercounter or freestanding. Keying of cabinetry should be included as part of its order (master keying if needed). See Section 4.4.6 for information on preferred lock types. File cabinets, lateral, 30" and 42" allow efficient front to back as well as side to side filing. Vertical file cabinets are to be letter sized unless directed otherwise by user. Specify hanging or other interior requirements (coordinate front to back / side to side requirement for laterals with user).
7. Need for seating area or meeting table.
8. Tack boards, marker boards, and chalkboards. Writing surfaces from base to door height are not uncommon.
9. Coat hooks
10. Panel system workstations and hanging components: acoustical panel of 54" or more in height to be effective. Panels must accommodate standard OIT Siemon RJ45 and provide sufficient space for cables with no sharp edges. Base entry is preferred with top cap cable layin for ease of service. Beltway receptacles are common.

B. Dormitory Furnishings

See Section 2.4 (Dormitory Design) for information.

Princeton University requires fabric wall decorations, furnishings and millwork with foam and or fabric be tested for CAL 133 compliance. This includes all furniture within residential dormitories (ie: built in benches, banquets, lounge furniture, etc)

C. Classroom Furnishings

See Section 2.3 (Classroom Design) for information.

D. Library Furnishings

The following considerations should apply in specifying library equipment and furnishings:

1. Circulation, Reference and Control Desks
 - a. Provide dual-height standing and sitting surfaces (refer to ADA standards and see Section 1.4 Regulatory Agencies);
 - b. Accommodate computer CPU and peripherals (flat screen monitor may be used);
 - c. Accommodate printer and supplies,
 - d. Accommodate telephone and directories;

- e. Accommodate credit card machines
- f. Provide pencil and money drawers; credit cards
- g. Provide appropriate surface for desensitizer and its access
- h. Provide file cabinets below; use mobile pedestals if appropriate;
- i. Provide space for book trucks;
- j. Provide built-in task lighting, if possible;
- k. Provide doors to limit access;
- l. Design structure and supports to allow movement under and around work surfaces to the greatest extent possible;
- m. Locate reference and reserve books nearby.

2. Reading tables

- a. Built-in lighting (LED preferred);
- b. Table-top data (in some cases) and power connections; consider lamp base as possible location as well as OIT and possible electronic component requirements;
- c. Durable solid wood chairs (unless adjustable height task chairs are requested).

3. Study carrels

- a. Knockdown construction is preferred for ease of relocation when important, by pallet truck and reassembly. Readily available, sustainable, and maintainable wood species and finishes are required ;
- b. Built-in lighting (LED preferred);
- c. Table-top data (where appropriate: verify with library) and power connections;
- d. Durable solid wood chairs (unless adjustable height task chairs are requested);
- e. Storage, to include bookshelf and occasional file drawers or pedestals; bookshelves should not interfere with laptop computers;
- f. Signage (with slide-in replaceable occupant name card). Confirm this requirement based on assignable vs. non-assignable carrels.

4. Shelving

- a. Adjustable shelving units, fixed in place (may include media and CD holders and microfilm carriers);
- b. Mobile/compact shelving; mechanical preferred over electrical;
- c. Periodical shelving;
- d. Newspaper racks and shelves;
- e. Shelving for oversized or odd-shaped articles.

5. Reference computer terminals and clusters

- a. Accommodate CPU and peripherals, with flexibility for equipment changes;
- b. Include wire management system with accessible connections;
- c. May be systems furniture, if appropriate.

6. Other computer use areas

- a. Review requirements for number and type of computers/peripherals with Project Manager, client user, and OIT;
- b. Accommodate CPU and peripherals (including printing stations, possible scanning stations), with flexibility for equipment changes and accessory storage (paper and toner);
- c. Provide work surface- or table-top data and power connections, with wire management;
- d. Provide durable solid wood chairs (unless adjustable task chairs are requested); Work surfaces vary from seated to standup – match seating needs.
- e. Provide workspace on table for books, etc. Confirm height requirements

7. Display cases

- a. Review need for display cases for normal use and special exhibits with client user and Project Manager;
- b. Review requirements for any necessary climate control or security features in display cases.
- c. Review need for cabinet locks with client user. See Section 2.5 (Furniture, Fixtures and Equipment), 10 (H) and Section 4.4.5.

8. Book drop

- a. Required at circulating libraries, not at non-circulating libraries
- b. Review size requirements with Project Manager and client;
- c. Determine whether CD slot and storage are needed;
- d. Review additional special considerations -- oversize books, music scores, etc.;
- e. Consider locations both inside and outside Library, as appropriate.

9. Copy area

- a. Review requirements for number and size of machines;
- b. Provide capability for coin and credit card use; review possibility of student ID card use for operation;
- c. Review need for connectivity with CIT, client user, and Project Manager;
- d. Provide for paper and toner storage in copy area.

10. Collection Security system

- a. Review requirements and options for security with client user, Project Manager, and Facilities Engineering Department. Magnetic strip system for book security is standard.
- b. Coordinate location of security reader to provide proper distance from steel framing and other possible sources of interference. Confirm with manufacturer specification.
- c. Refer to section 2.7 Security for guidance on other security requirements

E. Lab Furnishings

Lab furniture is a very complex design issue -- consult with Project Manager for guidance at the beginning of the design process. See section 2.10 for Lab Design requirements.

At a minimum all seating should be coordinated with bench heights. Appropriate finishes for lab function (ie: chemical resistance, static resistance properties) should be specified on seating and loose furniture.

Accommodations for coat hooks, backpack storage and lab coat storage are to be coordinated with lab design.

F. Furnishings for Meeting Spaces

1. Coordinate table placement with power and data connections; provide table-top connectivity;
2. Determine type of seating to be used -- stacking/non-stacking, ganged, task seating, etc.;
3. Review need for power and data connections, A/V equipment and screens at presentation wall.

G. Furnishings for Lounge Spaces and Lobbies

Because lounge spaces and lobbies are often areas that are closely tied to the architectural aesthetic of a building, the Designer may place special emphasis on coordinating the furniture and fixtures with the architectural character of the space. Consideration for durability and maintenance in these heavy use areas is needed. During events furniture is often removed or supplemented in these spaces. These requirements should be discussed during programming. **Thought should also be given to the replacement value and ease of replacement.**

In planning a lobby or building entry space, the Designer should allow for the practical necessity of providing direction to the general public: a directory, either standard display or electronic, should be included; key plans of the building could be useful; any display boards for special events that are held in the building should be integrated with the room design.

H. Cabinet and Furniture Locks

Confirm the requirement for individual locks for all contract furniture. For custom millwork, specify Best deadbolt cabinet locks as primary choice; "National" or CCL cabinet locks are also acceptable for heavy-duty wood applications, and for any custom millwork furniture. See Section 4.4.6 (Door Hardware, Millwork and Cabinet Locks) for more information.

I. Carpet

The University has a purchase agreement with a number of manufacturers for broadloom and modular carpeting goods. Term contracts are also in effect for several dealer/installers in the local market area, if such services are needed on a project. See Project Manager for manufactures.

Whenever possible, the use of 100% solution-dyed nylon fibers is encouraged. Face weights should be a minimum of 26 ounces, and generally at or above 28 ounces. Consideration must be given to the use of soil-hiding patterns and colors for carpeting being specified for student living and social spaces.

Modular carpet tiles are a desirable alternative to broadloom in certain installations such as locker rooms, library shelving areas, food service locations, and office area with numerous systems-style workstations. Cushion-backed tiles, as compared to lower-profile PVC-backed tiles, offer increased foot comfort and are believed to lengthen the life of the carpet product. The University recommends the use of modular carpet products from Milliken, Mohawk, Interface, and Shaw.

- J. Tack boards, marker boards, and chalkboards for public areas.
- K. Mail Boxes: include provisions for name plates
- L. Wall Coverings

Vinyl wall coverings are discouraged because of the difficulty in properly repairing damage to the finish.

6. Requirements for As-Built Drawings and Project Closeout

Contractor/Vendor at the end of the project to supply in electronic format as-built furniture installation plans indicating all wall mounted components, systems furniture and freestanding case goods, locations of work surface supports, integral lighting and power and data accommodation. Product identification and dimensions are to be included on the plans, as well as walls, window and door openings, and elements requiring access such as HVAC units, power and data receptacles. The expectation is that the electronic as-built documentation is produced from electronic architectural base sheets supplied by the Designer.

Office and workspaces, meeting, and library furniture installations are critical areas; public spaces with freestanding loose furniture such as seating or dining furniture are not critical in terms of installation Drawings.

All furniture, provided for all furnished spaces, is to be included in an electronic schedule of furniture and accessories indicating manufacturers, product numbers, finishes, colors, and quantities. Also required are lamp specifications for relamping task and ambient fixtures. Information is to be formatted so that it can be tied to locations, and make it possible to derive the contents on a room-by-room basis. One hard copy with actual finish samples and vendor contacts to be provided for project library.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

1. Introduction

The main campus of Princeton University is crisscrossed by a network of data and communication lines which have been installed and are maintained by the University. The three types of cables which comprise the network are telephone, which originates in Palmer Hall/Frist Student Center; data, originating at 87 Prospect, the Computing Center; and video, which is also located at 87 Prospect .

Office of Information Technology (OIT) operates and maintains this system throughout campus, and provides services to extend and revise the system for the University.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. Manager of Hardware Support 171 Broadmead, 609-258-6042
- C. Manager of Network Installations 171 Broadmead, 609-258-6015
- D. Manager of Telecommunication Technical Operations 171 Broadmead, 609-258-6655

3. Index of References

<http://www.facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

- A. *Horizontal Distribution*, Siemon Cabling System Training Manual IS-1821-01 Rev M
- B. *Backbone Distribution*, Siemon Cabling System Training Manual IS-1821-01 Rev M
- C. *Telecommunications Spaces*, Siemon Cabling System Training Man. IS-1821-01 Rev M
- D. *Installation Practices*, Siemon Cabling System Training Manual IS-1821-01 Rev M
- E. *Administration*, Siemon Cabling System Training Manual IS-1821-01 Rev M
- F. *Normative Annex B*, Siemon Cabling System Training Manual IS-1821-01 Rev M

PDF

- G. Face Plate Detail Drawing, OIT Appendix 2.6-8
- H. Elevator Phone Details, Telephone Office Appendix 2.6-10
- I. Cut Sheet of Emergency Phone, Telephone Office Appendix 2.6-11
- J. Specifications for Telephone Terminations Appendix 2.6-12
- K. Blue Light Communication Tower Detail Appendix 2.7-1

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines - Preliminary Design and Design Development

During preliminary design, Designer is to consult with University Project Manager to ascertain the requirements for telephone, data and WIFI installation. The Designer is to cooperate with any adjunct professionals providing assistance to the University, and is to coordinate his work with other disciplines so a cohesive set of documents is produced for the telephone, data and WIFI work.

During preliminary design and design development the Designer is to consult with the Project Manager and with OIT to define system distribution strategies and to discuss any obstacles that might be existing in a building, or problems inherent in a particular design or structural system.

OIT will provide information on design requirements for point-of-entry (POE), building distribution frame (BDF), and intermediate distribution frames (IDFs). This information will be based on the number of outlets anticipated for the project, the length of wiring runs in the project, the distance of terminations from POE, BDF, and IDFs, and any other pertinent information. See the Siemon Cabling System Training Manual for thorough review of design considerations for these facilities.

Discuss the need for supplemental distributed antenna systems (DAS) in the building. These systems would be for campus radio, emergency responder radio and cellular systems.

7. Guidelines and Requirements for Documentation

The preferred approach to documenting OIT requirements for a project is to provide Drawings dedicated to OIT design and construction. Upon submission of DD and 50% CAD drawings, OIT will then produce an Aruba WIFI design to be overlaid on the construction drawings. The same process will be followed for the Salto WIFI keyless lock system, if it is called for. These Drawings should be coordinated with the electrical Drawings (the electrical contractor will typically install the raceway system for OIT work), with the Architectural Drawings for inclusion of closets, backboards, etc. that support OIT work, and the Drawings for any other trades affected.

See Section 1.4 (Regulatory Agencies) for requirements for code review and permits, including the organization of construction Drawings and documents for timely release of permits.

At a minimum, the following are to be provided at the indicated phase:

Documentation	SD	DD	50% CD	85% CD
MEP Design Intent	X			
MEP Basis of Design		X		
Floor Plans - BDF & IDF	X	X	X	X
Floor Plans – System “Backbone”		X	X	X
Floor plans - showing horizontal and vertical routes of raceways			X	X
Floor plans - showing locations of all devices			X	X
Conduit riser Diagram showing all devices		X	X	X
Symbols & Notes		X	X	X
Outline Specifications		X		
Specifications			X	X
Details			X	X

8. Considerations for OIT Systems Design

Industry standard guidelines (see references for Siemon Design Manual) are to govern the installation of equipment, raceways, wiring, outlets, etc., and govern distances of runs between terminations and BDF/IDF. Princeton University does not use consolidation points.

Specific requirements for portions of the system are as follows:

A. Point of Entry

1. Minimum of three 4” conduits into building (1 telephone, 1 data and video, 1 spare). These are minimum requirements, and should be reviewed in preliminary design with Project Manager and OIT.
2. Conduit between POE and BDF to be (3) 4” minimum.
3. Telephone to have surge protection within 50’ of POE (may be extended if cable is in conduit outside building; review with Telephone Office);

4. Provide adequate work light (4" fluorescent preferred) and general purpose power outlet and six (6) dedicated quad receptacles, one circuit per quad in closet. Three (3) quads are to be placed on stand-by power supply; three (3) quads on standard building power. The dedicated circuits are to be wired with #10 wire for future upgrades to 30 amp circuits as needed. Circuits and outlets to be 20 amp at initial installation.
5. BDF and IDF to have ground buss bar.
6. All closets are to be ventilated and cooled as necessary to maintain a room temperature not exceeding 78 degrees F. Two complete air exchanges per hour as required.

B. Building Distribution Frame (BDF)

1. Conduits between BDF and each IDF in building are to be, at a minimum, two 4" conduits to create a "building riser system."
2. Wiring between BDF and IDF to be home runs, for fiber, telephone and (2) Cat. 5c.
1. Provide adequate work light (4" fluorescent preferred) and general purpose power outlet and six (6) dedicated quad receptacles, one circuit per quad in closet. Three (3) quads are to be placed on stand-by power supply; three (3) quads on standard building power. The dedicated circuits are to be wired with #10 wire for future upgrades to 30 amp circuits as needed. Circuits and outlets to be 20 amp at initial installation.
2. BDF is to be ventilated. Two complete air exchanges per hour.
3. BDF to have ground buss bar.
4. Base closet size = 12' 0" x 12' 0".

C. Intermediate Distribution Frame (IDF)

1. OIT to provide area requirements for closets based on cable count; see section 4.1 Communications Closets for additional information. Base closet size = 12'0"x12'0".
2. If project includes emergency power installation in building, provide emergency power to IDF (include IDF power outlets in emergency load calculation).
3. Provide adequate work light (4" fluorescent preferred) and general purpose power outlet and six (6) dedicated quad receptacles, one circuit per quad in closet. Three (3) quads are to be placed on stand-by power supply; three (3) quads on standard building power. The dedicated circuits are to be wired with #10 wire for future upgrades to 30 amp circuits as needed. Circuits and outlets to be 20 amp at initial installation.
4. Evaluate equipment heat load and provide adequate ventilation and cooling as necessary to maintain a room temperature not exceeding 78 degrees F. At a minimum, provide exhaust ventilation with tempered make-up air based on closet size and volume; allow a minimum of two air changes per hour. Review anticipated equipment heat load and configuration of equipment with OIT prior to calculating HVAC requirements.

5. Cable design length, including service loops, cannot exceed 295', station terminal to IDF terminal.
6. IDF to have ground buss bar.
7. No other services are to share IDF closet space, or to require access in closet (e.g., no electrical pull or junction boxes, no valves for piping, no mechanical equipment, etc.).
8. Closets are to be on the University's SALTO keyless lock system.
9. Ceiling clearance of 8' 0" maintained throughout the closet.

D. Individual Outlets (Stations)

1. OIT's 5/8" diameter standard cable bundle to each outlet consists of: (2) cat 5e cable for data, (1) cat 5e for telephone, (1) coax for CATV and a fiber optics cable for future. OIT's 5/8" high-density cable bundle consists of: (4) cat 5e cables for data with fiber optic cable for future.
2. 1" EMT conduit from outlet to tray system or piped back to BDF/IDF. Tray system path must return to the BDF/IDF; all turns are to be made with sweeps (no LBs in run and must be in accordance with Siemon Guidelines for bending radius). If 1" EMT is not practical, provide written argument detailing difficulties and suggested alternative solution. NOTE: Flexible conduit may not be used without OIT review and approval.
3. Floor Boxes
 - a. Walker 880 Series for data/phone.
 - b. FSR Series for data/phone/AV
 - c. Steel City 655-SC Series for data/phone.

Note: Walker 880 and FSR Series floor boxes will have a 1 1/4" conduit installed with an isolated 2-gang spot specifically dedicated for the data/phone. The Steel City 665-SC Series floor box will have (2) 1" conduits installed to two dedicated data/phone compartments

4. LCD Displays

If a presentation box is desired it shall consist of:

A standard OIT wall box installed behind the LCD with a 1 1/2" conduit running to the desired location in which the user would operate from, this end may go to a Standard OIT wall box or it may go to a conference table box.

5. Conduit, Cable Tray & Junction Box Cable Capacity

a. Conduit Sizing and Cable Counts

- 1" Conduit = (1) Standard, High Density or CACS Cable
- 1.25" Conduit = (2) Standard, High Density or CACS Cable
- 1.5" Conduit = (3) Standard, High Density or CACS Cable
- 2" Conduit = (4-5) Standard, High Density or CACS Cable
- 2.5" Conduit = (6-8) Standard, High Density or CACS Cable
- 3" Conduit = (9-11) Standard, High Density or CACS Cable
- 3.5" Conduit = (12-14) Standard, High Density or CACS Cable
- 4" Conduit = (15-17) Standard, High Density or CACS Cable

- b. Network WIFI, CVMS, Salto WIFI and DAS Cell Cables
 - Each location is a 1” conduit with a standard OIT wall box at each antenna location
- c. Radio Cables
 - Will be a J-hook and tray infrastructure in accessible ceilings. Hard ceiling will be conduit with bushings, 1 – 2” conduit per radio cable passing through the hard ceiling.
- d. Flex Tray
 - OIT tray systems will carry all of the above cables and tray sizing shall be based on a 70% fill ratio.

Note:

All Conduits shall have a pull string & conduit bushings installed by the installer

6. Minimum bending radius is governed by cat 5e and fiber optic requirement, in accordance with the Siemon Specification.
7. Maximum 270° from any pull point.
8. Face plates to be by Siemon.

E. System Wiring

1. For data, cat 5e wiring by Belden, Berk-Tek, BICC General Cable, Champlain, Commscope, Mohawk/CDT, or Optical Cable Corporation.
2. For video, 5704R cable by General Cable.
3. For voice, cat 5e cable by General Cable.
4. For fiber optics, Siecor cable.
5. Plenum-rated cable shall be used if cables are run without UL-listed conduit in ceiling space or other space subject to use as return or supply air plenum.
6. Installers are to be Certified Siemon Installer.
 - Awarded installer shall provide updated certificate and have a minimum (1) Siemons Certified Installer (technician) at all times per awarded project.
 - OIT supplies all cable and termination materials.

F. System Distribution

1. Raceways, cable trays, conduits, shall be utilized; review method of distribution with OIT during the schematic design phase.
2. Cable shall be properly supported (cat 5e requirements); raceways and trays shall be properly supported from the building structure
3. Any fireproofing material removed from the structure during installation of raceway system shall be replaced in kind.
4. System components penetrating fire-rated assemblies shall be fire-stopped to meet requirements for rated assembly breached; UL listed fire-stop systems by Hilti or 3M

shall be utilized. Review system to be used with the University Project Manager prior to undertaking work.

G. WIFI Distribution

OIT views Wireless Ethernet a complimentary service to hard wired Ethernet, not a replacement. OIT wireless application consists of (2) cat 5e wires from the BDF/IDF out to Aruba WIFI access points located throughout the building; placement to be determined by Aruba design software.

Confirm that no 2.4 GHZ fluorescent lighting (Fusion lighting) is designed in the Project; this will cause Aruba WIFI system to malfunction.

H. Salto Keyless Lock WIFI

Salto Keyless lock system WIFI consists of (1) cat 5e wire installed from the BDF/IDF out to the WIFI devices located throughout the building; placement to be determined by OIT and SALTO.

9. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the construction contractor and any systems installer.

As-built documents shall include all routing details, wall and floor box locations, and wireless antenna locations.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

See Section 1.5 (Documentation and Archiving)

END OF DOCUMENT

	<u>PDF</u>	<u>AutoCAD</u>
E. Princeton University Typical Plan/Elevation Security/ADA Features Layout	Appendix 3.1-1	Appendix 3.1-1
F. Princeton University Typical Building Processor Cabinet with UPS Diagram	Appendix 3.1-2	Appendix 3.1-2
G. Princeton University Typical Single Door Details	Appendix 3.1-3	Appendix 3.1-3
H. Princeton University Typical Double Door Details	Appendix 3.1-4	Appendix 3.1-4
I. Princeton University Cash & Check-Handling Policy (updated 2014) http://finance.princeton.edu/policy-library/cash-handling-receipts-1/cash-and-check-handling-p/		
J. Campus Video Management System	Appendix 2.7-3	
K. Security Programming Checklist	Appendix 2.7-4 (excel)	
L. Security Programming Document	Appendix 2.7-5 (word)	
M. BAS Specifications	Appendix 3.2-1	Appendix 3.2-1

4. Procedural Guidelines – Programming and Schematic Design

Prior to schematic design, Designer is to consult with University Project Manager and the ✓PS-19 **Executive** Director of Public Safety and the Site Protection Senior Manager to ascertain the level of security needed for the project, and that required for specific building areas, and that needed in the area around a building. Most projects will fall into one of the following **Security Programming Safety Level Categories** based on analysis of the program, location and public interface desired by the occupants:

Programming Security Levels for New Buildings and Renovations

CVMS = Campus Video Monitoring System
 CACS = Card Access Control System
 DPS = Department of Public Safety

<u>Exterior Security Requirements</u>		<u>Interior Security Requirements</u>		<u>Facility Examples</u> <i>(Percent of PU Space)</i>							
Security Level 1 (SL-1) - Description		Public Zones	User Zones								
Single-Security Layer	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Entrances</td> <td>Keyed Locks Padlocks at gates</td> </tr> <tr> <td>Windows</td> <td>Latched catches</td> </tr> <tr> <td>Other</td> <td>Knox Box (outside Princeton only) Site Lighting per ordinance Min/None DPS Comm Ctr Integration</td> </tr> </table>	Entrances	Keyed Locks Padlocks at gates	Windows	Latched catches	Other	Knox Box (outside Princeton only) Site Lighting per ordinance Min/None DPS Comm Ctr Integration	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Lockable buffers at User Zone No egress through user Zone</td> <td style="width: 50%;">Locksets per Hardware Stds No interior locks in residential EM cores for GBM access to MEP</td> </tr> </table>	Lockable buffers at User Zone No egress through user Zone	Locksets per Hardware Stds No interior locks in residential EM cores for GBM access to MEP	<p>Graduate Housing Faculty / Staff Housing Service Structures GBM Facilities * Off Campus Admin. (depending on program, may also be Level 2) Single-Function Academic Single-Function Admin 21%</p>
Entrances	Keyed Locks Padlocks at gates										
Windows	Latched catches										
Other	Knox Box (outside Princeton only) Site Lighting per ordinance Min/None DPS Comm Ctr Integration										
Lockable buffers at User Zone No egress through user Zone	Locksets per Hardware Stds No interior locks in residential EM cores for GBM access to MEP										
Security Level 1 (SL-1) - Description		Public Zones	User Zones								
Moderate risk level											
Non-student Programming											
Low replacement content costs											
<i>Same as Security Level 1 PLUS:</i>											
Security Level 2 (SL-2) - Description		Public Zones	User Zones								
Dual - Security Layers	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Entrances</td> <td>CACS Vandal Resistant Latches (Key operation latches only)</td> </tr> <tr> <td>Windows</td> <td>First Floor Security Screens OR Opening Limiter hardware</td> </tr> <tr> <td>Other</td> <td>Review CACS at Non-door openings Blue Light Phones DPS Comm Center Monitoring</td> </tr> </table>	Entrances	CACS Vandal Resistant Latches (Key operation latches only)	Windows	First Floor Security Screens OR Opening Limiter hardware	Other	Review CACS at Non-door openings Blue Light Phones DPS Comm Center Monitoring	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Lockable zone perimeter barriers No egress through user Zone Review zone perimeter construction</td> <td style="width: 50%;">Keyless Locks at high value content Limited CVMS at high value content</td> </tr> </table>	Lockable zone perimeter barriers No egress through user Zone Review zone perimeter construction	Keyless Locks at high value content Limited CVMS at high value content	<p>U/G & Graduate Dorms Residential Colleges Academic - no vivarium Admin Main Campus Book Annexes * Off Campus Admin. (academic bldgs., depending on program & scale of bldg.) 44%</p>
Entrances	CACS Vandal Resistant Latches (Key operation latches only)										
Windows	First Floor Security Screens OR Opening Limiter hardware										
Other	Review CACS at Non-door openings Blue Light Phones DPS Comm Center Monitoring										
Lockable zone perimeter barriers No egress through user Zone Review zone perimeter construction	Keyless Locks at high value content Limited CVMS at high value content										
Security Level 2 (SL-2) - Description		Public Zones	User Zones								
Student Programming											
Campus Community Access											
Clear user separation of functions											
Possible Cash Contents											
Regular after-hours use											
<i>Same as Security Level 2 PLUS:</i>											
Security Level 3 (SL-3) - Description		Public Zones	User Zones								
2 - 3 Security Layers	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Entrances</td> <td>CVMS at Critical Entrances</td> </tr> <tr> <td>Windows</td> <td>(No operable windows at this level)</td> </tr> <tr> <td>Other</td> <td>Increased Footcandle Ratings Decreased Landscaping Upgraded DPS monitoring</td> </tr> </table>	Entrances	CVMS at Critical Entrances	Windows	(No operable windows at this level)	Other	Increased Footcandle Ratings Decreased Landscaping Upgraded DPS monitoring	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Keyless Locks at zone perimeter Clear separation of public realm No egress through user zone Review buffer wall construction Consider additional Requirements</td> <td style="width: 50%;">Interior CACS at Special Areas CVMS at High Value Locations</td> </tr> </table>	Keyless Locks at zone perimeter Clear separation of public realm No egress through user zone Review buffer wall construction Consider additional Requirements	Interior CACS at Special Areas CVMS at High Value Locations	<p>Museum - Storage areas Library Data Centers Science/Vivarium Bldgs 22%</p>
Entrances	CVMS at Critical Entrances										
Windows	(No operable windows at this level)										
Other	Increased Footcandle Ratings Decreased Landscaping Upgraded DPS monitoring										
Keyless Locks at zone perimeter Clear separation of public realm No egress through user zone Review buffer wall construction Consider additional Requirements	Interior CACS at Special Areas CVMS at High Value Locations										
Security Level 3 (SL-3) - Description		Public Zones	User Zones								
Limited Campus Access											
High Value Contents/Replacement Cost											
Mission critical user activities											
Additional user monitoring needs											
<i>Same as Security Level 3 PLUS:</i>											
Security Level 4 (SL-4) - Description		Public Zones	User Zones								
4th Security Layer	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Entrances</td> <td>Limited or Single Entrance DPS Monitoring at all other openings</td> </tr> <tr> <td>Windows</td> <td>Film or limited view glass</td> </tr> <tr> <td>Other</td> <td>Access way CVMS Monitorig</td> </tr> </table>	Entrances	Limited or Single Entrance DPS Monitoring at all other openings	Windows	Film or limited view glass	Other	Access way CVMS Monitorig	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Turnstiles / separated vestibules</td> <td style="width: 50%;">Dual Validation / Biometrics Staffed access points Intrusion Detection- Area/Contents Interior Panic Alarms Property Detection Systems</td> </tr> </table>	Turnstiles / separated vestibules	Dual Validation / Biometrics Staffed access points Intrusion Detection- Area/Contents Interior Panic Alarms Property Detection Systems	<p>BSL 3 Laboratories MRI Laboratories Museum display cases Highly Hazardous Mat'l Areas < 1%</p>
Entrances	Limited or Single Entrance DPS Monitoring at all other openings										
Windows	Film or limited view glass										
Other	Access way CVMS Monitorig										
Turnstiles / separated vestibules	Dual Validation / Biometrics Staffed access points Intrusion Detection- Area/Contents Interior Panic Alarms Property Detection Systems										
Security Level 4 (SL-4) - Description		Public Zones	User Zones								
Limited User access area											
Extreme sensitivity or high value content											
Primary User monitoring											
Special Circumstances	Explanation										
Critical Locations on Campus Non-standard Programming Operational Challenges	Additional discussion required for facilities where particularly complicated programs or operational questions arise during design. The designer is reminded that the Project manager will facilitate these discussions and seek administrative approval prior to the start of Construction documents if possible.			Athletic Facilities Locker Rooms Power Plants Parking Garages 13%							

Once a Security Level (SL1 thru 4) is established for a project, then as per Appendix 2.7-4 a **Security Programming Checklist will be prepared by the Design Team** and reviewed to define additional categories of security programming for the project. These issues may include but are not limited to the following:

1. Discussion and coordination of goals user requirements.
2. Card Access Control System (CACCS) design.
3. Transition from mechanical (keyed) lock sets to keyless locks.
4. Campus Video Management System (CVMS)
5. Blue Light Phone Requirements
6. Building Access Points
7. Building Envelope
8. Fire Safety Security Monitoring System (FSMS) building.
9. Fire alarm testing to the public safety Computer Graphics Response Monitoring System (Simplex “True Site Workstation” (TSW)).
10. Automatic Temperature Control Points Reporting
11. Hazardous Material Usage
12. High-Value Content
13. Miscellaneous Safety and Security issues (locks – keyless and mechanical, lighting, etc.)

Advice and direction for security-related programming decisions will come from members the University Safety and Security “Tech Team”, consisting of various technical stakeholders with expertise in CACCS, FSMS, BAS and other related disciplines. The Project Manager facilitates these discussions during execution of the **Security Programming Checklist** prior to formal commencement of any security design documentation. Review of this document by the Executive Director of Public Safety or appointed designee is required **before proceeding** with Design Development. After acceptance of the checklist, it is memorialized through a formal **Security Programming Document** (Appendix 2.7-4) **prior to the start of Construction Documents.**

In certain situations, direction from the University “Security Advisory Group” (SAG) may be necessary to resolve project security priorities within the current campus environment. SAG provides the necessary policy oversight, leadership and guidance on physical security matters of institutional importance as they relate among similar building occupancy types. Review of the Security Programming Checklist may trigger additional design reviews by SAG at the discretion of the Director of Public Safety or his designee.

Additionally, during schematic design and design development the Designer is to also consult with the Project Manager and the University’s Code Analyst to discuss any code issues that have an impact on the planned security features of the project. The approved **Security Programming Document** shall be used to document the final compliant security priorities.

5. Review Guidelines

As the project moves toward the construction documentation and code review phases, it is required that construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction, Site Protection (SP), Department of Public Safety (DPS) and, as needed, from Environmental Health & Safety (EHS) for compliance with University standards. Documentation is to be submitted for review at:

- A. Completion of Pre-Schematic Design;
- B. Completion of Schematic Design;
- C. Completion of Design Development
- D. At 50% completion of construction documents;
- E. At 85% completion of construction documents;
- F. At 100% completion of construction documents, if required, at the discretion of the Project Manager

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

All facilities that fall into Security Level Type 4 should review DPS and Departmental operational concerns. Facilities that fall outside of currently established operational practices may require an outside consultant to aid the University in developing the facilities' security operation protocol. This protocol must be approved by DPS.

Requirements for specific areas of documentation are as follows:

Documentation	Pre SD	SD	DD	50% CD	85% CD
Security Programming Checklist	X	X			
Security Programming Document			X		
CVMS documentation				X	X
FSMS documentation				X	X
CACS documentation				X	X
BAS Commissioning requirements					X
Details				X	X
Outline Specifications				X	
Full-Length Specifications					X

6. Design Guidelines - "Passive" Security Features

In designing the project, the professional should be aware of features that can be included to enhance safety in and around the building, and should also be aware of problematic conditions that might make a project inherently less safe. Some of the features to consider follow below:

A. Landscaping

Use landscaping to enhance a design, but avoid creating heavy cover, dark areas, and isolated areas

B. Path Routing

Design paths with sufficient lighting, and avoid cul-de-sacs and dead-ends

C. Building Configuration

1. Exterior

Take care in the building layout to avoid, or at least to compensate for such features as:

- a) Alcoves
- b) blind corners
- c) enclosed courtyards

2. Interior

Inside the building, care should be taken in design of exit paths for fire safety, personal protection, and prevention of theft of property. The location and travel paths for the following are particularly important.

- a) entry configuration
- b) hallway configuration
- c) common spaces / public spaces
(avoid uses which compromise access security in buildings)
- d) emergency exits

7. Design Guidelines - "Active" Security Features

The Designer should pursue solutions that will enhance the safety of the project, both during construction and subsequent occupancy. Refer to the approved Security Programming Document for guidance. During the security programming review consider the following with for appropriate locations/ applications with the Tech Team.

A. Exterior

1. Lighting

See Section 3.5 (Lighting Design).

2. Fences/walls/enclosures

Site logistics are to be planned by the Designer, working with the Project Manager and construction manager; logistics will be reviewed by Public Safety and Grounds.

3. Security telephones/Blue Light Towers

Security telephones are placed strategically around campus. On certain projects, additional installations may be necessary depending on the site location. Alternatively, a localized Blue Light Tower may circumvent the need for a Security telephone outside a building. See Appendix 2.7-1.

4. Security cameras (CVMS)

Security cameras may be placed at selected areas of campus, where required. Any proposed use of CVMS must be approved by SP and Public Safety in accordance with the Review Guidelines above.

B. Interior

The emerging standard at Princeton University favors “smart” buildings with selective access systems, doors that can be locked and alarmed, electronic latches for nighttime security, and systems that will report to Public Safety through fire alarm and security systems. A number of control and protective methods are used, some highly technical, others less so. Many of the features that provide safety to building occupants and to the public in general, can be arrived at simply through the process of thoughtful design, and the employment of common-sense solutions.

1. Card access, using identification cards
 - a) Proximity (“prox”) cards for activation of locking hardware on dormitory entries and selected other buildings and areas. See Section 3.1 (Access Control Systems).
 - b) Hotel-style card locks (Salto Keyless Locks). If keyless locks are selected the intended use is for interior doors such as dormitory rooms and bathrooms. A University ID card is to be the “key” that will operate the off-line electronic lock system.
2. Combination locks in specific areas (Trilogy or Salto electronic locks, non-alarmed, for use in dormitory bathrooms, and special-use areas such as computer rooms)
3. Although security cameras are generally not used, they may be placed at selected areas of campus, where required. Any proposed use should be reviewed with Life Safety and Security Systems and Public Safety. See Appendix 2.7-3.
4. Window screens (in residential buildings; heavy-duty frame and screen on ground-level and first-floor rooms; must be lockable but operable). All screens should be either lockable, provided with heavy duty magnetic operators, or have limiter hardware to prevent forced entry in the open position.
5. Duress buttons/ emergency phones are generally only specified for public areas used intermittently or at odd hours, such as laundry rooms, remote social areas in dorms, and at building entries. Additionally, they may be required for code-mandated Areas of Refuge within egress pathways.
6. Lighting, both normal lighting and motion-activated
7. Maintenance-only access to special uses/areas such as roof hatches and windows to roofs or unprotected balconies. Review all locations on a case-by-case basis.
8. Maintenance-only access to service/mechanical areas (see Section 4.4 Door Hardware)
9. Use of magnetic door hold opens on rated door assemblies along required egress paths.
10. The Building Automation System (BAS) shall be designed to incorporate the reporting of all non-security related MEP system alarms, including high-water alerts,

maintenance breakdowns and other general building issues. See Appendix 3.2-1, BAS Specifications, for specific University BAS requirements (including commissioning).

8. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the electrical and security contractors.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

On the as-builts, the contractor is to highlight changes made to submittals and approved documents. The as-builts are to include, as a minimum, security/utility/environmental and other alarms layout plan with all other system interfaces, components, equipment schedule and riser Diagrams. Card Access Control System (CACS) Acceptance Test Procedure (ATP) will be included with As-Built Drawings.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

1. Introduction

Environmental graphics includes both interior and exterior signs or lettering that are project specific, as well as campus-wide sign systems for wayfinding and information. Project Designers are encouraged to retain the services of a Graphic Designer for all project specific signage and to coordinate their work with the adopted campus-wide sign systems designed by others. (See Wayfinding below). **A meeting shall be held to coordinate exterior wayfinding and signage with Landscape Project Manager and University Coordinating Architect.**

Exterior Building Signage:

To be determined on a case by case basis - each building project may require at least two types of exterior signs: 1) a building identification sign (building ID) showing the officially recognized name of the building, and 2) information signs for ADA routes, service deliveries, parking, **no smoking**, etc. Generally, the building identification sign should be located near the primary entrance and its design integrated into the architectural elements of the building façade. There are many existing precedents on campus for building ID's. Some examples are: lettering carved directly into the building's stone, pin-mounted metal lettering on masonry, metal lettering incised into stone, applied lettering on glass, carved stone **tablets and metal plaques**. Another option is to use the standard building ID sign type as shown in the Princeton University Wayfinding Signage Handbook, (Appendix 2.8-1). For all other exterior informational signage associated with the building and its site, the university recommends using the campus standard signage as shown in the Handbook. **Be advised that the Forrestal Campus has different exterior wayfinding standards than main campus.**

Interior Building Signage:

Although governed by ADA and NJUCC guidelines, interior signage should be project specific in its scope and should be designed to complement the architectural style of the particular project.

Dedicatory Inscriptions:

In addition to the design of interior building signage, graphic design services may also include design of a dedicatory, commemorative, or memorial inscription or plaque, as part of the project. Whenever possible the requirements for same will be provided to the project team during the schematic design phase

Print Graphics:

If needed, editorial and design guidelines, (Logos, typefaces, etc.) for interior print graphics, are available from the Communications Office online. See www.princeton.edu/pr/

Wayfinding:

Princeton University is implementing a comprehensive, yet discreet, Campus Wayfinding Program. The program consists of campus-wide vehicular and pedestrian directional and informational sign system, campus maps and directories, geared primarily for campus visitors. Wayfinding signage will be designed by the University's Graphic Design Consultant and will be implemented over time. Campus wayfinding is generally independent of project specific signage but may in some instances be used to supplement exterior building identification.

2. Contacts

- A. Project Manager (in Office of Design and Construction, Office of the University Architect, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. Landscape Project Manager 200 Elm, Drive, 609-258-8338
- C. University Coordinating Architect MacMillan Building, 609-258-1189
- D. Architectural Engineer for Standards 200 Elm Drive, 609-258-2094
- E. Assistant Director of Grounds MacMillan Building, 609-258-6046

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- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Uniform Fire Code](#)
- C. Princeton University Wayfinding Signage Handbook Appendix 2.8-1
- D. Fire Alarm/Signage Nomenclature Spreadsheet sample, Princeton University Appendix 3.4-3
- E. Uniform Traffic Control Device Manual, Federal Highway Safety Administration Public Document
- F. Room/ Space Numbering System Guidelines Appendix 1.5-3

4. Review Guidelines

Documentation for (interior) signage typically comes late in a construction project, and review is generally limited to the Project Manager, the University Architect, the University Coordinating Architect, and representatives of the client department.

If the Project Manager determines that a consultant independent of the design firm will be used for signage, then the signage is usually shown on plans specifically drawn for that purpose; otherwise the signage will be included on the construction documents as shown in the chart shown on page 3 of this section.

Typically, signage proposals will be reviewed in preliminary form, and may proceed directly to the final plans, depending on the complexity of the project.

Designers shall provide timely and coordinated responses to all review comments. Preferably, with the assistance of the Project Manager, review meetings should be held with respective internal contacts as identified by the Project Manager to facilitate this process. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent

revisions may be discussed and documented. If these review meetings are not held, or if any non-compliant design or component is selected, the A/E shall provide the University written documentation of respective changes prior to submission of the next round of documents.

Required Documentation	SD	DD	50% CD	85% CD
Compliant Room Number Designations (per Appendix 1.5-3)		X	X	X
Interior Signage Schedule				X

5. Procedural Guidelines - Preliminary Design and Design Development

The Project Designer should determine at the beginning of the project, in consultation with the University Project Manager, whether a Graphics Consultant will be used on the project and what the scope of graphic services will be for the project. The University, with the help of the Designer, will establish a budget for the graphics work.

During preliminary design, Designer is to consult with Project Manager to ascertain the level of signage needed for a building, that required for specific building areas, and that needed in the area around a building. The Designer is to develop a code-conformance schedule, outlining the minimum signage to meet code requirements.

The building signage should complement the architecture of the building.

To facilitate the establishment of room numbers, a meeting with the Architectural Engineer for Standards, SPMIS Assistant Manager and Design team should occur before the start of Design Development. This meeting will clarify the appropriate method for assigning room numbers. Compliant room number designations, including all mechanical rooms and circulation spaces, are due as part of Design Development Submission, see Appendix 1.5-3.

The Graphics Consultant may be asked to provide assistance to the University Project Manager and the project Designer in determining the scheme for room numbering. This numbering scheme may include nomenclature for the building fire alarm system; this nomenclature is developed in coordination with the Department of Public Safety.

While in development, Designer is to review plans with the Project Manager, Office of the University Architect, the client/user, Public Safety, and any other parties that might be affected by the proposed installation. During development, full-scale mockups should be temporarily installed on site and in context to aid in the final review of signage design.

In the final design, a sign schedule is to be created, with sign types listed on a room-by-room basis, with floor plans keyed into the schedule. Typical elevations showing mounting heights and relative location of sign types are to be prepared, as is a written specification that will allow accurate pricing of the signage and installation.

6. Guidelines for Installation and Performance

- A. Signage for room numbers is considered permanent, should comply with ADA and NJ barrier-free requirements.

Names that may be attached to or be a part of a room number sign should be easily adaptable and changeable. Window signs, for example, allow the client/user to maintain the signs in the building.

- B. Interior signage is typically installed using a silicone sealant, with double-faced foam tape providing temporary adhesion.
- C. For exterior signage, concealed fasteners are preferred. Through-bolts are not to be used unless no other option is available, and then only with permission from the Project Manager. Embedded anchors are typically used on masonry.
- D. Building identification is often hand-carved into the masonry of a building facade. An alternative is a plaque of carved stone, set into the building walls or anchored with concealed fasteners. Cast metal and porcelain enamel are also acceptable options.
- E. Dormitory signage (interior) See Section 2.4.

7. Guidelines for Door Number Labeling

For maintenance purposes, the University requires individual door numbering all spaces. For locations not included in a formal signage package, these requirements shall be indicated on final construction documents in table format for the following doors:

- A. Exterior Card Access Doors: Each door with access control (CACS) hardware shall receive a 1/2" exterior grade vinyl label coordinated lettering and numbering from the CACS design. These labels are to be adhered to the frame directly above the center of the door from the exterior. Labels are available from the owner.
- B. Interior Room Doors: The interior sign package often includes room signage / numbering for most rooms. However, for rooms with doors that may not include standard interior signage, each door shall include a 1/2" vinyl label supplied by the owner. The consultant should review the signage package with the Architectural Engineer for Standards to ascertain the projects need for labels.

END OF DOCUMENT

1. Introduction

Princeton's campus has grown to over 660 acres today, with holdings in excess of 2,000 acres. The College expanded greatly in the 1870s under president James McCosh, a Scot who brought with him from Britain a love of the English garden, and who first applied some of the gardening concepts to what at the time was a rather austere campus.

In 1912 Beatrix Jones Farrand began what was to be a long term association with the University, when she was brought in to work on the project to create the Graduate College, with Architect Ralph Adams Cram. Farrand became the University consulting Landscape Architect and was associated with the University for some thirty years. She was responsible for the landscape design that helped shape what is today the Historic Campus, and her basic design principles are still evident - emphasize rather than conceal architecture; simplify and unify with careful, controlled planting; and select materials with a view to the seasonal use of the campus.

The campus has historically grown as a series of plazas or quadrangles connected by walkways. Today the main campus reflects that historic growth, and is organized along two east-west axes - McCosh Walk near the north end of campus, and Goheen Walk farther to the south. North-south paths are generally discontinuous. Elm Drive is the primary vehicular path through the central campus and connects the north and south campus entrances.

The lasting impression that the campus has on visitors centers on the attention given to open spaces. Careful design of outdoor spaces provides the continuity of experience for the campus. In 2008 the University published the Princeton Campus Plan (Appendix 2.9-12) as well as a 10-year Landscape Master plan to assist in determination of how it could accommodate significant academic expansion while preserving the historic beauty and walkability of the Campus. This plan breaks down the scale of the campus to assess local site relationships within the vibrant diversity of the campus as a whole. Consulting architects are encouraged to become familiar with the Campus Plan and embrace its five guiding principles within each respective project design:

- Maintain a pedestrian-oriented campus
- Preserve the park-like character of the campus
- Maintain campus neighborhoods while promoting a sense of community
- Build in an environmentally-responsible manner
- Sustain strong community relations

Site Design implementation and corresponding internal review procedures for each project can be found later in this section; item 6.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, Office of the University Architect, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. Landscape Project Manager (ODC) 200 Elm Drive, 609-258-8338
- C. Office of the University Architect (OUA) MacMillan Building, 609-258-9823
- D. Manager, Civil Engineering and Construction (CE) MacMillan Building, 609-258-6682
- E. Engineering – Mgr. of CAD Dept. MacMillan Building, 609-258-8205

F. Assistant Director, Campus Grounds (GBM) MacMillan Building, 609-258-6046

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| A. Campus Utility Maps in Facilities Engineering | Consult Project Manager |
| B. Campus-wide Tree Survey | Consult Project Manager |
| C. Campus Accessibility Map | |
| D. Outdoor Lighting Master Plan | Appendix 2.9-15 |
| E. Campus Emergency Services Access Route Map | Appendix 2.9-5 |
| F. Map of University-Owned Roadways | Appendix 2.9-6 |
| G. Exterior Pole Lamp Details | Appendix 3.5-2 |
| H. Reunion Sites | Appendix 2.9-8 |
| I. Site Details | Appendix 2.9-9 (ACAD) |
| J. General Survey Requirements | Appendix 2.9-10 |
| K. Geodetic Control Monument Detail | Appendix 2.9-11 |
| L. Princeton Campus Plan | |
| M. Standard University Handrail Details | Appendix 2.9-13 |
| N. Standard University Outdoor Furniture | Appendix 2.9-14 |
| O. Stormwater Guidelines | Appendix 2.9-16 |
| P. Programming Guide | Appendix 1.3-2 |

4. Code References

- | | |
|---|--|
| A. New Jersey Uniform Construction Code (NJUCC) | |
| B. ANSI/CABO A-117.1 (Barrier-Free Guidelines) | |
| C. Shade Tree Ordinance, Municipality of Princeton | |
| D. Tree Removal Ordinance, Municipality of Princeton | |
| E. Code of Laws, Volume II, Land Use, Municipality of Princeton | |
| F. Land Use Ordinance, Municipality of Princeton | |
| G. Land Use Ordinance, Township of West Windsor | |
| H. Land Use Ordinance, Township of Plainsboro | |
| I. Mercer County Soil Conservation Report | |

5. Design Guidelines

It is appropriate to think of buildings as backdrops to the exterior spaces that are, ultimately, the cohesive factor in experiencing Princeton's campus.

Buildings may give form to the exterior space, they may frame an exterior space, or they may create circulation patterns for exterior space. Overall, the following concepts should be adhered to in the site planning aspects of project design:

A. Hierarchy of Spaces

There should be a hierarchy of spaces which building placement and plantings should reinforce and enhance. The most successful exterior areas on campus rely on a hierarchy of spaces - the intimate ambulatory providing a vista through an archway to a grand courtyard, for example.

B. Sequence

A design goal in developing Princeton's outdoor spaces is to create a sense of continuity between spaces, where major spaces are enhanced by the prelude of moving through secondary spaces, where there is a play of expansion and contraction, of light and shade. The campus is typically experienced by moving through exterior spaces involving minor spaces leading to major spaces by means of connectors.

C. Connection

It can be argued that, while the grand spaces may be the most beautiful aspect of the campus plan, the connections or paths of travel are what provide the sense of campus. Campus walks provide the views, the vistas, and the experience of coming upon or into the courtyards, quadrangles and gardens of the campus.

D. Continuity

The buildings at Princeton are remarkably diverse, yet the campus is still perceived as cohesive. It is a challenge to the Designer to work within that established context: to impose what might be a unique volume upon an existing array of solids and voids, and to have that volume - and the means of going through and around it - become a seamless part of that whole.

6. Internal Review Guidelines – Site Plans / Landscaping

The campus landscape is governed by two standing committees, the Landscape Policy Committee (LPC) and the Landscape Coordinating Committee (LCC).

The LPC membership includes upper management and meets quarterly. It sets policy regarding the campus landscape and approves design direction for all major landscape projects and long-range site planning initiatives.

The LCC meets bi-weekly to review all substantive landscape projects and policies usually in more detail than the LPC. LCC acts as a forum recommend landscape improvements and for design reviews of all aspects of landscaping projects including circulation, site lighting, horticulture, sustainability, storm water management, maintenance and options for study.

The University Coordinating Architect should be contacted for any project which disturbs an exterior site in any manner to determine if a review is required, the level of review and schedule the review time. ✓PS-20

The purpose of the review is to determine the appropriate scope and design concept for all site work. The expectation is that the Design Team and University Coordinating Architect will come to a complete agreement on each matter. If it is not possible for all to agree, differences will be resolved by the Landscape Coordinating Committee, which meets bi-weekly. All final site plans should be reviewed by the Landscape Coordinating Committee before implementation.

The University Coordinating Architect has the responsibility of insuring that the scope and concept for all site design has been approved.

During the process of design, plans are to be submitted for review by Facilities departments as well as the LCC at appropriate intervals or milestones that may include:

- A. Completion of Schematic Design; Existing Conditions Survey must be completed by schematic design. Refer to this section, item 16 for more information.
- B. Completion of Design Development; Proposed plant material should be represented on drawing at 70% of size at maturity. Sections should show scale, form, and opacity of proposed trees.
- C. At 50% completion of construction documents
- D. At 85% completion of construction documents
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

7. Internal Review Guidelines - Utilities

At initiation of programming, it is useful to begin informal discussions about site utilities with the Manager, Civil Engineering and Construction. This group maintains the campus utility plans and can also be a source of general knowledge about utilities the University can provide about methods for involving agents for public utilities in the project.

Please see Section 3.6 (Utility Guidelines) for additional information.

Please see this section; item 13-D, for layout of trees over utilities.

8. Internal Review Guidelines – Storm Water

The Designer should note that the University has developed stormwater management guidelines and criteria that address water quantity as well as quality for all projects with site impacts. Specific project performance requirements can be found in the appendices. Design teams should coordinate stormwater management requirements with the Office of the University Architect. Stormwater concepts should be developed in conjunction with all of the appropriate design team members and reviewed periodically with the University for conformance.

Sustainability Charrette – Stormwater management goals and strategies should be identified in coordination with the University's storm water management consultant.

SD, DD, 50% CD, 85% CD – Princeton University's storm water management consultant in conjunction with the tech teams, Office of the University Architect and the LCC will review the documents. An additional review may be required at 100% completion of construction

documents, at the discretion of the LCC. A report by the Designer is required for the storm water design at 100% CD's and post construction in order to verify construction has meet the design.

9. Municipal Review Guidelines - Landscaping

Building projects, major landscaping projects, and landscaping projects undertaken in conjunction with building construction, are likely to require review by a number of municipal and county agencies. Site plans must be reviewed by the Princeton Regional Planning Board. In some instances, site plan review becomes the responsibility of a municipal Zoning Board of Adjustment.

The legal intricacies of site plan approval are typically addressed by the University's legal counsel. The Designer must be prepared to offer support in the effort to obtain site plan approval, which might require presentation Drawings, appearances at the meetings of the Regional Planning Board or the municipal zoning boards, pre-meetings with a key subcommittee that supports all the agencies, the Site Plan Review Advisory Board (SPRAB), and with municipal officials and professionals.

SPRAB takes the leading role in landscape review for the municipalities, and can have a major impact on the details of a site plan. This board is well regarded in the municipality, and approval by SPRAB can ease the passage of a project through the subsequent hearings before the Planning or Zoning Boards.

To expedite the review and approval of a project at the local level, close coordination with civil/site Engineers, Landscape Architects, and University personnel is required of the landscape Designer.

See Section 1.4 (Regulatory Agencies) for additional information.

10. Guidelines and Requirements for Documentation

As noted above, the University maintains campus utility maps that can be used as the starting point for site survey information. In addition, Auto CAD planimetric data covering the campus can be obtained through Facilities Information Technology to supplement the campus utility maps.

Site design and development documents are generally prepared well in advance of construction Drawings for a given building, at a time when the size, shape, and volume of a building may be finalized, but the details may be in flux. The site documents are used in obtaining permission to proceed into construction from the local planning and zoning agencies, and from county bodies such as the Mercer County Soil Conservation Agency.

The local agencies have checklists for project documentation, and these play a crucial role in successfully moving a project through preliminary review. A project will not be scheduled for a site plan hearing (except in concept) until the project has been deemed complete by the board of jurisdiction; that is, until each item on the checklist has been successfully addressed and documented. As an example, a typical site development application, classified as a "major" site plan, must provide documentation on each of the following:

- A. Site plan, with existing and proposed site features
- B. Fire protection plan
- C. Variance appeals, if applicable
- D. Site survey (see this section item 16.)

- E. Drainage and utility plan
- F. Landscaping, lighting, and signage plan
- G. Soil map
- H. Building Drawings
- I. Soil erosion and sedimentation control plans
- J. Environmental information statement
- K. Traffic Impact Study

There is a sublist of required information for each of these checklist items, outlined in the respective land use ordinances for the municipality. The Designer, working with the Project Manager, Office of the University Architect, University legal counsel, and other University consultants must address each of the requirements of the checklist to move the project forward.

Requirements for specific areas of documentation are as follows:

Required Documentation	SD	DD	50% CD	85% CD
Key Map	X	X	X	X
Vicinity Map	X	X	X	X
Existing Conditions Survey	X	X	X	X
Site Utility Plan	X	X	X	X
Preliminary Site Plan	X			
Preliminary Landscape	X			
Preliminary Stormwater Peer Review	X			
Preliminary LCC Review	X			
Stormwater Peer Review		X	X	X
LCC Review		X	X	X
Overall Site Plan		X	X	X
Demolition and Removals		X	X	X
Grading		X	X	X
Site Lighting		X	X	X
Soil Erosion and Sediment Control		X	X	X
Construction Details		X	X	X
Outline Specifications		X		
Full-Length Specifications			X	X
Fire Protection Site Plan			X	X
Landscape Layout		X	X	X
Landscape Materials		X	X	X
Planting Plan		X	X	X
Coord. Planting/Utility Plan		X	X	X
Planting Schedule		X	X	X
Accessibility Plan		X	X	X
Site Details		X	X	X
Planting Soils Plan			X	X

See Appendix 1.3-2 – Programming Guide for additional information.

See Section 1.4 (Regulatory Agencies) for additional information.

11. Sustainability

One of the University's Guiding Principles for Future Expansion, as articulated by the Administration in 2003, is to "build in an environmentally responsible manner - a manner which is sensitive to geography, sensitive to energy and resource consumption and works to sustain strong community relations." These Guidelines are intended to provide direction and resources for the sustainable design and construction of new buildings and the comprehensive renewal of existing buildings for capital projects at Princeton. The requirements of this process are described in Section 1.2 Sustainable Building Guidelines.

12. Considerations for Exterior Design - Circulation

Open space priorities are a major concern of the Landscape Policy Committee and should be the starting point in site plan development. Designers should strive to enhance the experience of the open spaces while guiding people through those spaces. Careful consideration must be given, then, to laying out walks and drives, to the way such paths intersect, and to the materials of the paths themselves.

The Designer should address building service issues as an integral part of the site design in order to produce a comprehensive plan that will augment - or improve - existing services. Planning should include delivery routes, loading areas, service parking strategies and trash storage ✓PS-27 strategies. Exterior trash storage areas and dumpsters are discouraged.

Although Princeton tries to minimize vehicular traffic in the main campus area, there are undeniable requirements for access to each building such as trash and recycling pickups, mail delivery and pickup, delivery of supplies, furniture delivery, shop vehicles for normal maintenance of a building, etc. Certain academic disciplines may require frequent delivery of equipment or materials, and dining facilities, for example, have extremely heavy service requirements. There are periods of the year -- move-in and move-out days in the dormitories, Reunions and Commencement - when unusual and unusually heavy traffic patterns are the norm, and universal access to campus areas is needed. Additionally, emergency access to a building must be provided for fire department and medical vehicles. Thus it is important to address service access in the early stages of design.

On campus, circulation paths fall into several different categories, depending on use:

A. Vehicular Circulation

1. Primary: characterized by full-width travel lanes, curbing, and raised sidewalks; typical of the main drive through campus (Elm Drive) and of the streets owned by the University. Usually paved with asphalt, with granite or Belgian block curbs, and sidewalks of bluestone, concrete or asphalt.
2. Secondary: these are typically pathways that serve both vehicular and pedestrian traffic, characterized by an asphalt center section, with additional width to either side in a different or contrasting paving material, set flush with the asphalt but defining the pedestrian space. The approach drive to Prospect House (1996) is an example.

Secondary vehicular pathways often serve as emergency access routes, and must provide an eighteen-foot wide lane of stabilized base at a depth sufficient for fire truck criteria; refer to Appendix 2.9-5 (Campus Emergency Services Access Route Map) for locations, and review requirements with Project Manager.

3. Tertiary: these are primarily pedestrian paths that can be used occasionally by service vehicles. Access is controlled by removable, lockable bollards spaced six feet on center (allowing for carts to pass, but excluding normal vehicles).

B. Pedestrian and Bicycle Circulation

Introduction

Designers should note that pedestrian and bicycle traffic generally share the same walks and paths throughout campus. Walk designs for the Historic Campus and elsewhere frequently use bluestone or other modular pavers as the center path material, flanked by borders of small-module cobblestone, brick or concrete pavers. Note that rough cobblestone pavements are best used for pathway borders and corners, where they effectively reinforce path shoulders, rather than for the center portion of the pathway walking surfaces. Rough or heavily textured pavements should not be placed where they will interfere with pedestrian or accessible routes to doors and entryways. In heavily traveled areas, such walks are edged in low bluestone curbing to protect adjacent lawns. Examples can be seen in McCosh/Dickinson courtyard and around Prospect House's south garden.

For walks seven feet wide or narrower, a single paving material without borders is recommended. In such cases bluestone, brick, exposed aggregate concrete or concrete pavers are among the possible material choices.

1. Primary paths: as noted above, the main campus pedestrian arteries such as McCosh Walk and Goheen Walk, may also, under special circumstances, serve as tertiary vehicular paths and are twelve to fourteen feet in width.

The Designer should consult with the Project Manager and review the **Campus Emergency Services Access Route Map** for requirements for a particular project. If a walk must be designed to carry emergency vehicles, there *may* be some increase in traffic-bearing capacity over normal University design, and the stabilized width most certainly will be increased. A common design variation is to provide the increased width using stabilized base and structural soil, which can be then be planted with grass or mulched. **The Designer shall coordinate all primary paths with underground roofs and steam lines to ensure proper protection.**

2. Secondary paths: secondary walks may lead from the main campus walks into buildings, may occur within courtyards, or simply cross open areas. These paths are constructed of durable materials such as stone, concrete pavers, or brick laid over compacted stone or quarry blend sub-bases, with a variety of bases, such as concrete, asphalt or sand, depending on the proposed paving material and the traffic expectations. With the exception of walks leading into buildings (which may be as wide as the building entry or form an entry plaza), these secondary walks are typically five to seven feet wide. If vehicular traffic is anticipated on a secondary walk, bands of unit pavers will be installed on either side of the walk, to increase the total width to eight to ten feet.
3. Tertiary paths: tertiary walks are paths that lead to secondary entrances in buildings, or crisscross a green area. They are designed for foot traffic across open areas (or are sometimes installed after a traffic pattern has been established). The material may be permanent in nature, such as bluestone, less permanent such as concrete, asphalt or

porous pavement, or may be renewable, such as compacted stone dust, stabilized gravel systems or wood chips. Minimum width for tertiary paths is **five** feet.

4. In order to accommodate some changes in elevation, steps may have to be incorporated into the design.

The Designer needs to keep in mind that all walks, drives and paths at the University are cleared of snow using mechanical means (as far as possible) so access for the equipment is important, as is the placement and finish of the path.

An emerging challenge in site design has to do with the use of steps and plazas by roller-blade enthusiasts, skateboarders, and stunt bicyclists. This activity has abused a number of elegant site amenities - stone-capped walls, memorial benches, handrails, and the like. While a punitive policy of public space design should not result, the Designer should include skateboard deterrents where required.

Along with circulation needs, the Designer should be aware of various parking needs - for employees, visitors, and the disabled. Quite often, parking will be accommodated in one of the University lots or garages. Nevertheless, it must be demonstrated that parking requirements will be met by some means before a project will receive site plan approval. The Designer should be prepared to compose a plan, working with the Project Manager, Office of the University Architect, Transportation and Parking Services, and other University consultants, outlining parking requirements and provisions for use in the site plan review process at the municipal level.

13. Considerations for Exterior Design - Planting Concepts

The following concepts should guide the Designer in both building and landscaping projects on campus at Princeton:

Note: While following the concepts listed below the Designer must co-ordinate with the layout of proposed utilities throughout the project and make adjustments to the plantings as necessary.

- A. There is a hierarchy of open spaces which the planting (and any building) should reinforce and enhance.
 1. The size of outdoor spaces should determine the scale of the planting, i.e. large spaces should contain large trees, while small spaces should have flowers, vines and groundcovers, shrubs, and small trees.
 2. Smaller, more defined spaces should be characterized by distinctive planting (color, scale, texture).
 3. Large spaces should be defined by “structural” tree planting (e.g. perimeter planting and entrance definition).
 4. Vistas should be demarcated by tree plantings where possible.
 5. General foundation planting should be avoided. Plantings at buildings should emphasize and enhance the character of the architecture. Plantings within the landscape should define spaces.
- B. Spatial sequences through the campus should be defined and enhanced.
 1. Major entrances should be identified by planting.

2. The campus perimeter should be strengthened with planting.
 3. Major campus axes should be defined by planting, as at McCosh Walk.
- C. Plantings should provide solutions for various functional needs.
1. Provide shade for events and for outdoor use areas:
 - a) Commencement
 - b) Reunions
 - c) Outdoor gathering places
 2. Conceal unattractive use areas:
 - a) Parking and loading areas
 - b) Refuse handling and recycling areas
 - c) Service areas
- D. Layout of trees over subsurface utilities:
1. Trees shall be located with an offset distance equal to 3 x the diameter at maturity plus two feet for most subsurface utilities and an offset distance equal to 3 x the diameter at maturity plus six feet for gas, and public utilities such as water.
 2. Conditions caused by backfilling of utilities should be examined before final location of trees.
 3. During Design Development and subsequent reviews, provide a coordinated utility/planting plan for review.
- E. Maintenance Periods for Landscape Plans
1. A 60 day minimum – 1 year maintenance period for lawns and plant material shall be specified as part of the Acceptance and Maintenance section of the project specifications. Any additional requirement shall be discussed with the Tech Team during design reviews.
- F. Warranty Periods
1. A minimum 1 year warranty for lawns and plant material shall be specified. Any additional requirement shall be discussed with the Tech Team during design reviews.
- G. Irrigation / Exterior Water Source
1. The University prefers not to irrigate its landscape.

If irrigation cannot be avoided for the site, factors such as area of planting beds, lawns, type of soils, and establishment period should be carefully considered in the design of the irrigation plan. All irrigation installations should be installed with a trace wire in order to enable the location of the underground piping during utility markouts. It is the goal of the University to be able to monitor all irrigation systems and water usage from one point. The Designer should check with the **Campus Grounds Assistant Director** when specifying the controller for the irrigations system to insure that it is compatible with the Princeton University systems used on campus.
 2. Hose bibs shall be provided on the exteriors of all buildings and planted roofs for landscape , hardscape and building maintenance. **The University accepts quick connect hose bibbs when they are located in a lawn area.**

H. Tree Logistics

1. Proper tree protection guidelines are to be spelled out in the specifications, logistic plans and/or site details. At a minimum the industry standard of no disturbance within 5x the diameter is to be adhered to. (see Appendix 2.9-9)

In choosing planting material for a project, the Designer should bear in mind that diversity of material and careful spacing of plantings are important factors. Diversity provides not only the opportunity for a pleasant variety of color and shade, but also insures that if disease strikes a particular variety, the entire bed is not lost.

The Designer should take care that no invasive species are used in site landscaping. **Preference should be given for native species. Projects outside of main campus should consider deer resistant species.**

14. Considerations for Exterior Design-Reunion Sites

Princeton's Alumni reunions date back to the University's earliest years. Many courtyards on campus are designated as reunion sites, see appendix 2.9-8. Individual Alumni classes set up large tents for Reunion Weekend which is held each year around June 1st. A reunion site may be used each year by a large number of people concentrated in a relatively confined area. Special design considerations such as open areas for tents, shade, drainage, soil compaction, power and accessible access should be incorporated when a project site is proposed to be used as a future reunion site.

15. Considerations for Exterior Design – Lighting

Lighting should be carefully considered in the design of the site. Thought needs to be given to lighting for foot travel and safety around the site, but glare needs to be controlled and over-lighting is to be avoided. A consistent, if low, level of lighting will provide a sense that the site is well lighted and safe.

The local municipalities have requirements for the type of exterior lighting to be used, although waivers can be sought from those requirements; the Designer should discuss the exterior lighting with the Project Manager **and the Office of the University Architect**. The use of LED lamps **is campus standard**. **The recommended color temperature for exterior lighting is 2700K – 3000K**. Fixtures using high-pressure sodium lamps and metal halide are being phased out.

The University recommends using the campus standard “gaslight” light poles and fixtures seen throughout campus (see Appendix 3.5-2). Review requirements for burial of power lines for lighting with Facilities Civil Engineering and Construction.

Photometric Diagrams of any proposed site and exterior building lighting must be presented as part of a site plan application. The New Jersey Uniform Construction Code requires that exitways be lighted (with emergency power backup) to the exterior of the building and at the exterior of the exitway; these lights should be accounted for in site plan applications.

The Designer should review site lighting proposals with the Project Manager and the LCC. Discuss the desirability of providing exterior building lighting and lighting of any site features such as steps, ramps, or stairways. At a minimum parking lots and garages shall have bi-level dimming controls activated on motion. Coordinate any additional dimming and or motion control of exterior lights with the Office of the University Architect and Facilities Engineering.

The Designer is also encouraged to study the Princeton University outdoor lighting Master Plan, which provides recommended design guidelines. (Appendix 2.9-15)

16. General Survey Requirements

For all projects which require existing conditions survey, the Designer shall obtain the required survey early in the project, and prior to design of utilities. The existing conditions survey must be completed at Schematic Design. See this section, items 6 and 10.

In addition to the required survey content, each survey will have specific characteristics. The following general list covers specific features which should be added if they are consistent with the original survey purpose.

- Boundaries

- Boundary and other roads

- Interior features

- Trees and Foliage (including caliper and species)

- Utilities

- Topography

See Appendix 2.9-10, General Survey Requirements for more information.

If a project requires a tree survey, the survey should be reviewed by the Assistant Director Campus Grounds for identification of invasive species.

All survey drawings are required to meet CAD Standards and digital submissions requirements. See section 1.5 Documentation and Archiving.

Requirements for geodetic control monuments are as follows.

Installation of permanent monuments should be considered in the design of the site. At a minimum, permanent monument should be installed on the north, east, south, and west sides of the site. See appendix 2.9-11 for monument detail.

The permanent monuments should be surveyed by a Licensed Professional Surveyor in the State of New Jersey. Upon completion of the project, the monuments should be included in the as-built drawings.

Preservation of Geodetic control points

All geodetic control monuments, (horizontal and vertical) such as discs and official benchmarks within the project site must be carefully protected and must not be disturbed by any construction activity.

Where such markers are located within new construction and are in imminent danger of destruction, the contractor shall retain a licensed land surveyor to ensure the markers' relocation prior to disturbing the original markers, in accordance with the manual for mark preservation being prepared by Geodetic Mark Preservation Guidebook.

17. Requirements for As-Built Drawings and Close-Out Documentation

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the contractors.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designed will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

On the as-builts, the contractor is to highlight changes made to submittals and approved documents.

The as-builts are to include, as a minimum, the following site features:

- Signs
- Fencing
- Bollards
- Sculptures
- Fixed seating
- Planters
- Bike racks
- Lighting locations
- Conduit runs
- Controls and circuiting
- Monuments
- Irrigation
- Storm water

In addition to as-built drawings the design team is to update the final storm water report to capture any changes to the design and implementation that occurred during construction.

See Section 1.5 (Documentation and Archiving)

END OF DOCUMENT

1. Introduction

Laboratories are critical to Princeton University's mission in the 21st Century. The laboratory Designer must be aware of the needs of the users, the ways the laboratory will and might be used, and the technical needs of the department involved and the technical requirements of the space itself. Critical to the success of the project will be the early involvement of the University Facilities Engineering and Ground & Building Maintenance Departments.

Establishing parameters for energy consumption and sizing of utility services and distribution is of paramount importance to the University. These parameters must be established early in the project, (Pre Schematic phase), applying established benchmarks, projected usage with demand & diversity factors. The Project Manager will meet with the academic department/end user, the Design Team and Facilities Engineering to establish these parameters which will be included in the Basis of Design.

The Designer should keep in mind that laboratory design is a highly specialized field. Adequate research, programmatic development and due diligence are essential to their successful design and construction. Codes and guidelines referred to in this (or any other) section of the Standards Manual are not to be assumed as comprehensive. It is incumbent upon the Designer to properly investigate the specific requirements of the lab to ensure compliance with all local, state, and national codes and regulations.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance Department, or as applicable).
- B. Program Manager - Sciences MacMillan, 609-258-9483
- C. Manager, Mechanical Engineering MacMillan, 609-258-3934
- D. **Executive Director of Engineering and Campus Energy** MacMillan, 609-258-5472
- E. Project Engineer for Standards 200 Elm Drive, 609-258-8589

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

PDF

- A. Princeton University - Laboratory Functional and Technical Criteria Checklist Appendix 2.10-1
- B. EH&S App D: Health & Safety Design Considerations for Laboratories <http://web.princeton.edu/sites/ehs/labsafetymanual/appd.htm>
- C. Labs21 www.labs21century.gov
- D. Pipe Sleeve and Fire Stopping Requirements Appendix 4.11-2

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)

- B. [NJ Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. ANSI – Z9.5 Laboratory Ventilation
- E. ASHRAE 90.1 Energy Standard

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, Environmental Health & Safety Representative, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. The review comments or recent revisions will be discussed and documented.

The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

Early in the programming phase of the project, the Project Manager will review the proposed project with the University Facilities Engineering department. The Project Manager, with the Designer, should meet with the Vice Provost of Space Planning to confirm the requirements for laboratory space in preliminary programming. If animals are involved in the usage of the laboratory, the Project Manager and Designer, should meet with the University Lab Animal Resources Group to determine any special requirements.

The Project Manager remains the Designer’s primary contact and source of information. The Project Manager will involve other University sources in the project, including the Program Manager for Sciences in the Office of Design and Construction, the project representatives for the Facilities Engineering and Campus Energy, Grounds & Building Maintenance, OUA, DPS, EHS, OIT personnel and LAR.

Meetings with the academic department/end user for the project will be arranged by the Project

Manager. Separate meetings shall be scheduled by the Project Manager with the University Code Analyst and DPS with the Designer during Schematic Design.

7. Guidelines and Requirements for Documentation

See Section 1.4 (Regulatory Agencies) for requirements for code review and permits, including the organization of construction Drawings and documents for timely release of permits.

At a minimum, the following are to be provided at the indicated phase:

Along with the Design Drawings, the Designer is to produce sufficient documentation to allow for code review of the project and for contract bidding of the work. See Section 1.4 (Regulatory Agencies) for requirements for code review and permits.

In addition to the documentation required for the permitting and construction of the project, the Designer will (if specified in the contract for services) provide a Statement of Design Criteria during the schematic design phase and a written Basis of Design (B.O.D.) document during design development.

These documents are intended to establish the **specific** design criteria against which the technical and design specifications for the final project will be measured.

8. Guidelines for Laboratory Design

A. General Approach

Meeting the educational and research goals of the academic department and those for the project should be the guiding principle for the Designer. Laboratory design should be reviewed with the Project Manager and the academic department/client to determine programmatic needs and parameters.

There are different requirements for Laboratories, teaching and research, depending on the educational approach to be used in the laboratory. Detail is extremely important to the success of laboratory space; it is incumbent upon the Designer to ascertain the needs of the various laboratory types in a project, to thoroughly understand the requirements for the systems to be incorporated into the laboratories, and to detail the space around those needs and requirements. Based on these meetings a “Statement of Criteria” will be developed.

Establishing parameters for energy consumption and sizing of utility services and distribution is of paramount importance to the University. These parameters must be established early in the project, pre schematic, applying established benchmarks, projected usage with demand & diversity factors. The Project Manager will meet with the academic department/end user, the Design Team and Facilities Engineering and **Campus Energy** to establish these parameters which will be included in the Basis of Design.

B. Space Requirements

Layout – General Requirements

- Laboratory space should be separate from offices and common space.
- Laboratories should be oriented such that a common service corridor can serve two laboratories (lab, service corridor, lab)

- Occupants should not have to go through a laboratory space to exit from non-laboratory areas.
- Fire-rated hallway doors should have magnetic hold-open devices
- Each door from a hallway into a lab should have a view panel and be at least 36” high
- Mechanical and Electrical devices shall be readily accessible

Laboratories should be oriented to take advantage of natural lighting (with consideration for controlling sunlight and glare). Operable windows are acceptable in office areas, but not laboratory space. This desire must be balanced against the Energy Modeling goals established for Sustainability, therefore operable windows must be in conformance with the intent of the project and space, and must be accounted for in the HVAC design.

C. Finishes

Acoustic considerations should be the primary concern in finishes for laboratories. Acoustic control between laboratories is also important, so that sound transmission classification (STC) ratings of structural components and finishes should be taken into account when selecting materials and systems.

1. Walls and Doors

There is no ‘standard’ wall material or finish, but the Designer must remember that the facility needs to be finished in a way that allows for normal cleaning, upkeep, and maintenance. In any “wet” laboratory the preference is for mold resistant gypsum wall board. See Section 4.9 (Painting) for additional information.

The Designer should attempt to incorporate breaks, reveals, or other architectural details to divide large expanses of painted surface, particularly in the vertical direction. This is especially true in high traffic areas, areas using high pigment paints, or locations that are especially subject to abuse.

Doors into laboratories should be provided with vision panels to allow students to see if room is in use.

2. Floors

Wet chemical laboratories should have chemically resistant coved flooring consistent with the use of the room.

Finished flooring shall be installed throughout the laboratory to accommodate flexible laboratory conditions and room modifications.

Preferably, floors shall be level with no floor drains to accommodate flexible laboratory conditions and room modifications. With the exception of safety showers, at these locations the floor will be locally pitched to the drain.

Floors in predominantly wet areas shall be non-slip and floor drains are preferred. All floor penetrations shall be sealed – see appendix 4.11-2.

3. Ceilings

Concern for proper acoustics should prevail in selection of ceiling materials. If acoustic ceilings are to be used, the preference is for a removable tile system framed on

a unistrut support system. Concealed-spline ceilings should not be specified, unless there is a special condition that must be accounted for; review with the Project Manager and the Director of Maintenance before including concealed-spline ceilings in a project. Generally, concealed spline ceilings are appropriate only in locations without ceiling access requirements.

4. Window treatment

Review need for sunlight filtering in laboratories. Standard room darkening shades are produced by Mecho Shade, and may be manual or motorized.

Room Darkening vs. Solar Controls - Solar controls to support the HVAC needs must be considered for both the exterior and interior of the laboratory space.

D. Furniture and Fixtures

Work surfaces should be chemical resistant, smooth, and readily cleanable. Work surfaces, including computer areas, should incorporate ergonomic features, such as adjustability, task and daylighting conditions, and equipment layout.

Benchwork areas should have knee space to allow room for chairs near fixed instruments, equipment or for procedures requiring prolonged operation.

Handwashing sinks for particularly hazardous chemicals or biological agents may need elbow or electronic controls.

Casework in Teaching Laboratories shall conform with ADA requirements. Casework in non-teaching (research) laboratories shall be adapted to the requirements of the individual users.

Limit the number of cup sinks in the laboratory (including in fume hoods) in order to avoid dry traps and the ensuing odors.

Ensure autoclaves have adequate space for use, maintenance and materials storage.

E. Lighting

1. General

Daylighting shall be maximized where possible for user comfort. Lighting should be even across the room, with a maintained light level for work surfaces in accordance with IES standards. Non - laboratory space shall also follow IES standards. A combination of lighting zones, dimmable fixtures, and controlled daylight in the room is ideal. Fixtures should control glare and should not produce veiled reflection in the room or on equipment. Indirect/direct fixtures are favored.

If a room is multi-functional, the Designer shall take into account in the lighting design the various tasks that are to occur in the different sectors of the room.

If a space has a ceiling above 12' in height, the project team shall review all access requirements for light fixture maintenance and incorporate any fixed requirements such as access panels, cat walks, etc. into the documents.

2. Special Features

Much of the public space lighting on the University campus is controlled by occupancy sensors. Typically, at least one light in a space will not be controlled by the sensor but will be on an emergency circuit (review this requirement in rooms that are to be totally blacked out for projection). The occupancy sensor is to be wired so that it can be bypassed with a conventional light switch. If occupancy sensors are to be included in a project, the operation should be carefully coordinated with the room use. Occupancy sensors should include additional contacts for integration with HVAC systems.

Review the need for daylight control. **Lab Animal Resources (LAR) requires holding rooms for rodents and HPS have lighting and possibly HVAC control via remote control (i.e. IPAD, etc...)**

See Appendix 3.5-6 for Networked Lighting Control Requirements. The design team is to coordinate system capacity and connectivity with the users as early as possible in design.

3. Lighting Types

For instructional spaces (as with interior lighting in general) energy efficient lighting is standard for Princeton. Indirect/direct lighting is preferred for its even quality. For any needed downlighting or highlighting, LED energy efficient fixtures are **campus standard**. No halogen lighting may be specified. Where possible at bench locations, under cabinet/shelf task lighting is preferable.

To minimize the need for storing a large variety of replacement lamps, Designers should (if fluorescent lamps are used) attempt to use two- and four-foot tubes as a standard, and PL tubes with a common base configuration throughout a project.

40 fc minimum ambient light levels to be provided in labs. Supplemental under-cabinet and standalone task lighting is to be supplied as necessary to support proposed space program. **Take into account the location of overhead lighting and position of user in the room.** Light levels on bench/work surface to meet the 40 ft candle requirement without shadows being cast by occupant at bench.

Occupancy or vacancy sensors shall NOT have an ultrasonic function. Discuss with Facilities Engineering **and Campus Energy** whether the sensor should be configured as occupancy or vacancy sensors.

F. Storage

1. Cabinets for chemical storage should be of solid, sturdy construction and vented as required. Hardwood or metal shelving is preferred.
2. Consider centralized space for any chemical and biological or radioactive waste storage.
3. Flammable liquid storage is not typically allowed below grade or near a means of egress; refer to applicable codes. The NJ Fire Code imposes limits on the quantity of chemicals stored in a building. There are individual limits for each of various types of chemicals, including flammable liquids, gases, acids, oxidizer, poisons, etc. The

storage limit quantities are also based on location, such that storage is more limited below grade and above the ground level.

4. The requirements for the use and venting of flammable liquid storage cabinets shall be in accordance with current code requirements.
5. Laboratories using compressed gases should have areas designated for cylinder storage and be equipped with devices to secure cylinders in place. Appropriate signage at remote cylinder storage should note via text and/or plan areas being served. In addition, gas turrets should indicate source location of remote cylinder storage.
6. Provide space for chemical waste collection containers other than in fume hoods and sinks.
7. Provide space for storage of supplies and combustible materials, e.g., boxes of gloves, spill kits, boxes of centrifuge tubes, etc.

G. HVAC / Plumbing

1. Ventilation rates are typically 6-10 air changes per hour minimum for occupied spaces and 4 air changes per hour minimum when unoccupied, but may vary based on room use/ program. Ventilation rates shall be reviewed with EH&S, Facilities Engineering and Campus Energy and LAR (if applicable). Where feasible, high performance hoods are preferable to standard hoods, except in student teaching environments.
2. A VAV system is preferred for laboratories
3. Unless otherwise specified (e.g., clean rooms), air pressure in the laboratory should be negative with respect to the outer hallways and non-laboratory areas.
4. If a space has a ceiling above 12' in height, the project team shall review all access requirements for HVAC equipment maintenance and incorporate any fixed requirements such as access panels, cat walks, etc. into the documents.
5. Any RODI should be Orion type White line – Socket Fusion in wall and mechanical fittings where exposed. If required, one meg-ohm water to be supplied throughout building. Add polishers as needed at point of use for increased resistivity. If proportionate building occupants have substantial RODI requirements based on overall user demands, consider central piped system.
6. Acid waste pipe for DWV shall be Orion (Blue) pipe or Charlotte ChemDrain. Heat welded when concealed in walls, heat welded or mechanical fitting where exposed in labs.
7. Duct and piping risers to be in separate accessible shafts. Plumbing riser shafts to have a structural floor infill at each level.
8. All concealed exhaust duct risers to be welded stainless steel.
9. Show air and water balancing devices on drawings.
10. In limited applications Pro-press fittings can be used (ie: certain process water applications in labs). The use of pro-press fittings MUST be discussed and approved by GBM during design.

H. Fume Hoods

1. Restricted bypass style fume hoods should only be used in laboratories with constant volume exhaust systems.

Newer fume hood designs generally allow for lower face velocities. These face velocities must be reviewed by EHS, Facilities Engineering and Campus Energy and the end user for approval and verification. Hoods shall have an Auto-Sash closing device and a face velocity of 60 – 100 linear feet per minute with the auto-sash fully open or at its standard configuration (e.g., at the stopper height). Occupancy sensor setback should be considered in non auto-sash closing hoods.

2. The location of fume hoods, supply air vents, operable windows, laboratory furniture and pedestrian traffic should encourage horizontal, laminar flow of air into the face of the hood, perpendicular to the hood opening. Hoods should be placed away from doors and not where they would face each other across a narrow aisle. Air velocity caused by supply vents should not exceed 25 feet per minute at the face of the hood. Locate supply diffusers far enough away from hood to avoid draft disturbances at face.
3. Each hood must have a magnahelic gauge as a continuous monitoring device. The device should display static pressure. Audible alarms should be considered in certain circumstances. Review alarm requirements with EHS and Facilities Engineering and Campus Energy.
4. Noise from the fume hood should not exceed 65 dBA at the face of the hood.
5. Fume hood exhaust ducts should be metal and not contain fire or smoke dampers.
6. Hoods for perchloric acid require stainless steel construction, a wash-down system and a dedicated isolated exhaust fan.
7. Hoods requiring filters (such as those for some radioisotopes or biological materials) should be designed and located such that filters may be accessed and changed easily. For particularly hazardous filtration (such as those for some radioisotopes or biological materials), a bag in/ bag out system is strongly advised.
8. Single vertical sliding sashes are preferred over horizontal or split sashes.
9. Debris screens should be accessible and placed in the hood exhaust plenum.
10. Fume hoods should have recessed work surfaces to control spills
11. Receptacles shall be GFCI, standard.
12. Provide atmospheric vacuum breakers for cup sinks as require by code. Ensure they are accessible for maintenance.
13. Consider alternative to fume hoods based on the intended operations. Ventilated enclosures, glove boxes, nanotechnology benches, downdraft tables, slot hoods and fume extractors may be effective and more energy-efficient.

14. Provide emergency ventilation purge buttons at the laboratory exits for use in the event of a spill or release. The style of the button should minimize potential for accidental activation and allow for cancelling the purge without the need for a key. Review potential with EHS and Facilities Engineering and Campus Energy.

I. Eyewash & Safety Showers

All Eyewash & Safety Shower locations must be reviewed and approved by the University EH&S group.

1. Laboratories using hazardous materials must have an eyewash and safety shower within 100 feet or 10 seconds travel time from the chemical use areas.
2. Eyewashes and safety showers are to have plumbed drains, unless approved otherwise by Program Manager. Floors shall be sloped to drains.
3. Eyewashes and safety showers should be standardized within a laboratory building.
4. Flooring under safety showers should be slip-resistant.
5. Discuss requirement for privacy curtains at safety showers.
6. Safety Showers shall be piped with tempered water; use Lawler 911 mixing valves or equivalent.
7. Water service to emergency shower / eyewash should be discussed with code official in early stages of project in order to confirm the use of non lab (potable) water.

J. Safety

1. Utility shut-off controls should be located outside the laboratory.
2. Environmental chambers where evacuation or other alarms cannot be heard should be equipped with strobe lighting or additional alarms.
3. The requirements for monitoring and control of Laboratories using highly toxic gases shall be reviewed with EH&S.
4. Include illuminated "Laser in Use" signs at all entrances to labs with lasers.

K. Power

1. Laboratories should have a sufficient number of electrical receptacles to eliminate the need for extension cords and multi-plug adapters.
2. Each laboratory shall have a dedicated panelboard located in an unobstructed accessible area.
3. Laser laboratories should have power interlocks for the laser to be tied into the "Laser On" light (installed at the entrance to the laboratory).
4. Laboratories with lasers and/or high voltage equipment should have an emergency power-off switch installed near the laboratory exit and not over the laser table.
5. Adjacent offices and Graduate Student offices shall have minimum one quad receptacle per occupant.

6. Typically the University does not supply standby or emergency power for academic research. The need for special circumstances should be reviewed early in the design process with Facilities Engineering and Campus Energy.

L. Security

Review the need for security control of laboratories with the Project Manager. The University employs access control, as part of a campus-wide system, at the entrances of many of its buildings, and to some interior spaces as well. Refer to Section 2.7 Security for further assistance. At a minimum all lab entry door shall have a stand-alone keyless locks (SALTO)

Laboratories classified by Environmental Health and Safety as Security Protection Level 2 (high value equipment or security-sensitive materials) or higher may require additional security measures, such as card access, intrusion alarms, cameras, etc.

M. Clean Rooms

The use of a Design – Build vendor for clean rooms is preferred. This sub consultant to the primary designer approach is a function of the clean room requirements. **The Designer shall coordinate all furnishings and equipment with the Design - Build vendor.**

N. Animal Care and Use Facilities

Animal care and use areas must meet Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) International guidelines. This includes guidance on materials of construction, ventilation design, security and more.

Any renovation or new construction to house or study animals used in research need to be planned with the research and the animals in mind. Principal Investigators (PI's), the Attending Veterinarian, the Director of Laboratory Animal Resources (LAR) and his staff need to be involved from the earliest concepts to the detailed planning. Since regulatory oversight of all research activities, including housing of animals, has to be approved by the Institutional Animal Care and Use Committee (IACUC), that committee should also be consulted from design until commissioning. Depending on the species, multiple regulations and/or guidelines may apply. While AAALAC has an excellent **Handbook of Facilities Planning**, many other guidelines exist for classical laboratory animals, birds, fish, farm animals, exotic animals, wildlife and others. Additional concerns when building animal care space is occupational health and safety of animal care staff and research personnel, as well as different levels of bio-containment or bio-exclusion of the species and type of research being conducted. Special consideration needs to be given to space for storage and logistics and separation of clean and dirty traffic flows and impact on the surrounding activities.

O. Radioactive Materials Laboratories

For laboratories using radioactive material

1. Eating and drinking areas must be physically separated and conveniently located.
2. Allow for separate storage of radioactive materials.

Consider designing the laboratory to allow separation of radioactive materials use from other laboratory spaces

P. Equipment UL Labeling

All hardwired equipment is required to be UL labeled or equivalent. Coordinate any non-UL labeled equipment with the Project Manager, Facilities Engineering and Campus Energy and the University Code Analyst. *Testing and Labeling may be required.*

Q. Off Hour Alarm Management (Remote Notification)

Alarms that require off hour response need to be set up to notify appropriate Princeton personnel via email and phone call. A meeting with the appropriate users shall determine which alarms require off hour response and where the appropriate notifications will be sent.

9. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of As-built Drawings prepared by the construction contractor and any systems installer.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record drawings to convert to as-builts.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

1. Introduction

Princeton University has several large apartment complexes housing graduate students. The student population is approximately two thousand two hundred and students typically reside in these units twelve months a year. These units vary from high-rise construction to wood frame housing. *(Note that italics will be used to indicate statements that apply only to apartment renewal design work.)*

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. University Code Analyst MacMillan Building, 609-258-6706
- C. Director for Housing New South Building, 609-258-1908
- D. Associate Director for Student Housing New South Building, 609-258-2691

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

	<u>PDF</u>
A. Interim Fire Code Reports	<i>Consult Project Manager</i>
B. Existing Conditions Reports	<i>Consult Project Manager</i>
C. Master Fire Alarm Technical Specification	Appendix 3.4-1
D. Memo: Standard Dormitory Paint Colors	Appendix 2.4-3
E. Fire Alarm / Signage Nomenclature Spreadsheet Sample, Princeton University	Appendix 2.8-2

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. NFPA 101 - Life Safety Handbook

5. Review Guidelines - General

For apartment renewal projects, planning begins at least two years in advance of construction. Planning for new construction may take a similar course. As the project moves toward the construction documentation and code review phases, it becomes important that the project be reviewed with Housing and Real Estate Services, Facilities Engineering, Grounds and Building Maintenance, the Office of Design and Construction, Office of the University Architect, the Department of Public Safety and to any department affected by the work.

For new construction each Housing project has a specific review committee. The committee is made up of representatives from the Office of the University Architect, Office of Design and Construction, the Facilities Engineering Department, Grounds and Building Maintenance, Housing and Real Estate Services, and the office of the Vice President for Facilities. Additionally, committee members come from the Office of the Dean of the Graduate School and Real Estate Development. Finally there is student representation from the Graduate Housing Advisory Board.

After preliminary design is complete, additional departments may be brought into the design development and construction planning phases. Departments such as Public Safety may be included in the review process.

During this pre-construction phase mockups are recommended (and may include complete full-scale models of rooms) to aid the review committee in selecting room finishes and accessories, window types, light fixtures, heating units, piping enclosures, etc. Every visible finish and system component is designed, constructed, tested, and reviewed. Mockups are also used to test the effectiveness of cleaning methods on building stone and other finishes to remain in place. A significant amount of effort is necessarily put into the design and documentation of mockups, for they are the tools that lead to final design decisions and to the aesthetic that ultimately forms the project.

During the process of design, plans are to be submitted for review by Facilities departments at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, Housing, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Considerations for Apartment Design

A. General Approach

1. In new construction and in renewal of Princeton's apartments the mix of social spaces with living spaces, the density of apartments and the type and number of support/utility spaces in an apartment complex, along with other design considerations, is highly dependent upon the purpose the community and who the apartment serves.

Graduate apartment complexes are generally high density and the premium space may not be able to be given over to social and educational programs within the building; and service-type spaces may be shared among a group of buildings.

All graduate apartment complexes will typically contain a full complement of service and support spaces such as in-unit laundry area, kitchenette (with sink, outlets, and refrigerator), public restroom, computer cluster, and a community room.

- 2. The initial step in an apartment renewal project is to determine a preliminary scope of work and to conduct a full-scale survey of the building. This survey should be performed after discussions with the Project Manager, the Housing and Real Estate Services, and the University's Grounds and Building Maintenance Department, to assemble available information on systems in the building, and to gain insight on any known defects in a building. In interviews prior to surveying a building, the Designer can be advised of any environmental issues that might affect the project; see section 10 below for additional information on this subject. A report on existing conditions is produced from the survey, including information on the building finishes, envelope, and systems. The report will be presented to the review committee, which may make suggestions for revisions or modifications before a final version of the report is produced.*

The report is used as a tool to develop the building program and to guide the professional in the schematic design process. Input from the design review committee is critical at this point in the process. The committee will prescribe the desired mix of bedroom counts, the bathroom fixture ratio, etc. Additional survey work may be needed to measure critical areas after initial planning and design is completed. Some core samples of building systems may be required to ascertain existing construction, and investigative demolition might be carried out in this effort.

- 3. After schematic plans are approved by the review committee, the Designer is to provide a furniture layout plan, which will be used to develop the design of electrical and mechanical systems in the apartments. This step is important in developing plans for new construction as well as in apartment renewal.*

As electrical and mechanical systems are developed for the building (with the chases, duct shafts, etc. that these systems require), the Designer will need to coordinate the mechanical systems with the furniture layout. The intent is to produce a plan that integrates building systems into the overall layout, without sacrificing utility and comfort to aesthetics, or vice versa. The review committee will be presented with the final building layout and furniture plan for approval before the project is carried into the Construction Documentation Phase.

- 4. Apartment Numbering Requirements*

It is the intent of all projects to have apartment numbers assigned during the Design Development Phase. It is the responsibility of the Designer to initiate and complete this process, and the Project Manager's responsibility to gather required approvals. All Drawings shall reference the University's approved numbering system and the United States Post Office requirements for street addresses.

See Appendix 2.8-2 for a sample spreadsheet for coordinating this process and Appendix 1.5-3 for room/space numbering system guidelines.

B. Exterior

1. Apartment Accessibility

One of the goals of the apartment renewal projects is to create accessible routes to as many apartment spaces as is reasonably possible.

The project review committee will advise the Designer on the level of accessibility desired in the project, based on options presented by the Designer and influenced by campus-wide accessibility needs. See Section 2.1 for a description of this process.

Placement of special devices such as audible-base detectors and strobe alarms are to be carefully planned in accessible/adaptable units. For more technical information see Section 3.4 (Fire Alarms).

2. Safety/Security

Consideration is to be given to vehicular and foot traffic routes into and along buildings, so that cul-de-sacs and dead-ends are eliminated. (The same considerations should apply to interior circulation.)

Exterior lighting should be sufficient to provide safety and security to passers-by and to building occupants.

3. Site Accessories

Intercoms with magnetic/electric releases are preferred to be installed at apartment entries. See Section 3.1 (Access Control Standards). The Designer is to consult with the Project Manager to assess the need for exterior emergency broadcast towers.

Consideration should be given to site furnishings, particularly bike racks, children's play areas, passive recreation, shuttle stops, storage, smoking areas, picnic areas, etc.

4. Finishes

Exterior finishes are of paramount importance in the perception of the quality of buildings at Princeton University. The exterior envelope of the building should be studied carefully during the building survey, and the existing conditions report should concisely describe the findings of the survey.

Envelope components that must be considered in the study include walls, copings, parapets, chimneys, and decorative and trim masonry; flashings, gutters, leaders, leader boxes and roof; windows, louvers and vents, doors, door accessories, entry steps, handrails and paving.

5. Site Utilities

When a building is a candidate for renewal, the Facilities Engineering & Campus Energy Department may decide to take the opportunity to replace services into the building or site utilities near the building. New buildings also require extensive investigation for utility work. The Designer will be asked to enumerate and evaluate the utility loads for heating, cooling, electrical, and similar systems in new and

renewal work, as well as the effects on water supply, sanitary, and storm lines on and around the site. The Designer will need to coordinate the efforts required for documentation, review and construction of this work, and may be requested by the Facilities Operations and Engineering & Campus Energy Departments to provide design services for the utility work. See Section 3.6 (Utilities Guidelines).

C. Interior Circulation

Interior circulation must provide reasonable access to all areas of the apartment.

1. Entries

Entries must be carefully and skillfully treated to enhance the Designer's intent. The Designer should integrate a number of standard elements into the design for each entry. These include:

- a) Card access on building entry doors (see Section 3.1 Access Control Standards). Door entry hardware is modified to incorporate electric release mechanism, or interlocked electric strike to accommodate door intercom and release system.
- b) Scrub mats or walk-off mats at the entrance, in a durable, cleanable, easily maintained material; the design should feature mats which can be easily replaced and slip resistant. See Appendix 2.4-5
- c) Message boards, such as tackboards (meeting code requirements for finishes); a variation on the standard types may be developed, either metal-framed or trimmed in wood.
- d) Specify durable, cleanable wall and floor finishes.
- e) Mailboxes, type and location shall be coordinated with Housing.

2. Public Stairs

- a) There is no "standard" stair material. The Designer may choose a durable and inherently safe material from wood to stone, to reflect the building aesthetic.
- b) Doors and frames should be of a durable construction to withstand the wear and tear of daily use by students and custodial staff. Smoke detector-activated hold-open devices are often used on stair/corridor doors to reduce wear and tear, and to create a more open appearance.

Refer to Section 4.4 (Door Hardware) for additional door hardware information.

- c) Guards, balusters, and handrails should be designed consistent with safety codes to enhance the finished appearance of the stairway.
- d) Specify durable and easily maintainable wall and floor finishes.
- e) Meet minimum lighting requirements, including exit and emergency lighting; use lighting to enhance design.
- f) *In an apartment renewal project, a Designer should assume that, if standpipes existed in the building prior to the renewal project, standpipes will be required as part of the renewal work.*

If retaining a standpipe in the building presents a major problem (due to space constraints, e.g.) the University may appeal to the State to remove the standpipe. The decision to file an appeal requires the approval of the AVP for Facilities, Design and Construction and the AVP for Facilities, Operations.

Those buildings that do not have a pre-existing standpipe can be evaluated on a case-by-case basis. The AVP of the Office of Design and Construction will make the final decision on the inclusion of standpipes in such a case.

All apartment standpipes will be dry systems charged using a post-indicator valve located near the fire department connection outside the building.

- g) Fire Extinguishers – The design of the fire extinguisher in hallways/corridors shall be incorporated with the overall stair design and enclosed in a fire-rated cabinet as required. Interior common corridors that serve apartments should be equipped with ABC extinguishers. See Appendix 3.8-2

3. Public hallways/corridors

- a) Specify durable wall and floor finishes; research requirements for fire ratings in corridors, provide listed assemblies where needed. At a minimum, use reinforced gypsum board for walls, with skim-coat finish. (Gypsum board walls with taped seams are the preferred wall finish in apartment halls.)

The project design review committee will advise the Designer on the use of hard-surface finishes in corridors.

There should be some form of base in corridors for housekeeping purposes, compatible with floor finish; tile, stone, wood, rubber; review with Project Manager.

Princeton University employs a range of standard colors for use in apartments; consult with the Project Manager.

Fire Extinguisher – The design of the fire extinguisher in stairs shall be incorporated with the overall stair design and enclosed in a fire-rated cabinet as required. See Appendix 3.8-2.

- b) Princeton University employs a standard apartment-to-corridor cylindrical lockset, a storeroom function lever-handle lockset, as well as standard hinges, closers, etc. See Section 4.4 (Door Hardware). For corridor doors leading to public or social spaces, consider using smoke detector-activated hold opens.
- c) Ceilings: consider routing of utilities early in design; if corridor ceilings are to be used for utilities, ceilings must be accessible. Minimizing MEP systems above ceilings is desirable. Appearance is important, and utility runs must be thoroughly planned and documented to minimize the need for multiple access doors in hard-finished ceilings. See Section 4.2 (Corridors).
- d) Lighting: must meet Code mandated minimum levels, and must meet University standard levels. Hallways should have lights that are lit 24/7/365, and may be lighted with ceiling lights, wall sconces, or a combination of both. **Light levels**

may reduce to a code minimum for egress with a controls system. Apartments, also, may be lighted with ceiling lights, wall sconces, or a combination of both. The type of lighting may be dependent on the style of the building. The Designer is responsible for insuring that all components of lighting - lenses, lamps, ballasts, wiring connections, etc. - are readily accessible and non-custom, for maintenance of fixtures. See Section 3.5 (Lighting Design). Code minimums for emergency egress lighting levels must be met for the entire egress pathway.

Any surface mounted exit sign mounted on edge below 9'-0" requires redundant support along a second edge or side, preferably located at a wall/ceiling intersection.

- e) Sprinklers: sprinkler heads are to be concealed in corridors if possible; if sidewall sprinklers are to be used; ONLY concealed type are to be used.
- f) Security and safety concerns - dead-ends and remote areas.
- g) Air handlers and other mechanical equipment placed in eave spaces off corridors require sound insulation, vibrant isolation and low db rating.
- h) Trash Collection – The Designer shall evaluate locations for dumpsters on site. Provisions for recyclable materials containers should be reviewed on each project. Currently residents bring their trash and recyclables to exterior bins.
- i) Electrical Outlets – Maximum 25' on center dedicated 20 amp. circuit per corridor or stair.

D. Social spaces/"public" common rooms

The mix of social spaces in an apartment building or complex should be determined in the preliminary design phase in consultation with the review committee.

If a social space is proposed above or near an apartment, specific approval for the location is required from the review committee.

Some comments on typically provided amenities follow.

1. Lounges / Computer Clusters / Multipurpose

- a) The size, shape, and number of lounges, computer clusters and laundry rooms should be discussed with the committee in the conceptual phase.
- b) Provision should also be made for wireless data communications.
- c) Vending area is to be located in a main "public" common area and provided with an OIT wiring bundle.

Designer is to consider heat produced by vending machines in calculating the HVAC requirements for lounge areas.

- d) Social spaces are considered special areas, and the normal constraints on paint colors do not necessarily apply to these spaces. These spaces should be child friendly. Consider the storage needs of these spaces, storage for complex provided items are commonly needed. Consult with the Project Manager.
- e) All apartments and common areas should have wireless technology as well as be

outfitted for hard wired telephone, cable and Dormnet.

2. Laundries

Laundry facilities are to be included in each apartment complex, **although there is a strong desire from Housing for in-unit laundries**. Access to the laundry room is to be through the interior of the building. Particular attention must be paid to the “nuisance factor” of a laundry room - the effect of noise and heat on nearby rooms. See Section 4.7 (Laundry Rooms). Classroom function locksets are required at Laundry room doors.

Laundry rooms are to have durable floor finishes and need to include a floor drain.

Typically, laundry rooms will contain the following:

- a) Commercial grade washers that are energy efficient, coin operated.
- b) Stacking electric dryers, coin or card operated, with individual vents located at the discharge point. Plan to install one dryer for each washer in the laundry room. Consult Building Services and the Housing and Real Estate Services for clearance requirements for maintenance of units; see Section 4.7 (Laundry Rooms) and Appendix 4.7-3.
- c) Motion sensor-activated light fixtures for general lighting (with an unswitched light in each area).
- d) A fixed table or counter with hanging rod, for folding with bins
- e) Large-volume trash receptacles
- f) An adjacent waiting/study area is desirable; visual connection with adjacent space or corridor is desirable.
- g) Room ventilation system is necessary
- h) For design purposes plan 1 washer for every 25 occupants and 1 dryer (stacked) for every one washer.
- i) Plan one utility sink per laundry room

E. Living Units

1. Living/study/common rooms

a) Space Requirements

This should be closely reviewed by the Office of Design and Construction and Housing and Real Estate Services.

b) Layout

The positioning of the living/kitchen room can be opened if this scenario provides the best use of space. In efficiency apartments, there should be a reasonable amount of distance from where one might position a bed in relation to the actual kitchen area. In one bedrooms and larger, the living area should remain separate from the sleeping space. Wherever possible, the bathroom should be accessed from the living room or from a corridor.

c) Location/ Orientation

When possible, the apartments should be accessed from a protected interior corridor.

d) Finishes

- 1) Walls: durable finish; skim-coated impact resistant gypsum.
- 2) Floors: durable finish; wood strip flooring, vinyl tile or approved equal. For wood flooring, finishes must meet New Jersey requirements for volatile organic compounds (VOC). (4-coat) water-based finishes have proven suitable for private rooms.
- 3) Ceilings: typically gypsum board or plaster; if utilities are run in ceilings or in soffits in rooms, carefully planned access panels may be required for valves, junction boxes, etc. Refer to Section 4.4 for specifics regarding access panel requirements.

e) Doors and hardware: **See Section 4.4 Door Hardware for additional information.** Door viewers shall be installed at all apartment doors.

f) Windows: Apartment renewal projects often include the reconstruction or replacement of windows original to the building. During the building investigation enough information should be gathered on the condition of windows to determine whether rehabilitation/reconstruction is a viable option, based on cost/life cycle.

New buildings should incorporate new window technology for energy performance and for ease of maintenance. Within these basic guidelines, a wide variety of types and designs are available.

Regardless of building type, the following requirements apply:

- 1) Ventilating sash: habitable rooms require natural ventilation if a mechanical ventilation system is not being installed in the building. **Designer shall provide a calculation of the opening to verify it meets code.**
 - 2) Screens: all operable sashes require screens, and windows at grade or first floor must be fitted with heavy-duty (.020 wire gage fabric) screens for security. Emergency egress requirements must be met by screens and windows; coordinate with building egress plans. Include positive latch from inside of room only.
 - 3) Shades: all windows in living units are to be supplied with shades. Simple spring-loaded roll-up shades are standard on campus. Evaluate window trim and screen operation to avoid conflict with shade operation. The shades may be purchased through the University shade shops, or shade fabric may be purchased (via University supplier) and supplied to the shade vendor.
- g) Utilities: System piping and equipment, ductwork, etc. must be carefully planned and routed to produce an integrated design for the building. Placement of apartments over or near the building's steam-to-hot-water converter can be problematic.
- 1) Heating/cooling: All units to be heated and cooled. Individual HVAC controls are to be installed in each apartment.

Ventilation with tempered make-up air is generally provided for laundry rooms and other spaces with mechanical ventilation requirements. Air-

conditioning is generally provided in new graduate apartments and major renovations. If a heat pump system is selected for HVAC, consideration should be given for alternative cooling systems such as geo-thermal wells for concurrent implementation or at a future date.

- 2) Power: *wiring is typically replaced in renewal projects, with one power circuit per room. Wiring should be totally concealed.* Outlet location should be carefully coordinated with furniture plans. A quad outlet should be installed at OIT jack locations.

For both new construction and apartment renovation each apartment should be supplied with its own circuit panel box and provide switched outlets where appropriate. This decision shall be made in conjunction with Facilities Engineering after determining if localized A/C units may be installed in the Living Unit.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conductor equipment.

- 3) Lighting: at least one switched outlet should be provided in the bedrooms. Review standard fixture with Project Manager to ascertain requirements for backboxes, conduit, switching, etc. Of primary concern for proper light distribution is the mounting height.

All fixtures should also be easily procurable, should the University need to get replacements.

- 4) OIT: the presence one two-port data with cable TV outlet with one phone outlet constitutes a standard OIT outlet. One OIT outlet per room is standard, with adjacent quad power receptacle. The OIT package should be reviewed which will include the current standard.

2. Sleeping rooms

- a) Doors and hardware: unrated doors with passage or privacy hardware may typically be used for doors interior to sleeping rooms.

Bedroom doors in apartments are equipped with Best Lock privacy locks, as are bathrooms within units.

Door viewers shall be installed at all corridor doors at both ADA and non ADA heights.

- b) Windows: the same considerations for common rooms apply to sleeping rooms.
- c) Utilities

In general, individual unit metering is preferred for incoming electrical service, and if required, gas service. Water service is not individually metered by unit on most projects.

- 1) Heating/cooling: as with common rooms, heating is usually provided by heat pumps. Individual HVAC controls are to be installed in each apartment.

Air-conditioning is generally provided in new graduate apartments and major

renovations. *For small renovations where through-wall air conditioning is considered, provide an additional AC power circuit to be installed in sleeping rooms adjacent to the proposed unit location.*

- 2) Power: Coordinate placement with proposed furniture layout; in rooms that are not in accessible areas, outlets should be mounted at 11'' (at renovations only) above floor to avoid possible conflicts with bed frames. For new construction, locate duplex outlets away from typical bed locations wherever possible. Provide quad power outlet at OIT outlet.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conductor equipment.

- 3) Smoke detection: locate heads away from possible sources of interference or damage such as doors, light fixtures, etc. Detectors must be 36'' minimum from air supply outlets. Cooking areas and bathrooms are to be avoided.
- 4) Fire suppression: concealed heads are preferred, either ceiling-mounted or sidewall type. If a dry standpipe is run adjacent to a room, access doors for inspection of the standpipe might be required within the room.

3. Bathrooms

a) Fixture Requirements

Princeton University generally has apartments with private single fixture bathrooms. **Review with Housing if residential style fixtures are to be used.**

Generally floor-mounted toilets with lids are preferred in concrete or steel construction. This approach is preferred for both new and renovation construction.

Soap dishes should be built into the wall of the lavatory and tub/shower area. Tubs should comprise a high percentage of the bathrooms (**1 tub/floor minimum**); shower units are to be installed to meet code required minimums. Bathrooms should have mechanical ventilation.

b) Finishes

Provide washable finishes; floors are typically ceramic tile or stone with colored grout, as are walls to at least the height of mirrors.

Materials must be water-resistant; at a minimum, use water-resistant gypsum board for walls and ceilings. A smooth plaster finish is preferred. Plan carefully for access doors that are often needed in bathroom walls or ceilings; minimum 12'' square doors are standard, with screwdriver operation. Consider resident quality – unobtrusive location.

c) Lighting and Power

Provide ambient lighting for the room and an additional sconce fixture by the lavatory/mirror. Provide ground-fault-interrupted receptacles at lavatories.

Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway

and conductor equipment.

d) Bathtub/Shower Combination Units

These units should include tile surrounds or have an insert. Shower units should have soap holder shelf built into the unit. Windows should not be located within the tub/shower area.

e) Accessories

1) The following need to be specified by the Designer: robe and towel hooks, towel bars, medicine cabinets (or mirror), and residential toilet paper holders.

4. Kitchens

a) Full-service Graduate Student Apartment Kitchens. These full-service kitchens are installed in graduate student apartments. They are installed for the purpose of providing graduate students kitchen facilities that would be used for daily meal preparation. The Graduate Student Full-service Kitchen will contain the following items:

- Freestanding 30” electric range with four burners and an integral oven;
- Hood above the range with an integral recirculation hood. Option: exterior ventilation. The designer shall take note to locate any required Fire Alarm Smoke Detectors as far away from this location as allowed by code.
- **Dishwasher;**
- Sink with bin, or bins, that is sufficiently sized for cleaning cooking utensils and equipment;
- Kitchen faucet;
- Mechanical Ventilation;
- Freestanding full-size refrigerator and freezer unit, without an automatic ice-maker/dispenser, white, 16 cubic feet;
- Overhead and under-counter cabinets;
- **Solid surface countertops**
- Garbage disposals will not be installed;
- Minimum of 24” or 26” width of available open counter space with a 4” high backsplash or cabinet to counter finish;
- The flooring finish is to be a durable material and is a function of the floor substrate, linoleum preferred;
- There should be a minimum of 4 electrical outlets to accommodate small appliances; and;
- Cabinets should have at a minimum wooden frames and doors. Knobs are discouraged, flush panel doors are preferred.

See Housing and Real Estate Services for current options for finish and appliance information.

7. Custodial Closets

Each apartment building, depending on layout, will require a custodial storage room of approximately 35 square feet (and possibly larger in larger buildings) for paper products and cleaning supplies and equipment for floors with social spaces and common rooms. Exact janitorial requirements for each building are a program issue to be resolved during design development. The closets should include utility sinks. Refer to Section 4.3 Custodial Closets and Storage for more information.

8. Signage Requirements

Prior to submitting signage design package the designer shall meet with the project manager to determine required locations and signage types. Generally, interior signage for apartment buildings shall include:

- A. Apartment Identification Signage - To be located on corridor side at entrance to each apartment. Includes room number and ADA Braille requirements. Each room I.D. sign shall be designed individual to each project.
- B. Stair Egress Signage - Denotes level and levels down to exit. Assigns a stair number and includes ADA Braille requirements.
- C. Common Area Signage – Includes door number and ADA Braille requirements.
- D. For Wayfinding see Section 2.8 Environmental Graphics.

9. Environmental Issues

Prior to undertaking renovation work in an existing apartment, the University will arrange for a survey of the building to determine the possible presence of hazardous materials. The University will engage a separate consultant for any remedial consultation deemed prudent as the result of this survey, and will attempt to abate any hazardous material prior to the start of construction, using a separate contractor qualified to perform the abatement work.

10. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the construction contractor and any systems installer.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts. See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

D. Princeton University Typical Double Door Details	Appendix 3.1-4	Appendix 3.1-4
E. Security Programming Checklist	Appendix 2.7-4	
F. Security Programming Document	Appendix 2.7-5	
G. Sample Secure Zone Diagram	Appendix 3.1-5	
H. Security Standard Device Legend	Appendix 3.1-6	

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. NFPA 101 – Life Safety Code
- E. ICC/ANSI-117.1

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Site Protection with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

The university utilizes a proprietary access control system. The designer is to provide construction documents that conform to the current components and operational features of this

system, including required pathways, wiring diagrams and device specifications. On larger and/or more complex projects a security and or hardware consultant may be required to assist in the planning process.

During Schematic Design the A/E should consult the Security Programming Document for CACS programming requirements. Also during design development the security consultant shall consult with the Project Manager and the University’s Code Analyst to define code strategies and to discuss any code interpretations affecting the project. For residential buildings, the Housing Office will be involved with all locations of access control points. All ADA requirements shall be defined during this process. In addition, the CACS Tech Team members shall also include the Site Protection Systems Engineer, Card Access System Administrator, Department of Public Safety and the Lock Shop Supervisor.

At Design Development, the Designer shall meet with Project Manager, Facilities CACS Tech Representative and Department of Public Safety Representative to ascertain the type of building(s) and the extent of access control points. The requirements for the construction documents will be based on this meeting.

7. Guidelines and Requirements for Documentation

Sufficient documentation shall be prepared for code review of the access control project and contract bidding of the work. Separate floor plans, riser diagrams, and details shall be prepared for all CACS construction documentation. This documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Design Intent	X			
Security Programming Checklist	X			
Security Programming Document		X		
Notes & Symbols		X	X	X
Floor Plans – CACS devices		X	X	X
Floor Plans–Raceway Routes			X	X
CACS Riser Diagrams			X	X
Security Zoning Diagram		X	X	X
CACS Door & Hardware Schedule			X	X
Details – equipment Connections			X	X
Door Elevations			X	X
CACS Specifications			X	X

8. Guidelines for System Installation and Performance

A. Reportability

1. The access control system communicates between the building processor located in the remote processor cabinet (RPC) and the host computer located at Office of Information and Technology (OIT) Facilities at Forrestal via PU LAN. This bundle includes a *private* network fiber line as well as other general purpose copper and fiber network communications. . The Designer shall incorporate the Processor Cabinet and an empty OIT conduit/raceway for this requirement in the design. **An elevation of the RPC shall be provided on the documents. (See Appendix 3.1-2)**

B. New Construction and Renovation

1. All access control devices and junction boxes shall be accessible in accordance with the National Electric Code.
2. Raceways in finished areas shall be concealed where possible.
3. In the event that exposed raceway must be employed, the Designer shall review the approach to the layout of the raceway and shall specify the appropriate material with the Facilities Site Protection Systems Engineer.
4. If hired by the contractor, the requirement for a **PU approved hardware integrator** and a **PU approved systems integrator** must be included in the project security specification.
5. All electromechanical door hardware shall be reviewed and approved by the Facilities Site Protection Engineer prior to installation and commissioning by **both** integrators. Doors shall be tested with electrical actuation of the hardware to provide proper adjustment. Testing equipment will be the responsibility of **both** integrators. .

C. Accessibility Considerations

1. Assisted door opener or fully automatic. For doors > 2” thick, evaluate and choose opener whose closer may be integrated with access control system.
2. Placement of card reader and/or accessible paddle, coordinate with swing of door
3. Consult with Section 2.1 (Accessibility) at the programming phase for additional requirements

D. Interface between Access Control and Fire Alarm Control Panel

1. Doors equipped with delayed egress features and or magnetic hold-open devices shall have appropriate “supervised” wiring provided from the building fire alarm panel release function.

E. Requirements for Access Control Panel Locations

1. The building access control processor cabinets (RPC’s) are preferably located in mechanical equipment rooms or electrical vaults that are in dry locations.
2. Data communication lines as well as emergency power and lighting requirements shall be provided at the (RPC) location in accordance with the University’s typical installation detail. (See Appendix 3.1-2)

F. Signage

Each door that is monitored and/or controlled by the card access system has a unique programming ID assigned by the University. This programming ID corresponds to a door number (assignment) on the Construction Documents. Each door that is monitored and/or controlled by the card access system shall be labeled with the door number. See Section 2.8, Environmental Graphics, for door labeling requirements. Exterior door numbers are determined no later than the 50% CD phase.

G. Operational Performance (Doors)

Doors shall be reviewed for proper operation as a single entity, to insure compatibility of all installed components **by a PU approved hardware integrator**. Components shall include, but are not limited to CACS hardware, hinges, sweeps, etc

H. Residential Intercom System

Off-Campus Residential Housing that requires a front door intercom system that controls the function of the front door lockset shall be the Door King Intercom System, or equal as approved by Site Protection. The need for this system shall be determined by Housing during the programming phase.

I. Spare Parts

A minimum of two spare units (or 2%) shall be provided to Site Protection for every unique, none standard, Electromechanical device installed (i.e. biometric readers). Include spare part requirements in all specifications.

9. Requirements for Testing & Commissioning

A. Commissioning

1. Commissioning shall be performed by:
 - i. **PU approved system integrator** – commissions the electronic systems
 - ii. **PU approved hardware integrator** - commissions the doors and hardware functionality
2. Tech Team representatives from Site Protection shall be an integral part of the commissioning process.
3. The procedure for testing shall be followed closely in accordance with the Site Protection Pre-Functional and Functional (ATP) tests as supplied by PU.

10. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the access control contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the Contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. The Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

Electronic CAD files with separate layers for access control along with separate CACS drawings shall be submitted with as-builts and include requirements listed in Section 3.1.7.

See Section 1.5 (Documentation and Archiving)

END OF DOCUMENT

3.2 Automatic Temperature Controls and Energy Management System

1. Introduction

Princeton University Facilities Engineering has been procuring, designing, installing, and maintaining automated HVAC control systems since the 1960's. Currently, Facilities Engineering maintains a single control center for the monitoring and control of most campus building mechanical, heating and cooling systems. The depth and level of control within these systems varies with the date of installed equipment, type of controls and communication capabilities. Moving forward, systems will employ server based direct digital control systems connected through the campus network. These will be MS Windows Server -based Energy Management Systems utilizing Automated Logic (ALC) WebCTRL or Siemens Insight software. Both systems provide the University with the ability to manage building environmental conditions and energy costs through web clients (ALC WebCTRL or Siemens Apogee Go) at any network connected computer.

Princeton University has a variety of automatic temperature control devices from pneumatic to electronic and Direct Digital Control (DDC). The DDC panel is a microprocessor based module that provides a wide variety of HVAC control and monitoring capability in a standalone or network environment using closed-loop, direct digital control. Some of the older systems still use pneumatic receiver controllers and most of the large buildings have compressed air systems to serve pneumatic actuators. Over the years through renovation and upgrade work hybrid combinations of pneumatic, electronic and DDC systems have come in to existence. The majority of new HVAC equipment, however, has electronic application controllers and zone controllers. The zone controllers in occupied spaces are typically electronically actuated DDC with adjustable zone sensors for the occupant. The benefits of DDC have made it the standard for all future projects.

The current energy management system consists of hundreds of DDC panels that communicate back to the Central Supervisory Control System (CSCS). These DDC panels utilize campus Ethernet. All future controls network connectivity will be through campus Ethernet.

The vast majority of current DDC panels are connected to the university's CDN infrastructure as its backbone. Princeton has recently constructed a reliable and secure BAS backbone by building a new network. All new building DDC panels will be connected to this network. Existing building renovations will need to be handled on a case by case basis until all DDC panels are migrated.

Princeton has a system that leverages the remote notification features of the BAS to inform appropriate staff of alarms without necessarily causing all alarms to route through the Public Safety staff.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. Campus Energy Manager MacMillan Building, 609-258-9008
Facilities Engineering

- | | |
|--|----------------------------------|
| C. Controls Engineer
Facilities Engineering | MacMillan Building, 609-258-5890 |
| D. Maintenance Control Shop Supervisor
Facilities Engineering | MacMillan Building, 609-258-5082 |

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

	<u>PDF</u>	<u>MS WORD</u>
A. Master Technical Specification for Building Automation Systems	Appendix 3.2-1	
• Building Automation System (BAS) General		Appendix 3.2-1A
• BAS Basic Materials, Interface Devices and Sensors		Appendix 3.2-1B
• BAS Operator Interfaces		Appendix 3.2-1C
• BAS Field Panels		Appendix 3.2-1D
• BAS Communication Devices		Appendix 3.2-1E
• BAS Software and Programming		Appendix 3.2-1F
• Sequences of Operation		Appendix 3.2-1G
• BAS Commissioning		Appendix 3.2-1H
		<u>AutoCAD</u>
B. Symbols	Appendix 3.2-2	Appendix 3.2-2
C. Recirc AHU with Preheat, Chilled Water, Humidifier, VAV, Economizer & Return Fan	Appendix 3.2-3	Appendix 3.2-3
D. 100% Outside Air AHU with Preheat, Chilled Water, Humidifier, & VAV	Appendix 3.2-4	Appendix 3.2-4
E. Recirc RTU with Preheat, DX, VAV & Economizer	Appendix 3.2-5	Appendix 3.2-5
F. Recirc AHU with Preheat, Chilled Water, Humidifier, CAV, Economizer & Return Fan	Appendix 3.2-6	Appendix 3.2-6
G. 100% Outside Air AHU with Energy Recovery Wheel with Preheat, Chilled Water, Humidifier, VAV & Exhaust Fan	Appendix 3.2-7	Appendix 3.2-7
H. Kitchen Exhaust / Makeup	Appendix 3.2-8	Appendix 3.2-8
I. Clean Room	Appendix 3.2-9	Appendix 3.2-9
J. Bathroom Exhaust	Appendix 3.2-10	Appendix 3.2-10
K. Steam to Hot Water Converter	Appendix 3.2-11	Appendix 3.2-11
L. Process or Secondary Chilled Water	Appendix 3.2-12	Appendix 3.2-12
M. Glycol Heat Recovery	Appendix 3.2-13	Appendix 3.2-13
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O. Boiler Hot Water System	Appendix 3.2-15	Appendix 3.2-15
P. Control of Smoke Purge Interface	Appendix 3.2-16	Appendix 3.2-16
Q. Single Duct VAV Cooling Only	Appendix 3.2-17	Appendix 3.2-17
R. Single Duct VAV with Reheat Coil	Appendix 3.2-18	Appendix 3.2-18
S. Chilled Beam Control	Appendix 3.2-19	Appendix 3.2-19
T. Fan Coil Unit	Appendix 3.2-20	Appendix 3.2-20
U. Fan Powered Box	Appendix 3.2-21	Appendix 3.2-21
V. Cabinet Unit Heater	Appendix 3.2-22	Appendix 3.2-22
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BB. VAV Zoned by Occupancy Sensor	Appendix 3.2-28	Appendix 3.2-28
CC. Heat Only Dorm Thermostat Control	Appendix 3.2-29	Appendix 3.2-29
DD. Valence Heat / Cool Thermostat Control	Appendix 3.2-30	Appendix 3.2-30
EE. Steam & Chilled Water Monitoring	Appendix 3.2-31	Appendix 3.2-31
FF. Compressed Air System	Appendix 3.2-32	Appendix 3.2-32
GG. Air Volume Traverse Station	Appendix 3.2-33	Appendix 3.2-33
HH. Wire & Cable Riser for Thermostats	Appendix 3.2-34	Appendix 3.2-34
II. Wire & Conduit Illustration	Appendix 3.2-35	Appendix 3.2-35
JJ. ATC Responsibility Checklist	Appendix 3.2-36	Appendix 3.2-36

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. ASHRAE 62

5. Review Guidelines

Initial planning and preliminary design will be conducted through the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an

internal “Tech Team” review process through the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

The Designer shall meet with the Project Manager and Controls Engineer to ascertain the number and location of control points in the Building.

The Designer is to familiarize himself with system requirements and plan the system functions (sequence of operations), equipment and raceway layout.

See also Building Commissioning Process in Section 3.13 and the Master Technical Specification for Building Automation Systems for further details.

7. Requirements for Documentation

Along with the specifications, the Designer is to produce sufficient documentation to allow competitive bid of the Automatic Temperature Control work. Confirm room numbering of Drawings with Section 3.4 *Fire Alarm Systems* and 2.8 *Environmental Graphics*.

This documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Design Intent (define seasonal environmental parameters)	X			
MEP Basis of Design (control strategy)		X		
Floor plans showing locations of all devices including thermostats or sensors that are part of or connected to the system;			X	X
Sequence of operation, including set-points and alarm limits.			X	X
Control Diagram / Flow Diagrams			X	X
Points list for every sequence or unit using owner approved point names.				X
PU Standard Installation Details		X	X	X
Full Length Specifications (refer to Appendix 3.2-1)			X	X

Show all dedicated power and dedicated communication cabling in conduit on the electrical series Drawings, in either plan or riser diagram format (shown as power and ATC communication), per the direction of the Controls Project Engineer.

Mounting heights for thermostats shall be in conformance with both ADA and Manufacturer's recommendations. Temperature sensors however shall be installed strictly per Manufacturer's recommendations. If the work is done as part of a renovation, existing switch mounting heights should also be considered. See the Master Technical Specification for Building Automation Systems for further details.

8. Guidelines for System Installation and Performance

A. General Approach

1. Hardware and software shall include point database, graphical system display and network interface to a central supervisory control system at the MacMillan Building. Include 20% spare capacity for hardware and software.
2. ATC contractor shall supply all control point designations to the Owner and shall program all sequences of operation into the energy management system. Include energy analysis software variables of information with real-time energy evaluations that reflect the design load calculation. Tracking and trending energy usage of chilled water, Kwh and steam is typically the first real-time energy evaluation performed. These evaluations provide useful input to peak demand control strategies.
3. All hydronic valves shall be protected from system flush with a separate spool piece including VAV units and fan coils.

4. Bids shall be received from both Siemens Building Technologies and Automated Logic Corporation. University Controls Engineer to review scope document prepared by Construction Manager and Design Engineer prior to bidding. Design Engineer will participate in bid review meetings.

B. Utility Metering

Chilled Water Meters (or approved equal)

Spirax Sarco/Emco model Mag 5100W

Flow Element Spirax Sarco/Emco model 5000

Electronics Siemens model Mag 5100W

Flow Element Mag 5000

Electronics Toshiba Model LF

Flow Processors (or approved equal)

Spirax Sarco/EMCO Model FP93BL11NTBBAC

Steam Meters (or approved equal)

- In Up to 4” pipe diameter: Spirax Sarco/EMCO VLM10 In-line Vortex Mass Flow meter with Bacnet & Modbus capability
- 4” inch pipe diameter and above: EMCO model MTMP-600.insewrtrion Flow meter with Bacnet & Modbus capability

ATC control panels in the building will be configured on BASNET (University subnet) to read all building’s Steam and Chilled water meter data. In addition Electric meter data will be configured on WATTNET (University subnet). All information to be displayed on building graphics and should trend all available meter data. All energy meter data is to be included on the campus energy map.

Meters shall be sized to read at mid-point for the nominal designed system load.

Meters shall not be sized for maximum capacity of the installed system.

CHW and Steam Meter locations shall be clearly shown on piping drawings with manufactures piping recommendations noted, a separate detail shall also be shown.

CHW and Steam Meters shall be provided and wired by ATC contractor and installed by Mechanical contractor.

C. Training

State the hours for each type of training session to be provided. A minimum of 8 hours for each DDC Panel installed and 2 hours for each Application Controller type installed. Two separate training sessions for two separate groups will allow onsite training of one group while the other group is able to respond the normal work requests.

D. Central Supervisory Control System (CSCS) at MacMillan – Front End

- Historical Data Collection – Standard data collection capabilities applicable to all data points. A minimum historical trend to include all analog points, every ten minutes.
- Information Reporting – The trend capabilities allows data to be transferred to Excel.

- Alarming Monitoring – Operators are notified of an “out-of-normal” condition. Alarms can be sent to a screen, printer. Alarms can have different priorities and messages can be directed to different locations depending on the severity of the alarm, allowing early warning notification for out-of-spec conditions.
- Off Hour Alarm Management (Remote Notification) - Alarms that require off hour response need to be set up to notify appropriate Princeton personnel via email and phone call. A meeting with the appropriate users shall determine which alarms require off hour response and where the appropriate notifications will be sent.
 - Any building with off hour alarm requirements – an autodialer will be required to be installed. The autodialer functions as a backup to the Remote Notification system and will require an OIT phone connection.
- Preventative Maintenance – Collection of equipment runtime allows maintenance to be performed on a “Just-in-Time” or predictive basis instead of incurring unnecessary and preventable costs due to a machine breakdown. Alarming functions can even notify the appropriate maintenance crew when service is requested. Run time information and alarms can also be transferred to a Maintenance Management package to produce work orders.
- Equipment Scheduling – Normal operating hours and special events can be programmed ahead of time so that an operator need not be on-site to turn on equipment and adjust set points for planned events.
- Control Sequence Programming – The ALC or Siemens programming code can be used to automate complex building HVAC systems, sustain strict environmental conditions and optimize control functions and applications for most of the Facilities
- Occupancy/Vacancy Sensor Integration
When occupancy sensors are to be integrated with the BAS system for HVAC control a series coordination meetings between trades will be required during both design and construction.

It is preferred that the Electrical Contractor installs the sensor and leaves a control wire stub for the Controls Contractor to tie the sensor back to the BAS controller. Start-up and commissioning of the occupancy sensor is the responsibility of the Electrical Contractor. The Electrical Contractor is to coordinate with the Control Contractor to verify that the HVAC system is responding as designed.

9. Requirements for Automatic Temperature Control System Testing & Commissioning

Testing procedures shall be in conformance with the Master Technical Specification for Building Automation (Appendix 3.2-1) In general the format consists of a milestone procedure layering increasing university involvement as the project transitions into occupancy and closeout. These milestones integrate the commissioning process (if contracted) and are conducted in the following order

- A. ***Prefunctional Commissioning Testing*** – Spot verification of system supervisory equipment, pathway & wiring, individual component installation and functionality.
(*Deliverables per PreFunctional Commissioning Log -see Section 3.13*)
- B. ***Point –to – Point Checkout*** – Comprehensive control point functionality review conducted for verification of signal and device response. This shall be done in two (2) stages:

ATC subcontractor verification

(Deliverable – Mfr standard start-up test)

1. ATC subcontractor with P.U. Shop & Design Engineer

(Deliverable – Reviewed/Approved Mfr start-up test)

C. Sequence of Operation Confirmation – Comprehensive validation of the control logic for the completed system, typically conducted **after balancing report has been reviewed and accepted**. This shall be conducted by the ATC subcontractor and representatives from Facilities Engineering to confirm the system design parameters have been achieved. This shall be done in two (2) stages:

1. ATC subcontractor verification

(Deliverable – Mfr standard Sequence of Operation Check)

2. ATC subcontractor with P.U. Shop & Design Engineer

(Deliverable – Reviewed/Approved Sequence of Operation Check)

D. Functional Commissioning Testing – Cross -disciplinary review of the validated ATC system and its related components such as heating/cooling modes, FA/FP supervisory controls, and occupancy controls. Functional testing is conducted by the Commissioning Agent in conjunction with the ATC subcontractor, PU Shops and Facilities Engineering.

(Deliverables per Functional Commissioning Log- see Section 3.13)

System Prefunctional and Point-to-Point checks can be tested incrementally if agreed in advance. However, Sequence of Operation checks and Functional Commissioning cannot be conducted without the reviewed and accepted Air Balancing report.

10. Master BAS Specification Implementation Guidance to the Design Engineer

These Guide Specifications set forth guidelines to assist the designers of building mechanical systems in specifying and procuring the controls for those building systems. This document provides tools for the designer to specify the appropriate level of control system quality for reliable control.

Decision-making guidance to the design A/E is provided throughout these specifications (Appendix 3.2-1) in the form of ‘Editor’s Notes’ so that the A/E may make prudent decisions and specify the most effective requirements for the system being installed and for those that have to use them. It is ultimately the designer’s job to assess the systems to be controlled and the environments in which they will be installed, commissioned, and operated and utilize the appropriate elements of this specification.

Edits to each specification section shall be performed in Microsoft WORD software. All editing shall be performed using the ‘Track Changes’ options with all changes not accepted. This allows Princeton to review all changes proposed to the Master Documents.

These Guide Specifications apply the following principles to the control systems in the order they are presented:

- **Principle 1 – The control system must first and foremost provide effective and reliable control, commensurate with the systems it is controlling.** Obviously the types, complexities and the criticalities of the systems being controlled will dictate the quality/power of the control system that should be applied to them. The ultimate quality of the control system is primarily dictated by the components that sense, execute logic for,

actuate, and document the systems they are controlling. These components are generally specified in BAS Basic Materials, Interface Devices, And Sensors, and BAS Field Panels. This specification applies the concept of an “Application Category” for controllers whereby the performance requirements of the controllers are grouped into categories, and the Specification must remain unchanged.

- **Principle 2 – The manufacturer and installer must be highly qualified with extensive experience and must be committed and bound to thorough Commissioning (Cx).** While the control system power/quality is very important, equally or more important is the expertise and commitment of the installing contractor and their collaboration with the overall commissioning team. BAS – General provides for qualifications of both the installer and manufacturers of the systems. BAS Commissioning dictates a high standard for the Commissioning of the system by the installer.
- **Principle 3 – The control installation must be fully documented as consistently as practical with nothing required to fully operate and maintain the system withheld from the University.** The system must always be put in the context of how it will integrate with existing systems and implemented and documented using standard approaches wherever possible. Point naming conventions, programming logic, network configuration requirements, security information, etc. must be strictly adhered to and wholly documented. No element for the continued operation and maintenance of the control system may be withheld in any way. No part of the installation may be considered confidential or proprietary information. This specification requires applicable documentation throughout.
- **Principle 4 - Require sufficient instrumentation.** The designer must require instrumentation to support both the sequence of operations, and the data acquisition capability to support equipment performance monitoring and building diagnostics analysis. A listing generally establishing minimum instrumentation requirements is included with the specifications. This identifies minimum instrumentation for common types of system. The designer is responsible for requiring additional instrumentation as necessary to support the sequence of operations, or to supplement data acquisition capabilities when the nature of the equipment or systems to be installed makes this sensible. Additional higher end devices shall be specified for control of critical systems or areas in a facility. It is the responsibility of the design engineer, in consultation with Princeton University Facilities Engineering, to specify the appropriate products for the application.

Conclusion:

Application of these Principles to a given project requires the designer to research/consider the project-specific environment and requirements and to edit this specification appropriately. The specific decision depends on a number of other important variables, including the specific HVAC control applications being served, the critical nature of the area or facility being served, the quality and capabilities of the local installer, and operator capabilities. Only those items listed in Blue Italic Text are to be modified, all other items in the specification are to remain unchanged unless prior, explicit permission has been obtained from properly authorized Princeton University Facilities Engineering representatives. The designer is cautioned to apply or find the appropriate level of expertise to complete this specification - otherwise, the result could be a specification with inadequate and contradictory requirements that cannot be enforced.

This specification extensively references detailed control drawings, detailed sequences of operation, point lists, etc. The A/E and design team must provide and incorporate these into the design documents.

11. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the ATC and Mechanical contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation.

Shop Drawing information in a sectionalized 8 1/2" x 11" three-ring binder with a Table of Contents listing all sections. An electronic "PDF" version will accompany the submittal for use by the Engineering Department. The contractor shall update all submittals to an as-built document for use by the University for operation and maintenance of the system. Provide a "PDF" version of the as-built blinder on the Facilities Engineering Front-End server that is linked to the Graphic Display. Provide a printed copy and "PDF" of each specified report demonstrate the reported data is accurate and complete. Provide an as-built document in each ATC Panel showing each system controlled by the ATC Panel, HVAC balancing reports, ATC conduit runs, boxes and devices with numbers, HVAC control schematic Drawings. All drawings shall be on AutoCAD.

See Section 1.5 (Documentation and Archiving) and the Master Technical Specification for Building Automation Systems for further details.

END OF DOCUMENT

1. Introduction

As part of the University's overall commitment to sustainable campus development, Princeton's goal is to reduce carbon emissions to 1990 levels by the year 2020, without the purchase of carbon offsets. Improving building energy efficiency is a major means to reach 1990 carbon emissions levels and is targeted to contribute to approximately 35% of the required reduction. In addition to the energy standards for new construction and major renovations outlined in this section, a program of aggressive energy efficiency retrofit measures for campus infrastructure and existing buildings will supplement the targeted reduction.

New construction and major renovation projects will benchmark against a LEED silver rating. The University will determine if formal project certification will be sought. Early on in the project it will be determined if LEED is the appropriate third party certification system for the project or if other systems will be sought in lieu of or in addition to LEED (i.e.: Sustainable Sites Initiative, Living Building Challenge). This approach is enhanced by a commitment to Life Cycle Cost Analysis (LCCA) as a more objective and quantitative approach to making informed design decisions. This process is outlined in Section 1.2, Sustainable Building Guidelines.

This Energy Guidelines section outlines targets for energy performance, as well as analysis and reporting requirements for all project design phases of major design projects, involving both new buildings and major renovations. Identification of energy efficiency measures, whole building energy simulation, building envelope design or upgrade, daylighting design, renewable energy, measurement & verification, and commissioning, are addressed. Small scale renovation projects, defined as those with existing envelopes and predetermined HVAC systems shall incorporate an abbreviated effort, while still considering appropriate energy efficiency measures.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, Real Estate Development, or as applicable)
- B. Director of Engineering MacMillan Building, 609-258-5472
- C. Energy Plant Manager MacMillan Building, 609-258-3966
- D. Campus Energy Manager MacMillan Building, 609-258-9008

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

	<u>PDF</u>	<u>MS Word/Excel</u>
A LEED Green Building Rating Systems	www.usgbc.org	
B New Jersey Higher Education Partnership For Sustainability - Mission Statement (NJHEPS)	www.njhep.org	
C OPR Template	Appendix 3.13-1	Appendix 3.13-1
D MEP Basis of Design	Appendix 3.13-7	Appendix 3.13-7
E Cx Roles and Responsibilities Matrix	Appendix 3.13-4	Appendix 3.13-4

F	High-Performance Systems Matrix	Appendix 3.3-10
G	US Department of Energy Building Energy Codes Program Compliance Website	www.energycodes.gov
H	ASHRAE 90.1 Appendix G Guidance Document	Appendix 3.3-12
I	Utility and Carbon Rate Structure	Appendix 3.3-13
J	Input and Output Reporting Spreadsheet	Appendix 3.3-14
K	Fan Power Calculation Spreadsheet	Appendix 3.3-15
L	Standard Utilization Schedules	Appendix 3.3-16
M	Glazing Factor Calculation Spreadsheet	Appendix 3.3-17
N	EPA Energy Star Buildings Website	Appendix 3.3-18
O	Energy Guidelines Deliverable Requirements	Appendix 3.3-19

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)

5. Requirements for Documentation

Project Team reviews of issues relating to energy use and building energy systems will occur within the larger context of the Life-Cycle Comparative Studies (LCCS) process (see Section 1.2 Sustainable Building Guidelines) and, for new buildings, in a focused manner at the Envelope Reviews during the Pre-Schematic, Schematic and Design Development phases. Project documents, as indicated below, shall be submitted for review by the Office of Design and Construction, Engineering and the Maintenance Department at specified design milestones.

Pre-Schematic Design:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
Sustainability Charette ✓PS-5	During pre-schematic design	Identify energy target category for project (e.g. new construction, major renovation, etc.). Identify daylighting coverage goals.	Submit report summarizing target category, massing model, energy efficiency measures for study, and envelope concept.
LCCA Workshop ✓PS-10	During pre-schematic design	Identify group of energy efficiency measures to study.	
Conceptual Envelope Workshop ✓PS-8	During pre-schematic design	Identify basic envelope strategy and peak heating and cooling load targets, as per Envelope Design Guidelines.	

Schematic Design:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
LCCA Review 1 ✓SD-16	Beginning of schematic design	Review energy efficiency measures to develop during schematic design.	
Envelope Review 1 ✓SD-14	100% schematic design	Demonstrate prescriptive or trade-off envelope compliance. Review daylighting strategy, perimeter thermal comfort, and perimeter HVAC strategy.	Submit Preliminary COMcheck report.
SD Energy Model	100% schematic design	Develop ASHRAE 90.1 Appendix G compliant model with all three baselines. If lighting is not designed yet, set targets for lighting power densities.	Submit input/output spreadsheet with zoning diagram.
Daylight Review 1	100% schematic design	Glazing factor calculation for typical rooms.	Submit glazing factor calculation spreadsheet OR report of results from daylight model.

Design Development:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
LCCA Review 2 ✓DD-8	Beginning of design development	Identify which energy efficiency measures should be kept and which should be discarded, based on the 100% SD energy model. Identify additional measures, if appropriate.	
Envelope Review 2 ✓DD-7	100% design development	Demonstrate prescriptive or trade-off envelope compliance. Review daylighting strategy, perimeter thermal comfort, and perimeter HVAC strategy.	Submit updated COMcheck report.
DD Energy Model	50% design development	Develop ASHRAE 90.1 Appendix G compliant model with all three baselines. Check progress against energy targets.	Submit updated input/output spreadsheet with zoning diagram.
Daylight Review 2	100% design development	Glazing factor calculation for typical rooms OR daylight simulation.	Submit updated glazing factor calculation spreadsheet OR report of results from daylight model.

Construction Documents:

<u>Activity</u>	<u>Schedule</u>	<u>Goals</u>	<u>Design Team Responsibilities</u>
CD Energy Model 1	Beginning of construction documents	Develop ASHRAE Appendix G compliant model with all three baselines. Check progress against energy targets. Model only what has been kept in the design after any value engineering exercises.	Submit updated input/output spreadsheet with zoning diagram.
CD Energy Model 2	85% construction documents	Develop ASHRAE 90.1 Appendix G compliant model with all three baselines with no approximated values.	Submit updated COMcheck report, zoning diagram, input/output spreadsheet, fan power spreadsheet, glazing factor calculation spreadsheet and final energy modeling report.

6. Energy Performance Targets

The objective of setting energy performance targets is to encourage design teams to develop well integrated energy efficient buildings without restricting their creativity by prescribing specific technical solutions. ✓PS-12

New projects connecting to central chilled water or steam should aim to achieve steady load patterns of utility usage through designs that promote higher thermal capacity, utility conservation and effective contextual response to the surrounding environment. The early timing of this effort is critical in order to have the best chance of effective decisions during the

construction documents phase. For renovation projects, envelope and MEP system enhancements should achieve similar goals.

This section sets energy targets for new construction and major renovation projects.

Procedures for demonstrating and calculating these reductions are included in the following section: “Modeling Procedures.”

New Construction Energy Performance Targets (≥ 20,000 ft²)

- o Relative Targets – Energy Cost
 - o **Three models** shall be created in total to calculate energy cost savings: one “Proposed” model of the building as designed, and three “Baseline” models against which to compare these results. The two baseline models will be used to break out building side energy efficiency measures from campus plant energy efficiency measures.

Baseline Model Number	Description	Baseline Cooling Plant	Baseline Heating Plant	Utility Rate (Appendix 3.3-13)
Baseline - 1	ASHRAE 90.1 Baseline Model	Cooling as per ASHRAE 90.1 Appendix G	Heating as per ASHRAE 90.1 Appendix G	Rate Structure 1
Baseline - 2	PSEG Baseline	Cooling as per ASHRAE 90.1 Appendix G	Gas-fired boiler with minimum efficiency per ASHRAE 90.1	Rate Structure 2

- o Results of all three models (one “Proposed” and two “Baseline”) shall be reported using the templates described in the following section, “Modeling Procedures.”
- o All new projects shall target a 20% annual energy cost savings when comparing the “Proposed” building model to “Baseline – 1”.

Depending on building size and programming, projects have an opportunity to apply innovative strategies to reduce energy usage if discussed early in the design process and combined with Life-Cycle Cost Analysis (LCCA) activities. During the Sustainability Charette in Pre-Schematic Design, the design team should determine appropriate energy goals for the project in consultation with the Princeton University Project Manager and Facilities Engineering staff. Princeton University is striving to set project goals that spur innovation without distracting a design team with unrealistic benchmarks. The design team should be aware that Princeton University is driving for and desires actual energy use savings and the limitations of ASHRAE 90.1 can sometimes prevent the use of certain strategies if credit is not given within the framework of the standard. Discussions among the design team should occur regarding interpretations of the standard and the potential impact on modeling efforts and predicted savings. Strict percentage improvement figures, although attractive for simplicity, do not always paint the complete picture especially when comparing different building types or even different sizes of the same building type.

- o Certain projects may be better served with a comparison of energy use intensity to other similar buildings in the CBECS database.
- o Although Princeton may or may not pursue formal USGBC LEED certification, a model of the proposed building as compared to a strict ASHRAE-90.1 baseline building (Baseline-1) would be required for any potential USGBC submissions as other benchmarking strategies are currently inapplicable to achieve credits.

- For projects using a local cooling plant, instead of campus chilled water, Baseline-2 does not need to be run.
- Rate structures available at the start of a project will be used until project completion. Updates of the rates during the project shall not be reflected.
- Relative Targets – Carbon
 - Carbon savings shall be calculated using the rate structure found in Appendix 3.3-13.

New Construction Energy Performance Targets (< 20,000 ft²)

- Projects shall follow guidance provided by the ASHRAE Advanced Energy Design Guides available for free on the ASHRAE website. Projects may alternatively follow the modeling guidance required for new construction greater than 20,000 ft².

Major Renovations

- Targets – Energy Use
 - Demonstrate either through energy simulation or through measured energy use that performance of the project meets the criteria for an EPA Energy Star rating of at least 75 using the EPA Target Finder tool.
 - For building types not addressed by Target Finder, demonstrate a 50% source energy savings over the existing building’s source energy use.
 - Baseline performance of the existing building may be derived from past energy use data available from Princeton University Facilities.

7. Modeling Procedures

Introduction

- Energy modeling shall be carried out according to the procedures contained in this section.
- Results from modeling will be used to track performance in comparison to the targets set in Section 6.
- These guidelines have been written in an effort to achieve greater consistency in modeling and reporting across University projects.

Modeling - New Construction and Major Renovations

- The baseline case shall be established according to the Princeton University ASHRAE 90.1 Appendix G guidance document (Appendix 3.3-12). This document is meant to be used alongside the actual standard and provides clarifications tailored to the University’s campus infrastructure, building types, and climate.
- To streamline comparison and development of modeling inputs and outputs between projects, several supplements are provided and are required for use according to the project deliverables table listed in Section 5. The front tab in each sheet provides instructions for use.
 - Utility and Carbon Rate Structure (Appendix 3.3-13)
 - Input and Output Reporting Spreadsheet (Appendix 3.3-14)
 - Fan Power Calculation Spreadsheet (Appendix 3.3-15)
 - Standard Utilization Schedules (Appendix 3.3-16)
 - Glazing Factor Calculation Spreadsheet (Appendix 3.3-17)

Additional Measures – Savings in areas not governed by ASHRAE 90.1

- There may be measures in a project design that are above and beyond standard practice and that will result in energy savings that will not be captured by a standard ASHRAE 90.1 Appendix G evaluation. This guideline allows for the inclusion of some of these measures, approved on a case-by-case basis with the Princeton Project Manager. Examples include:

- Reduction of minimum ventilation rates in labs from 6ach to 4ach
 - Reduction in process loads by use of efficient receptacles
- This guideline allows for the inclusion of these savings by modifying the parameters in addition to the three baselines to reflect “standard practice” baselines. The baseline performance for each measure must be approved by the Princeton Project Manager during the LCC process.
- This guidance is separate from that offered in ASHRAE 90.1 G2.5 – Exceptional Calculation. An exceptional calculation can be done for a measure that is traditionally allowed in ASHRAE 90.1 with a specified baseline (such as natural ventilation, complex system types, demand controlled ventilation etc.) but that modeling software cannot calculate directly. This allowance for “Additional Measures” is a departure from the ASHRAE 90.1 baseline to demonstrate the magnitude of savings for certain measures where the design goes above and beyond standard practice.

8. Envelope Design Guidelines

Introduction

- Energy, comfort, and daylighting performance of the building envelope must be considered early on in the design process. Many lower energy HVAC systems require that building envelope loads be well controlled.
- The goal of this guidance is to ensure that building envelope components achieve a 20% improvement over ASHRAE 90.1 without trade-offs with other building systems, such as lighting, HVAC, or service hot water heating.

Definitions

- Skylight: a fenestration surface having a slope less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.
- Vertical fenestration: all fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 12 in. of a mass wall, are considered walls, not fenestration.

Process

- COMcheck (http://www.energycodes.gov/comcheck/ez_download.stm) shall be used to demonstrate envelope code compliance at three stages in the design process:
 - 100% Schematic Design
 - 100% Design Development
 - 85% Construction Documents

Opaque Building Envelope Components

- Opaque element U-values should be derived from ASHRAE 90.1 Normative Appendix A. For assembly types not listed in Appendix A, provide calculations for envelope thermal performance. Otherwise, use maximum allowed ASHRAE 90.1 U-values for load and energy modeling.

TABLE 5.5-5 Building Envelope Requirements for Climate Zone 5 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.119	R-7.6 c.i.
Metal Building ^a	U-0.055	R-13.0 + R-13.0	U-0.055	R-13.0 + R-13.0	U-0.083	R-13.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
<i>Walls, Above-Grade</i>						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151 ^b	R-5.7 c.i. ^b
Metal Building	U-0.069	R-13.0 + R-5.6 c.i.	U-0.069	R-13.0 + R-5.6 c.i.	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.064	R-13.0 + R-3.8 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.074	R-10.4 c.i.	U-0.064	R-12.5 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^c	U-0.35		U-0.35		U-1.20	
Metal framing (curtainwall/storefront) ^d	U-0.45	SHGC-0.40 all	U-0.45	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^d	U-0.80		U-0.80		U-1.20	
Metal framing (all other) ^d	U-0.55		U-0.55		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -1.10	SHGC _{all} -0.77	U _{all} -1.10	SHGC _{all} -0.77	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.10	SHGC _{all} -0.62	U _{all} -1.10	SHGC _{all} -0.62	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
^aWhen using R-value compliance method, a thermal spacer block is required; otherwise use the U-factor compliance method. See Table A2.3.
^bException to Section A3.1.3.1 applies.
^cNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
^dMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Figure 1 ASHRAE 90.1-2010 Building Envelope Requirements for Princeton, NJ

Fenestration

- Fenestration components must meet the rating requirements of ASHRAE 90.1 Section 5.8.2.
- U-values provided by glazing manufacturers are often center-of-glass values and do not include the effect of edge spacers, framing, or local thermal bridging.

- U-values provided by glazing manufacturers for skylight applications are often center-of-glass values not corrected for slope. Insulating glass units experience a significant decrease in thermal resistance when sloped, due to increased convection in the gas cavity.
- During schematic design and up to 50% design development, use Table 4 from the 2005 ASHRAE Fundamentals Handbook (U-Factors for Various Fenestration Products) to estimate U-values.
- In the absence of credible thermal performance data, ASHRAE 90.1 Table 5.5-5 maximum U-values and SHGC's (40% vertical fenestration, 5% skylight) must be used for load and energy modeling.

General Guidance

Energy Code

- Consider that ASHRAE 90.1 Appendix G allows no greater than a 5% skylight-to-roof ratio in the baseline model.
- Consider that ASHRAE 90.1 Appendix G allows no greater than a 40% vertical fenestration-to-above-grade wall ratio in the baseline model.

Thermal Comfort

- Building envelope systems for shallow plan rooms (e.g. enclosed offices) should be evaluated carefully. During peak cooling conditions, solar radiation may lead to significant local heating discomfort. During peak heating conditions, downdrafts and low fenestration surface temperatures may lead to significant local cooling discomfort.

HVAC

- Careful control of building envelope gains and losses is required for use of lower energy systems, such as active chilled beams, radiant systems, and displacement ventilation. High solar gains in shallow plan spaces may result in excessive supply airflow requirements (> 2 cfm/ft²).

Visual Comfort

- Use of significant amounts of vertical fenestration and/or skylight may result in local glare issues. Where occupants will be using visual displays (e.g. TVs, LCDs, etc.), consider the impact of high levels of natural daylight.

External Shading

- External shading devices should be considered as a means to reduce direct solar gain.
 - South facing – overhangs.
 - West and east facing – vertical fins.
 - North facing – external shading not required.
 - Skylight – consider north facing clerestory windows, as an alternative.

Summary of Submission Requirements

- COMcheck Envelope Compliance Form (ASHRAE 90.1).

9. Systems Performance

Air conditioning in the dormitories is not normally operated from Labor Day to Memorial Day (during the academic year). The design team must ensure that the building maintains relatively comfortable living conditions during this period when the air conditioning is not operating.

High-Performance Systems Matrix

✓PS-7

A list of energy efficiency measures to consider is provided in Appendix 3.3-10. This list is not meant to be all inclusive, but highlights a range of measures that have been evaluated on past Princeton University projects. Design teams are required to develop a customized high-performance systems matrix as per the Sustainability guidelines.

10. Daylighting

Daylighting will be utilized as a primary light source in all new buildings for both energy savings as well as improved indoor environmental quality. The success of daylighting design depends largely on the building floor to ceiling height, the cross-sectional depth of the building, the window head height above the finished floor and the visible transmittance of the glazing. In general, the shallower the depth and the higher the ceiling, the greater the building area covered by natural light.

Correct building orientation and window treatments are synergistic strategies for effective daylighting. Mitigation of glare and luminance contrast is critical to creating a comfortable daylit environment. Passive daylighting measures such as clerestories, atria, light wells, and light shelves are recommended to mitigate glare and heat load in the building envelope.

A. Daylighting Coverage Goals

Project-specific Daylighting Coverage Goals will be identified at the Sustainability Charette during the Pre-Schematic Design phase of a project. Typical guideline performance targets are as follows:

	Daylighting (Work Surface)	Space Coverage (unless otherwise noted at project inception).
Critical Visual Task Spaces offices, conference rooms, classrooms, libraries, auditoriums and laboratories.	25 -50 fc	75%
Lighted Transitory Spaces informal break-out spaces, meeting spaces and corridors at least 10ft in width with seating.	15-25 fc	(can contribute to 75% of space coverage for Critical Visual Task Areas)

B. Glazing Factor Calculations and Computer Daylight Simulation

During the design phases, daylighting issues shall be reviewed at the Envelope Reviews and, where relevant to selected LCCA study categories, at LCCA Reviews.

Fulfillment of the project Daylighting Coverage Goals should be confirmed through Glazing Factor Calculations at the conclusion of Schematic Design and Design Development phases, when deemed appropriate for primary or typical spaces, computer simulation. A calculation should be completed for each typical space type. Regularly occupied spaces appropriate for daylight should demonstrate a minimum glazing factor of 2% in the daylit areas occupied for critical visual tasks and a minimum glazing factor of 1.2% in the daylit transitory spaces. The glazing factor is calculated as follows:

$$\text{Glazing Factor} = \frac{\text{Window Area [SF]}}{\text{Floor Area [SF]}} \times \text{Window Geometry Factor} \times \frac{\text{Actual } T_{vis}}{\text{Minimum } T_{vis}} \times \text{Window Height Factor}$$

Glazing Type	Glazing Orientation	Geometry Factor	Minimum T _{vis}	Height Factor	
Windows					
Window area > 7'-6" aff	vertical		0.1	0.7	1.4
Window area 2'-6" - 7'-6" aff	vertical		0.1	0.4	0.8
Skylights					
Vertical clerestory monitor	vertical		0.2	0.4	1
Sawtooth monitor	sloped		0.33	0.4	1
Horizontal skylight	horizontal		0.5	0.4	1

A spreadsheet is provided as Appendix 3.3-17 for glazing factor calculations.

Conformance to daylighting goals shall also be demonstrated through post construction field measurement. See Section 3.3.12 (Measurement and Verification).

11. Renewable Energy

The design team should consider the use of on-site renewable energy on projects. Life-Cycle Comparative Studies (LCCS) will be used to determine appropriate systems. LCCS analyses should incorporate all available rebates and incentives. These may include programs such as the New Jersey Clean Energy Program. Renewable energy includes: wind, solar power, solar thermal and solar hot water heating systems. Ground-source heat pump systems do not fall under this category, but rebates may still apply.

12. Measurement and Verification

Measurement and verification will continually confirm that all building systems are operating as intended and will provide data to inform further operational improvements. Monitoring equipment should be used for end-uses such as lighting systems, motor loads, and HVAC equipment. Data from this equipment will be analyzed and appropriate adjustments made to verify that systems are meeting the energy performance requirements set forth by the design team. Projects shall comply with the requirements of Section 3.2 (Automatic Temperature Controls and Energy Management System) and with the project Commissioning Plan as described in standards section 3.13 Commissioning.

END OF DOCUMENT

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. NFPA 70 - National Electrical Code
- E. NFPA 72 - National Fire Alarm code

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. FM Global is the University's current property insurance carrier. Effort should be made to comply with FM standards. If FM designs are not feasible – the design team is to communicate no compliance with the Project Manager. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers University Code Analyst, the and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

The Designer is to first review the Princeton University Master Technical Specifications for the project, and is to proceed into design guided by that specification. Any variations proposed by the Designer from the master spec are to be reviewed with the University's Project Manager, Code Analyst and Special Projects Coordinator of Site Protection, and, if the change is to be incorporated, it may be reviewed with the author of the Specifications, Hughes Associates (through the Special Projects Coordinator). This document is only available to the design team in uneditable pdf format. All project specific edits by the design team will be completed by the University. A new project specific pdf file will then be distributed to the design team.

The Designer is to meet with the Special Projects Coordinator of Site Protection and Simplex during the preliminary design phase to familiarize themselves with system requirements. During preliminary design and design development the Designer is to consult with the Project Manager and the University’s Code Analyst to define code strategies and to discuss code any interpretations affecting the project.

7. Requirements for Documentation

Along with the specifications, the Designer is to produce sufficient documentation to allow for code review of the alarm project and for contract bidding of the work. This documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Design Intent	X			
MEP Basis of Design		X		
Floor plans showing locations of all devices that are part of or connected to the system;		X	X	X
A complete riser Diagram showing all devices that are part of or connected to the system;			X	X
Final Room number designations		X	X	X
Specifications		X	X	X
Details for a sequence of operations (selective signaling, control by event, etc.)			X	X
Details of fire alarm equipment connections and mounting requirements;				X
Details of connections between fire alarm system and any special devices, and connections between alarm system and telephone system, with mounting details.				X
Proprietary design requirements per IBC 2015 (NJ Edition) 907.1.2				X

Separate Floor Plans are required for Fire Alarm Plans. The drawing number or sheet label shall use FA as the prefix. The Designer is to coordinate reflected ceiling plans with all trades.

8. Guidelines for System Installation and Performance

A. Reportability

1. Fire alarm control panel is to report to location at Department of Public Safety via University fiber; Contractor will provide the communications interface for point I.D. at panel.

2. Designer to consult with Special Projects Coordinator of Site Protection for details for mounting the communications interface and for related wiring to be provided by contractor.

B. New Construction and Renovation

1. All fire alarm devices and junction boxes shall be accessible and mounted at heights compliant with NFPA. If an existing box location is to be reused, the height shall be discussed on a case-by-case basis.
2. Raceways in finished areas are to be concealed where possible. During programming and preliminary design raceway layout is to be reviewed with University Project Manager and manufacturer's rep; raceway layout is to be approved by University prior to design development phase.
3. In the event that exposed raceway must be employed, Designer is to review the approach to be taken to running raceway, and is to specify the appropriate material.

C. Consideration for the Hearing Impaired

1. In order to provide for variety in the housing stock available for the hearing impaired, the University typically outfits a number of rooms over and above the number required by Code. The Housing Office and the Office of the Dean for Student Life provide information for Designers on the number and location of rooms needed.
2. Special wiring arrangements are required for the strobe unit in hearing impaired rooms: the device must activate in "first alarm condition" and must be wired as separate homerun to the fire alarm control panel.

D. Magnetic Hold-Open Devices

1. In dormitories, all doors from corridors to stairs, and doors dividing corridors from public spaces are typically outfitted with smoke detector-activated hold-open devices. Other doors subject to chocking shall be evaluated for installation of smoke detector-activated hold open devices.
2. Princeton University prefers wall-mounted devices (over floor-mounted or devices for closers).
3. All locations of proposed hold-opens are to be reviewed with Princeton University, including Building Services, Facilities Department, and User during the design development phase.
4. To accommodate accessibility in egress pathways, connect hold opens to activate within 5' of a detector in alarm, plus the next adjacent door in sequence (in applicable), unless otherwise directed by the tech review team.

E. Special Requirements Due to Location

Designer is to coordinate selection of detector type with awareness of environmental conditions in the rooms protected, with special emphasis on the presence of heat-producing equipment, supply diffusers and return-air grilles, and other equipment that might prevent the proper long-term operation of the fire alarm devices.

F. Beam Detectors

Due to high maintenance requirements, beam detectors are only to be used in special cases, typically atriums and other spaces where a smoke detector would otherwise be above 15 feet in height. Review any proposed installation of beam detectors with University personnel during design programming phase.

G. VESDA System

Due to high maintenance requirements, a VESDA system shall only to be used in special cases, typically atriums and other spaces where a smoke detector would otherwise be above 15 feet in height. Review any proposed installation with the Special Projects Coordinator of Site Protection during design programming phase.

H. Smoke Control System

If a smoke control system is required every effort should be made to make the system fully automated, including resetting itself once an activated system is no longer required. The sequence of operations will need to be reviewed with the Special Projects Coordinator of Site Protection and the University Code Analyst. See Section 1.4 (Regulatory Agencies) item 14.

I. Interface Between Fire Alarm Control Panel and Other Equipment

In addition to providing alarm notification to the proprietary supervising station at 200 Elm Drive, fire alarm control panels are generally no longer used to supervise building systems and report failures of critical building systems, such as environmental/ HVAC systems, sewage ejectors, refrigeration equipment, etc. Review any additional requirements with the Project Manager. BAS is the preferred reporting platform for non-fire alarm related building reporting points.

J. Requirements for Fire Alarm Control Panel Locations

1. Fire alarm control panels (FACPs) are to be located in proximity to other equipment controls, preferably in mechanical equipment rooms or electrical vaults. FACPs are only to be installed in dry temperature controlled locations.
2. All wiring leaving the FACP shall be labeled as to its purpose.
3. One OIT outlet shall be installed with each panel that reports to the proprietary system at 200 Elm Drive.
4. A duplex A/C power convenience receptacle is to be installed below the panel.
5. A four-foot fixture (on emergency power) is to be installed over the FACP with an on – off toggle switch in close proximity.
6. Coordinate smoke and heat detector locations to allow for annual maintenance. Ensure proper clearances for access are provided.

9. Requirements for Room and Device Designations

It is the intent of all projects to have permanent room numbers assigned during the Design Phase. It is the responsibility of the Consultant to initiate and complete this process, and the Project

Manager's responsibility to gather required approvals. All Drawings shall reference the University approved final room number system as per Appendix 1.5-3.

The Room number assignments must be coordinated with the building signage and FA System nomenclature designations. A sample spreadsheet for coordinating this can be found in [✓SD-32](#) Appendix 2.8-2. In summary the process is as follows:

- Consultant develops final room numbers during Design Development
- FA vendor determines device nomenclature using above information and prepares a submittal for review
- Consultant & PM verify nomenclature is consistent with Public Safety requirements. This can be done through the Special Projects Coordinator of Site Protection at 258-3659
- After approval, vendor inputs device nomenclature into FA panel

The PM and Consultant also are responsible for coordinating the approved device nomenclature with the approved building signage package. Avoid conflicts with installed signage and the approved FA room number designations.

After the final fire alarm nomenclature is developed, the Fire Alarm Contractor is also responsible for producing laminated, secured to a wall, fire alarm floor plans showing all devices with point I.D. numbers. These Drawings shall be done at such a scale as to be easily readable by those responding to alarm calls, and sized to fit in the immediate vicinity of the fire alarm panel.

10. Requirements for Fire Alarm System Commissioning

- Commissioning shall be performed in accordance with Section 3.13 of this manual and the requirements of the Master Fire Alarm Technical Specification per Appendix 3.4-1
- In addition, the extent of audibility and candela testing shall be determined during the schematic design phase of a project, either using in-house, or an independent third party commissioning agent (acceptable by the University).
- Tech Team representatives from Site Protection shall be an integral part of the commissioning process
- The Designer is responsible for conducting the final acceptance test with the fire alarm system representatives and the fire alarm contractor.
- Room numbers are to be on all building doors prior to final testing.
- The Designer is responsible for witnessing and approving the acceptance test. The Designer shall certify the printout of the test data, including the point I.D. readout at 200 Elm Drive, and shall deliver a signed and sealed copy to the municipal building official as part of the occupancy permit process, if allowed by the municipality.

11. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the fire alarm contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

The as-builts are to include the following as a minimum:

- Fire alarm identification points, location and nomenclature
- Fire alarm layout plan (complete with all other system interfaces and all components)
- Equipment schedule
- Final as-builts shall be submitted on AutoCAD files (within 2 versions of current release) and include conduit/wire runs showing splice locations.
- Copy of the Fire Alarm Program File from installation vendor.
- Sequence of operation matrix
- Updated battery calculations

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

The Designer shall meet with Project Manager, Design Architect and End User to develop lighting types for all spaces. During this time, the Designer is encouraged to investigate emerging technologies of fixtures, lamps and lighting methods. Generally, full scale mock-ups of emerging technology fixture selections require input and approval by the University Architect and Facilities Engineering. These prototypes will be previewed for color rendition, energy consumption, light output, aesthetic appeal, lamp maintenance and established manufacturers, along with conformance with applicable local ordinances.

Lighting fixture types should be reviewed on a case-by-case basis. When suspended ceilings (10'-0" or above) can be utilized, pendant mounted indirect/direct fixtures are preferred.

In Academic/Administrative Buildings with low ceilings (10'-0" or below), or no ceilings, direct lighting is preferred.

Designer will be required to provide light level calculations and energy efficiency as it relates to typical spaces for review and compliance with established standards (IES Standard) of light level quality. Coordinate any dimming requirements with end user.

Preferred type of Room lighting (where applicable):

1. Classrooms – Pendant mounted Indirect/Direct energy efficient fixture when ceiling height allows.

Emergency lighting shall be installed in each assembly space with occupancy of more than 50 people.

Refer to section 2.2 AV Standards and 2.3 Classroom and Conference Room design for specific lighting requirements.

2. Administrative Areas and Offices – Pendant mounted Indirect/Direct energy efficient fixture or recessed energy efficient fixture. Consider accent lighting. Accent lighting on perimeter walls should be considered.
3. Student Dormitory Rooms (Studies and Bedrooms) – Indirect energy efficient wall sconce. See Appendix 3.5.3. See Section 2.4 – Page 19 for acceptable mounting locations and heights.
4. Laboratory Rooms – Pendant mounted Indirect/direct energy efficient fixture. Where possible at bench locations, under cabinet/shelf task lighting is preferable.
5. Mechanical Spaces – Linear industrial protected reflector energy efficient fixture
6. Public Spaces –Energy efficient /Decorative based on use of space, quantity and configuration.

7. Guidelines and Requirements for Documentation

Along with the specifications, the Designer is to produce sufficient documentation to allow for code review of the lighting system and for contract bidding of the work. This documentation shall be coordinated with all trades and will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
Notes & Symbols		X	X	X
Lighting Plans		X	X	X
Location and type of control device. Provide operating logic description for occupancy sensors, day/night controls and dimming systems.			X	X
Panelboard Schedules			X	X
Lighting Fixture Schedule including; Manufacturer dimensions, model numbers, number of lamps, type of lamps, watts/fixture, volts, mounting characteristics and color/finish.			X	X
Specifications including product data sheets for each proposed lighting fixture		X	X	X
Details				X
Coordinated Architectural reflected ceiling plan and Engineering lighting plan showing location and types of all fixtures.				X
Networked Lighting Controls – Schematic Diagram: sequence of operation matrix, lighting control hardware, fixtures, wiring diagrams			X	X
Networked Lighting Controls – on lighting plan drawing: control hardware and zones				X

8. Guidelines for System Installation and Performance

A. New Construction and Renovation

1. Design shall facilitate ease of fixture maintenance and replacement of lamps. All fixtures and junction boxes shall be accessible.
2. Raceways in finished areas are to be concealed where possible.
3. Ceiling heights over 15 feet shall be reviewed by Project Manager and Electrical Maintenance Shop Foreman to address lamp, driver and ballast access.

B. Lamps, Ballasts and Drivers

1. The required color temperature for LED fixtures is 3000K in office / meeting rooms. Acceptable color temperature for other applications to be discussed with Facilities Engineering and the Office of the University Architect.
2. If selected, 4'-0" LED lamps shall have a color temperature of 3000K. For special use areas, other color alternatives shall be considered.
3. Minimize the number of different types of lamps per building.
4. Ballast shall be programmable start two, three or four lamp ballasts as appropriate. PL lamps shall have electronic ballast. Dimming ballast to be **compatible with both Lutron Ecosystem and DALI protocols**.
5. The range of dimming ballasts should typically be 100% to 5% for all dimmable fixtures.
6. Consideration shall be given for lamp replacement. A minimum of ¼" around the edge of the lamp for hand clearance is preferred for lamp replacement.
7. ALL drivers and ballasts need to be accessible for maintenance purposes. Consider remote ballasts/drivers for hard to reach / high volume and/or atrium spaces.
8. Provide access to drivers for all LED fixtures. In historical/high finish areas consider "retrofit" fixtures for ease of access to LED fixture drivers.

C. Exterior Lighting

1. Campus-wide gas style post lamp (208 volts) to be used in the older section of Campus for both street and walkway lighting. This type of fixture is proprietary, provided by PU and installed by the contractor. Typical configuration is a LED lamp, spaced 60' to 70' apart. The lamp base is to be installed on a poured in place footing, no pre-fab footings.
2. Non-Main Campus site lights (shoe box) LED fixture to be used in parking and roadway areas, voltage shall be 480v (208/120v in special applications). See Appendix 3.5-4 for fixture cut sheet, Check with Landscape Coordination Committee (LCC), Section 2.9.
3. Bollard fixtures. Locations are driven by Landscape Coordination Committee (LCC). Fixtures to be LED.

4. The control of exterior gas style post lamp lighting shall be through a photocell with a keyed by-pass switch and lighting contactor, maximum height 6'-0". Locate photocells on north face of adjacent building. Consider motion-sensing for instantaneous-on exterior fixtures for building.
5. Regardless of fixture, all exterior light poles shall have grounding rods.
6. Parking lots/structures to have LED fixtures with bi-level motion and daylight dimming controls. **Control modules to be Lumewave wireless.**
7. **All exterior lamps color temperature to be 3000k or warmer.**

D. Exit Signs

1. Sign shall be red or green LED with diffuser panel, such that LED sources are not directly visible.
2. Any surface-mounted exit sign mounted on edge below 9'-0" requires redundant support along a second edge or side. Preferably located at a wall/ceiling intersection.

E. Emergency Lighting Circuiting

1. Emergency Lighting levels in egress paths shall be in accordance with the NEC. In each stairwell connect a minimum of ½ of the fixtures to the emergency system and the other ½ to normal power. In each bathroom connect an un-switched fixture over the sink to the emergency system; avoid using any fixtures located by the door. Each mechanical and electrical room should have one or more fixtures connected to the emergency system. These fixtures should be controlled by a switch with a pilot lit handle located closest to the door buck where the space is entered. UL924 relays on emergency fixtures or equivalent functionality by centralized control system. (for this whole section)

9. Lighting Controls

In general, lighting controls should be considered for energy requirements and to meet dimming requirements. Consideration for the size and space requirement for a networked lighting control system should be taken into account early in the design process. The Designer should locate the lighting properly so as to not create needless maintenance, under-use of fixtures, or unreasonably high initial or life cycle costs. Based on these criteria, the University has identified several areas where controls have been successfully incorporated into the design.

A. Dimming Controls – typically suggested, at a minimum, in the following spaces:

1. Classrooms (See section 2.3)
2. Audio/ Visual areas
3. Dining Halls and other large gathering spaces
4. Large multi-user laboratory spaces
5. Discuss additional dimming possibilities with Facilities Engineering

B. Occupancy/Vacancy Sensors

1. Typically motion sensors configured as occupancy or vacancy sensors will be located, at a minimum, in Restrooms, Offices, Meeting Rooms, Classrooms, Hallways, Laboratories, Library book stacks, and Locker Rooms, Dorm lounges/kitchen/common

room/laundries. Review these and any other locations with Project Team. Include manual override feature for offices and classrooms. Discuss with Facilities Engineering whether the sensor should be configured as occupancy or vacancy sensors.

2. Typically light shall remain lit for 15 minutes after occupant has left (30 mins for fluorescent bulb). See Appendix 3.5-7 for Typical Programming Standards for Occupancy / Vacancy Sensors

C. Daylight Requirements

1. Designer to review with Project Team when and where daylight sensors can be used.
2. Daylighting will be utilized as a primary light source in all new buildings for both energy savings as well as improved indoor environmental quality. Project specific Daylighting Coverage Goals are outlined in Section 3.3.7 (Energy Guidelines).

D. Egress Lighting Verification

1. The extent of foot candle testing shall be determined during the schematic design phase of a project, either using in-house, or an independent third party commissioning agent (acceptable by the University).

10. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the contractor. Designer shall verify all branch circuiting (lighting and power) has been shown in its entirety including conduit runs, number of wires in each conduit and panel/circuit numbers.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation.

Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

See Section 1.5 (Documentation and Archiving).

11. Requirements for Spare Lamps

10% of the total number of specialty lamps in proportion with the various types shall be provided for spare storage. Discuss need for attic stock items with Grounds and Building Maintenance. Location will be determined by the Project Manager. Included with this submittal shall be a written list of fixture descriptions and their corresponding lamp type. This shall be supplemented with a copy of the approved light fixture schedule with respective room numbers designated for each fixture type.

END OF DOCUMENT

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

See Matrix at end of this section.

Additional requirements for specific areas of documentation are as follows:

Required Documentation	SD	DD	50% CD	85% CD
Key Map	X	X	X	X
Vicinity Map	X	X	X	X
Existing Conditions Survey	X	X	X	X
Site Utilities Plan	X	X	X	X
Preliminary Site Plan	X			
Overall Site Plan		X	X	X
Coord. Planting/Utility Plan		X	X	X
Demolition and Removals Plan		X	X	X
Grading Plan		X	X	X
Site Lighting Plan		X	X	X
Soil Erosion and Sediment Control		X	X	X
Construction Details		X	X	X
Outline Specifications		X		
Full-Length Specifications			X	X
Fire Protection Site Plan			X	X

6. Procedural Guidelines

The Designer shall meet with Project Manager, Manager, Civil Engineering and Construction, Energy Plant Manager, Executive Director of Engineering & Campus Energy to ascertain the type of building(s) and the anticipated utility demands.

During programming and preliminary design and design development the Designer is to consult with the Project Manager, Manager, Civil Engineering and Construction, Energy Plant Manager, and Executive Director of Engineering & Campus Energy.

Existing Conditions mark out procedure is as follows:

If there is a need for existing utility mark-out during the design phase, the A/E shall contact the Manager of Civil Engineering and Construction to have the utilities staked out. Refer to Appendix 3.6-1 for additional information.

Excavation mark out procedure is as follows:

Princeton University is registered with the State of New Jersey "One-Call System". All contractors prior to excavation on any University project shall contact New Jersey "One-Call System" at, 1-800-272-1000 or 811. Refer to Appendix section 3.6.-2 for additional information.

7. Positional and Tolerance Requirements for Existing Conditions Surveys

At the beginning of a project the existing conditions survey should be started early in the process and shall be completed by the of schematic design submission. All existing conditions surveys indicating the location of Surface Utilities or surface accessible indications of underground utilities (i.e. Manholes, valves, inverts within manholes, vents, etc.) must locate the utilities to within 0.01 of a foot, horizontal and vertical.

It is understood that the underground utilities without visible surface structures are not able to be located at this accuracy at the time of a survey, unless trench or other means of excavation is at time of survey. Where subsurface utilities are not exposed for location, industry standards for location are acceptable. The Manager, Civil Engineering and Construction is to be notified of any discrepancies discovered between the field survey and the University base map.

However, if a trench or other excavation is planned during the course of a project, it is expected that the actual location of subsurface utilities will be obtained and included in subsequent revisions of the plans.

8. Guidelines and Requirements for Documentation

As early as possible in the programming stage, the Designer is to produce sufficient documentation to allow for utility system planning and interconnection with the existing infrastructure. This documentation will include, as a minimum:

- A. Provide a table indicating building peak, average, and minimum utility demands including: electric demand in kW, steam flow in M#/hr, chilled water flow rate in gallons per minute, and total chilled water capacity in tons, firewater and domestic water flows. Generally there are two water service entrances per building one for domestic water and one for fire protection water.
- B. Project to plan for exterior water service meter pit on all buildings.

- C. Anticipated annual building energy use. (steam, electric and chilled water)
- D. Building location and footprint.
- E. During preliminary design, a drawing conveying all utility interface points and a table listing required capacities at the building envelope shall be submitted.
- F. Provide invert elevations of all gravity drain piping especially foundations and exterior below grade stairs.
- G. Designer may be required to calculate sewage flow requirement needed for sewer connection permit. Check with Project Manager.
- H. Designer shall contact Manager, Civil Engineering and Construction as early as possible but no later than 50% CD submission when applications are being submitted to a Public Utility for any of the building services.

9. Guidelines for System Installation and Performance

The Facilities Operations, Civil Engineering Department typically performs the installation of most campus utilities. This shall be confirmed during preliminary design. Requirements for design services shall evolve from this meeting.

- A. All tie-in points for utilities shall be coordinated with Facilities Engineering Department and Facilities Operations, Civil Engineering Department.
- B. Indicate on Documents all connections to Building. i.e., direct burial, tunnel, etc.
- C. Special attention should be paid to preserve any geodetic monuments. See section 2.9 Site Planning, item 16.
- D. A coordination meeting with Facilities Engineering and Civil Engineering and Construction shall happen early in the design process to coordinate burial depths at point of entry into the building.

10. Requirements for Acceptance of Utility Installations

- A. All underground utility systems installed by contractors shall be inspected by either the Facilities Operations Civil Engineering Department or their designated inspector. This inspection is to ensure that the installation is in accordance with the design documents and/or standard industry practice when no detail is provided in the design documents.
- B. A coordination meeting with the Facilities Operations Civil Engineering Department shall happen early in the design process to coordinate what inspections are necessary and the frequency of the inspections.

C. A table listing all utilities and typical inspections is below:

Inspection Type	STEAM / LOW TEMP HW / CONDENSATE / CW	FIRE PROTECTION / DOMESTIC WATER	ELECTRIC / OIT	GEOTHERMAL
Trench	PU	PU	PU	PU
Depth	PU	PU/Municipality	PU/Municipality	PU
Bedding	PU	PU/Municipality	PU/Municipality	PU
Pipe	PU	PU/Municipality	PU/Municipality	PU/Municipality
Backfill	PU	PU	PU	PU
Pressure Test	PU	PU/Municipality	PU/Municipality	PU/Municipality
Concrete Encasement	---	---	PU	---

11. Requirements for Easements

- A. All utilities that are owned by a public entity may require an easement.
- B. Existing easements shall be shown on the construction plans. These plans shall include:
 - a. The location, dimensions, and specified use of each existing easement
 - b. The recording information of the existing easement, including the document number or the book and page number of the existing easement
- C. Proposed Easements shall be developed by the design team and submitted to Princeton for review by the Office of General Counsel.
- D. Easements will be filed with the public entity by the design team as part of their design services.

12. Requirements for As-Built Drawings

- A. All points of interface with campus utility infrastructure must be documented on the related building Drawings and schedules. Confer with Facilities Engineering at closeout for delivery of reviewed as-built site plans to facilitate updating University utility maps. This shall include but not be limited to: all utilities (including phone & data) enter building (location & shutoffs, etc.), area draining, outdoor irrigation layout and controls location. Site plans to be transmitted in both pdf and AutoCAD format.
- B. The table listing all campus utility interface points and required capacities at the building envelope shall be updated with other project Drawings.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

SERVICE REQUIREMENTS FOR UNDERGROUND UTILITIES (*)

	STEAM	LOW TEMP HOT WATER	CONDENS.	CHILLED WATER	DOMESTIC WATER	FIRE PROTECTION	ELECTRIC OFF CAMPUS	ELECTRIC ON-CAMPUS COGEN	GEOTHERMAL
Ownership	PU	PU	PU	PU	NJ AMERICAN WATER	NJ AMERICAN WATER/PU	PSE&G	PU	PU
Design Responsibility	PU	PU	PU	PU	PU/AE	PU/AE	PU/AE	PU	PU/AE
Demand Calcs. by	A/E	A/E	A/E	A/E	A/E	A/E	AE	A/E	A/E
Point of Interface	INTERIOR	INTERIOR	INTERIOR	INTERIOR	EXT.	INTERIOR	REVIEW	INTERIOR	INTERIOR
Permit or Application Requirement	NO	NO	NO	NO	YES	YES	YES	YES	NO
Redundancy	NO	NO	NO	NO	NO	NO	NO	YES	NO
Existing u/g Locations on File?	YES	YES	YES	YES	YES	YES	NO	YES	YES

(*) – Third Party or University oversight is required during installation of below grade utility lines when not installed by PU Civil Engineering.

	EMERGENCY ELECTRIC	SEWER SANITARY	SEWER STORM	GAS	DATA OIT	DATA VOICE	DATA ATC	DATA SECURITY
Ownership	PU	PSOC/PU	MUNICIPALITY/PU	PSE&G	PU	PU/ VERIZON	PU	PU
Design Responsibility	PU	PU	PU	PU	PU	PU	PU	PU
Demand Calcs. by	PU	PU CONSULTANT	PU CONSULTANT	A/E	N/A	N/A	N/A	N/A
Point of Interface	INT.	EXT.	EXT.	EXT.	INT.	INT.	INT.	INT.
Permit or Application Requirement	YES	YES	YES	YES	NO	NO	NO	NO
Redundancy	NO	NO	NO	NO	NO	NO	NO	NO
Existing u/g Locations on File?	YES	YES	YES	YES	NO	REVIEW	REVIEW	REVIEW

- E. NFPA 13 - Installation of Sprinkler Systems
- F. NFPA 14 – Standpipe and Hose Systems
- G. NFPA 20 – Stationary Pumps for Fire Protection

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. FM Global is the University’s current property insurance carrier. Effort should be made to comply with FM standards. If FM designs are not feasible – the design team is to communicate no compliance with the Project Manager. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. The review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

During pre schematic design the Designer is to consult with the Project Manager, University’s Code Analyst and University Fire Marshall to define code strategies and to discuss any code interpretations affecting the project. The Designer is to review system requirements with the Project Manager and research existing infrastructure and capacities near the project area prior to laying out the new system. ✓PS-23

The Designer, with the Project Manager, is to request from the Code Analyst any available hydrant or pump test data. In the absence of such data, the Designer shall request that the water utility, New Jersey American Water, test hydrants in the project vicinity to obtain the flow test data needed to design the system.

In early review with the Project Manager and the University Code Analyst, a decision will be reached whether to proceed with a proprietary design, including full hydraulic calculations,

design, and dimensioned layout of the system (shop drawing equivalent), or whether a performance specification will be used for the project. This shall be determined prior to establishing the Design Fee. The preference of the University is to have the designer provide a fully researched and documented design. **Failure to confirm the type of design with the Project Manager will mean that it should be a proprietary design by default** (shop drawing equivalent).

In consultation with the Project Manager and Code Analyst, the Designer is to determine the type of sprinkler system to be used in the building or part of a building. Depending on the use of a building or spaces within the building the following systems might be used:

- A. Wet Pipe System
- B. Dry Pipe System
- C. Preaction System
- D. Deluge System (see following Standards Section for special suppression)
- E. Standpipes

When Pre-action or Deluge Systems are selected for use in buildings equipped with standard University addressable fire alarm systems (Simplex), the initiating devices and related components shall be the same manufacturer and Model as the building system, unless otherwise directed by the Site Protection Group. Release Modules, UL Listed for the specific operations designed, shall be used in lieu of packaged systems when possible.

The Designer, with the Project Manager and Code Analyst, must also determine whether additional suppression methods or equipment is necessary for the project; these may include:

- A. Wet Standpipe System
- B. Dry/Manual Standpipe System
- C. Fire Department Connection
- D. Fire Pump

To provide some guidance on this issue, the intent will be to keep standpipes in all buildings that have standpipes before a renovation. Those buildings that do not have a pre-existing standpipe can be evaluated on a case-by-case basis with the understanding that standpipes are preferred but might not be required. The Director of Office of Design and Construction or the Vice President for Facilities in conjunction with the Code Analyst will make the final decision.

All Dormitory standpipes will be dry and charged using a post indicator valve located near the fire department connection to prevent unauthorized use and/or vandalism. The sprinkler and standpipe systems shall be designed so the fire department can pump in to both systems through the F.D.C. (fire department connection) independent of the PIV being open. A Variation is required from the Authority Having Jurisdiction (AHJ) to do this as a matter of protocol.

7. Requirements for Documentation

Along with the specifications, the Designer shall produce sufficient documentation for a code review of the suppression project and for contract bidding of work. If a proprietary design is the approach chosen by the University, the documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
Notes & Symbols		X	X	X
Site Plan for utility conn & PIV locations		X	X	X
Floor Plans – total zoning package		X		
Floor Plans – device locations			X	X
Riser Diagram			X	X
Specifications			X	X
Floor Plans – dimensioned piping routes				X
Hydraulic Calculation ¹				X
Details – alarm equip conn & mounting				X
Hanger locations				X
Seismic Restraint details ²				X

Notes:

1. *Stand pipe systems require hydraulic calculations.*
2. *Seismic bracing is required on pipe 2-1/2" and larger.*

The Designer shall coordinate reflected ceiling plans with all trades. All plans, specifications, hydraulic calculations, shop drawings, etc. shall be signed and sealed by a professional Engineer or Architect licensed in New Jersey. All contractor prepared documents and permit applications shall bear the license and certification number of the Contractor.

8. Guidelines for System Installation and Performance

A. General Approach

1. Construction Permits are required for all work unless specifically excluded by Section 5:23-2.7, or other Section of the State Uniform Fire Code (UCC).
2. Amended Construction Permits are required for all work not installed per the approved plans released by the Authority Having Jurisdiction
3. Refer to Section 1.4 of this Standard, "Regulatory Agencies", for the administrative requirements of System Installation and Performance.
4. All work and installation of fire protection and alarm systems shall be performed by Contractors licensed and certified by the state of New Jersey DCA.
5. All sprinkler system components shall be UL listed in accordance with NFPA Sprinkler Requirements.
6. Sprinkler piping is to be concealed where possible in finished areas.
7. In areas with finished ceilings, use concealed pendant heads, unless otherwise approved by the Project Manager in conjunction with the Code Analyst. Typically, provide factory-finished heads of a color to match ceiling finish.

8. When sidewall sprinklers are used, flush heads are required for exposed installations. Concealed (flat cover) sidewall heads shall be used in finished walls and soffits unless otherwise approved by the Project Manager in conjunction with the Code Analyst. Consult with University Code Analyst for location and types of sprinkler heads.
9. Flexible drops are accepted in limited applications. All drops shall be stainless steel, UL listed and FM approved.
10. Heat trace is typically not acceptable. Any heat trace proposed for the project is to be reviewed and approved by the University Code Analyst, Facilities Site Protection Manager and the Facilities Site Protection Supervisor.
11. Install dry pipe valves in basement or lowest level of the building with proper means for drainage, unless not physically practical (as confirmed by the Facilities Site Protection Group).
12. Install PIV's for Private Fire Mains. The PIV shall be a lockable control valve, or a OS& Y valve with a Tamper Switch in a pit and installed in accordance with NFPA 24.
13. Provide additional sprinkler coverage, as required, in areas obstructed by surface mounted equipment, i.e. lights, projection screens, fan coil units, etc.
14. Air compressors need to fully charge the system within 30 minutes.
15. For Fire pumps, the straight length of pipe into the suction of the pump, must be 10 times the diameter of the pipe.
16. Check valves are to be installed on feeds to new building fire protection systems, especially when fed from a fire pump that supplies more than one (1) building.

B. Piping

1. The following types of piping are acceptable for use:
 - a) Schedule 40 Steel, screwed or grooved; galvanized for exterior applications, dry and pre-action systems as well as drains in wet systems;
 - b) Type K or L copper (for underground, type K only);
 - c) Schedule 40 CPVC (with University Code Analyst and Facilities Site Protection Supervisor approval prior to design);
 - d) Cement-lined Ductile Iron (for underground use only).
 - e) Pipe must be welded if installed in areas not accessible.
 - f) Dry pipe systems must be accessible for inspection.
2. Drain lines, inspector's test valves, and fire pump test headers for sprinkler systems are to be piped to the exterior to a location approved by the University Facilities Site Protection Manager and Facilities Site Protection Supervisor.
3. Drain valves, control valves and inspector's test valves are to be readily accessible for maintenance and test personnel: valves are to be accessible from floor level (not to exceed 7'-0" A.F.F.) and are not to be blocked by piping, fixtures, ductwork, or the like. Review proposed locations with University Facilities Site Protection Manager and Facilities Site Protection Supervisor prior to beginning system installation.

4. Adjustable drop nipples shall be UL or FM approved.
5. Flexible drop assemblies to have a rating of 200 psi.

C. Heads

1. Sprinkler heads are to be Bellville spring seal type, such as those manufactured by Viking or equal. Sprinkler heads relying on O-rings for seal are NOT to be used.
2. Concealed pendant heads are to be used in finished ceilings.
3. Concealed sidewall heads are to be used in finished walls and soffits.
4. Listed sprinkler head cages shall be installed for all heads mounted 7' or lower or subject to mechanical damage.

D. Valves

1. Control valves shall be equipped with a port to monitor street side of system. Valves to be by Kennedy (OS&Y) and Kennedy or Victaulic for butterfly valves.
2. Double-check valve and RPZ/backflow preventers are to be by Ames.
3. Dry system activation valves are to be by Viking or Victaulic.
4. Alarm check valves are to be by Viking or Victaulic.
5. PIV's shall be Kennedy or Mueller, lockable, with no supervisory provisions.

E. Flow Indicators and Supervisory Devices

Flow and tamper switches and any additional supervisory devices are to be manufactured by Potter.

All flow and Supervisory devices shall initiate a building alarm, and report the condition to the Public Safety Dispatch Desk through the building fire alarm system-signaling unit. (Simplex).

F. Inspectors Test and Drain

Drain shall be AGF model 1000. Install a valve at the lower end of the main line to remove air from system.

G. Standpipes

1. Include post-indicator valve on all manual dry systems for all R2 Dormitory Projects.
2. Install a locking device on exterior valve (not a tamper switch).
3. At entry point, install OS&Y valve with an auxiliary port for testing; provide 1/2" ball valve with capped outlet on test port.
4. For Manually Dry Standpipes: Note that if piping is concealed in building it must be visually accessible for inspection (by mirror and light at the least). Plan and provide access doors with the appropriate fire resistance rating in building finishes as necessary to provide for inspection.

5. Provide valves at the base of risers. All valves must be accessible (public areas) and must drain to exterior of building at grade level. All drain valve location must be reviewed.
6. Provide vent valve at top of each riser.

H. Backflow Preventer

1. Ames Silver Bullet
2. When chemical treatment is utilized, an Ames 4000 RPZ backflow preventer shall be installed with valves – provide drain line to closest floor drain.

I. Fire Department Connections (F.D.C.)

1. Guidelines require that fire department connection be within fifty feet of a fire hydrant, and outside the exterior collapse zone of the building served. After determining preferred location, review location with the local Fire Official, and obtain approval.
2. Pipe threads for connection of fire department equipment shall be 5” Storz connection, unless directed otherwise by the AHJ. In that case the connection will be NST (National Standard Thread)
3. All connections to be 5” Storz large diameter hose outlets. Supply a sleeve over piping to match the head (brass/chrome) as well as an identification sign.
4. The F.D.C. shall be UL listed
5. Provide a Knox lock cap for FDC. Coordinate with Site Protection.

J. Air Compressors

1. For dry and pre-action systems, air compressors are to be by General unless otherwise directed by the University Facilities Site Protection Manager.

K. Microbiological Influenced Corrosion (MIC) Treatment

1. MIC chemical treatment shall be installed as directed by Facilities Site Protection. Site Protection shall determine the manufacturer of the chemical treatment system to be used.

9. Requirements for Suppression System Testing

The system is to be ready for testing prior to scheduling a test with the local enforcement agency. A pre-test is to be conducted prior to scheduling the official test for approval. The system shall be ready for inspection.

The procedure for testing shall be followed closely in accordance with NFPA 13. A Representative(s) of the University Facilities Site Protection Group shall be present for the hydrostatic and acceptance tests of the system, and the local Fire Subcode Inspector.

The contractor will be responsible for the acceptance test for the local enforcing agency, and for any remedial work and re-testing required. Contractor is responsible for draining systems as

needed for test or repair, and for recharging system so they are left in operating condition. Hydraulic calculation placards shall be installed at main sprinkler risers prior to acceptance testing.

10. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the Fire Suppression Contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the Contractor is maintaining record Drawings to convert to as-builts.

The as-builts are to include the following as a minimum: layout plan complete with all other system interfaces and all components, riser Diagram, equipment schedule, hydraulic calculations, etc.

The University Project Manager is responsible for distributing copies of the as-builts to the appropriate University representatives for review prior to project closeout. In addition to posting of all as-built documents to Centric Project, a hard copy and electronic copy (CD) shall be provided to the Facilities Mechanical System Coordinator for Life Safety and Security.

See Section 1.5 (Documentation and Archiving).

11. Requirements for Spare Parts

A spare head cabinet(s) is to be provided near the entry point of the sprinkler system to be determined by Facilities Site Protection. A minimum of six replacement heads, or each type used in the system, are required to be provided with the cabinet. The proper sprinkler head wrench(s) for replacement of heads will be required. Include spare part requirements in all specifications.

When dry heads are installed and there are more than three (3) pieces of the same length, the Contractor should provide a spare head to match.

END OF DOCUMENT

1. Introduction

Fire suppression chemical installations today range from protecting rare book collections in Firestone Library and the painting storage rooms in the Art Museum, to providing life safety in more typical locations such as an exhaust hood in a Dining Services food preparation area.

Dormitory food preparation areas require discussion of the requirements for hood suppression at cooking sources. Generally, the hood suppression requirement is a function of the type of usages programmed for the dormitory kitchen considered. This discussion must occur in conjunction with the Housing Office and University Code Analyst.

Chemical fire suppression systems also include hand-held extinguishers, distributed in buildings. Note that the local fire code official has jurisdiction regarding the placement of fire extinguishers.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. University Code Analyst MacMillan Building, 609-258-6706
- C. Facilities Mechanical Systems Coordinator,
Site Protection 306 Alexander Street, 609-258-3659
- D. Facilities Site Protection Supervisor 306 Alexander Street, 609-258-8132
- E. Director of Engineering MacMillan Building, 609-258-5472
- F. University Fire Marshall 200 Elm Drive, 609-258-6805
- G. University Safety Engineer Office of Env. Health and Safety, 609-258-5849

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

PDF

- A. Environmental Safety & Risk Management (ESRM) See Project Manager
- B. Princeton Fire Extinguisher Use Matrix Appendix 3.8-2

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. NFPA 10 - Portable Fire Extinguishers
- E. NFPA 11A - Medium- and High-Expansion Foam Systems
- F. NFPA 12 - Carbon Dioxide Extinguishing Systems

- G. NFPA 12A - Halon 1301 Fire Extinguishing Systems
- H. NFPA 15 - Water Spray Fixed Systems for Fire Protection
- I. NFPA 16 - Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems
- J. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations
- K. NFPA 2001 - Clean Agent Fire Extinguishing Systems
- L. UL 300 - Kitchen Systems

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. FM Global is the University's current property insurance carrier. Effort should be made to comply with FM standards. If FM designs are not feasible – the design team is to communicate no compliance with the Project Manager. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

During pre schematic design the suppression Designer is to consult with the Project Manager, University's Code Analyst and University Fire Marshall to define code strategies and to discuss any code interpretations affecting the project. The Designer is to review system requirements with the Project Manager and research existing infrastructure and related systems near the project area prior to laying out the new system. ✓PS-23

In early review with the Project Manager and the University Code Analyst, a decision will be reached whether to proceed with a proprietary design, including full chemical calculation, design, and dimensioned layout of the system, or whether a performance specification will be used for the project. This shall be determined prior to establishing the Design Fee. The preference of the University is to have the designer provide a fully researched and documented design. **Failure to confirm the type of design with the Project Manager will mean that it shall be a proprietary design by default.**

When a Clean Agent Suppression System is selected for use in buildings equipped with standard University addressable fire alarm systems (Simplex), the initiating device shall be the same manufacturer and model as the building system. Release modules, UL Listed for the specific operations designed, shall be used in lieu of packaged systems when possible. The actuator for releasing the Clean Agent suppressant shall be a solenoid type, compatible and listed for use with the building fire alarm system Releasing Module, and capable of reuse after reset.

Kitchen Hood Suppressions Systems shall be UL Listed, and designed to provide suppression commensurate with the type of cooking proposed. The system shall be equipped with a proprietary control panel from the manufacturer, and shall be interconnected to the main building fire alarm panel (Simplex), when available. In all cases, the system shall be compliant with State Uniform Construction Code.

In consultation with the Project Manager, University Code Analyst, Facilities Site Protection Manager, Facilities Site Protection Supervisor, and the Designer is to determine the type of suppression system to be used in the application. Depending on the use of a building or spaces within the building the following systems might be used:

- A. Carbon Dioxide Gas (for renewal of existing systems)
- B. Halon 1301 Gas (for renewal of existing systems)
- C. Halon 1211 Gas (for renewal of existing systems)
- D. FM 200, Inergen, or the "FE" line of clean agent fire extinguishers (laser labs)
- E. Dry Chemical/Ansul (kitchen hoods and some labs)
- F. Wet chemical range hood systems
- G. Water misting systems
- H. Hand-held extinguishers (in general use)
- I. Additional specialty suppression systems not noted (i.e. chemical deflagration systems)

The Designer, with the Project Manager, must also determine whether additional suppression methods or equipment is necessary for the application or the particular project.

7. Requirements for Documentation

Along with the specifications, the Designer shall produce sufficient documentation for a code review of the suppression project and for contract bidding of work.

If a proprietary design is the approach chosen by the University, the documentation will include, as a minimum:

Required Documentation	Pre SD	SD	DD	50% CD	85% CD
Code Analyst Meeting	X				
Notes & Symbols			X	X	X
Site Plan for utility conn & PIV locations			X	X	X
Floor Plans – device locations				X	X
Fire Extinguisher Cabinet Locations				X	X
Specifications				X	X
Sequence of Operation for Clean Agent				X	X
Floor Plans – dimensioned piping routes					X
Hydraulic Calculation					X
Details – alarm equip conn & mounting					X
Hanger locations					X
Seismic Restraint details					X

The Designer shall coordinate reflected ceiling plans with all trades. All plans, specifications, hydraulic calculations, shop drawings, etc. shall be signed and sealed by a professional Engineer or Architect licensed in New Jersey. All contractor prepared documents and permit applications shall bear the license and certification number of the Contractor

8. Guidelines for System Installation and Performance

A. General Approach

1. Construction Permits are required for all work unless specifically excluded by Section 5:23-2.7, or other Section of the State Uniform Fire Code (UCC).
2. Amended Construction Permits are required for all work not installed per the approved plans released by the Authority Having Jurisdiction
3. Refer to Section 1.4 of this Standard, “Regulatory Agencies”, for the administrative requirements of System Installation and Performance.
4. All work and installation of fire protection and alarm systems shall be performed by Contractors licensed and certified by the state of New Jersey DCA.
5. UL listed systems and components are to be used.
6. Pre-engineered listed systems shall be utilized when possible, e.g., listed kitchen hood used in conjunction with make-up air unit tested as part of manufacturer’s pre-engineered system.

7. Complete system is to include all “options,” e.g., breathing apparatus for CO2 systems; seals, HVAC interlocks, dampers and controls, purge systems, alarm tie-ins, etc. for systems as applicable.

B. Piping

The following types of piping are acceptable for use:

1. Schedule 40 Steel, screwed or grooved (only if approved and must be listed); galvanized for exterior applications and kitchens;
2. Cleanable surface within hood and exposed in kitchen: stainless steel or chromed. (NSF approved)

C. Nozzles

1. Match the UL listed system
2. Nozzle locations must be coordinated to minimize destruction of items the system is protecting (ie: don't locate heads too close to shelving).

D. Tanks

1. All clean agent tanks shall be fitted with liquid level indicators. If agent stored in tank prohibits the use of liquid level indicators, provide an alternative means of measuring agent quantity. Weighing of tanks is not an acceptable means for measuring agent quantity.

E. Supervisory Devices

Supervisory devices or shut off valves are to be manufactured by Milwaukee (shut-off tamper combination). If there is an over-riding reason not to use the preferred manufacturer, Designer will review requirements with University Code Analyst.

F. Supervision and Reportability

Suppression systems shall be tied into the building fire alarm system panel (Simplex) and will report to the University's proprietary system. In a building that has no fire alarm panel, one shall be designed unless in the opinion of the University Code Analyst a panel is not required. In addition, shunt trip devices may be required to disable other surrounding electric appliances when the suppression system activates. Shunt trip breakers shall be designed to disable only associated devices under kitchen hood, and not other equipment in the space.

9. Requirements for Suppression System Testing

The system is to be ready for testing prior to the suppression contractor's scheduling of a test with the local enforcement agency. A pre-test is to be conducted prior to bringing code official on site for testing, so that system is leak-free and otherwise ready for inspection.

The procedure for testing shall be followed closely in accordance NFPA. Representatives of the University Facilities Site Protection Group are to be present for the hydrostatic tests of systems. Project Manager is to be present for any pressure testing of room-sealant systems.

The contractor will be responsible for the acceptance test for the local enforcing agency, and for any remedial work and re-testing required. Contractor is responsible for draining systems as needed for test or repair, and for recharging systems so they are left in operating condition.

If suppression system is tied in to building fire alarm system, representatives of the Maintenance Alarm Shop are to be present.

10. Fire Extinguishers

The New Jersey Uniform Fire Code governs (refer to NFPA 10) the placement of fire extinguishers in buildings. The Designer should review Fire Code requirements for extinguishers and carefully plan for them in the project; however, the local Code Official has jurisdiction regarding placement of extinguishers under the code. Designers should review proposed locations with the University Code Analyst prior to finalizing plans.

See Appendix 3.8-2 for recommended types of extinguishers for particular uses and locations.

The preference for mounting extinguishers is in cabinets recessed into hallway walls (and in other required room locations). Cabinet doors shall have glass panels so extinguishers are visible. If the building is to have standpipes, the preference is to house extinguishers in a combination extinguisher/standpipe cabinet. Doors without vision panels shall have proper signage identifying the standpipe and extinguisher.

11. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the fire suppression contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

On the as-builts, the contractor is to highlight changes made to submittals and approved documents.

The as-builts are to include plans, details, sequence of operation of any tie-ins to other systems, such as fire alarm, electric, plumbing, and HVAC systems.

The University Project Manager is responsible for distributing copies of the as-builts to the appropriate University representatives for review prior to project closeout. In addition to posting of all as-built documents to Centric Project, a hard copy and electronic copy (CD) shall be provided to the Facilities Mechanical System Coordinator for Life Safety and Security.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

P. Medium Pressure Drip Trap	Appendix 3.10-16	Appendix 3.10-16
Q. Cooling Coil Condensate Drain Detail	Appendix 3.10-17	Appendix 3.10-17
R. Fan Coil Unit	Appendix 3.10-18	Appendix 3.10-18
S. Air Handler Filter	Appendix 3.10-20	Appendix 3.10-20
T. Pressure Powered Pump Detail	Appendix 3.10-21	Appendix 3.10-21
U. Side – Stream Shot Feeder	Appendix 3.10-22	Appendix 3.10-22
V. Valence Piping Schematic Elevation	Appendix 3.10-23	Appendix 3.10-23
W. Steel to Copper Connection Detail	Appendix 3.10-24	Appendix 3.10-24
X. Pipe / Valve ID Schedule Requirements	Appendix 3.10-25	Appendix 3.10-25 (MS Word)
Y. Mechanical Cx Specifications	Appendix 3.13-12	Appendix 3.13-12 (MS Word)
Z. Pipe Sleeve and Fire Stopping Rqmts	Appendix 4.11-2	

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)

5. Review Guidelines

Initial planning and preliminary design will be conducted thru the Office of Design & Construction and Facilities Engineering with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. **The A/E shall provide timely and coordinated responses to all review comments.** The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines

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The Designer shall meet with the Project Manager and Facilities Engineering to ascertain the number and types of systems to be installed in the building. A formal process for documenting this data can be found in the Building Commissioning Standards in Section 3.3 (Energy Guidelines). Designs must meet the requirements of Section 1.2; Sustainability Guidelines and Section 3.3; Energy Guidelines.

A. Design Conditions

1. Summer Outdoor 90°F/74°F (ASHRAE 1%); for critical spaces and labs 89°F/78°F (ASHRAE 0.4%)
2. Winter Outdoor 10°F (ASHRAE 1%)
3. Indoor Design conditions are 72°F (winter) and 75°F (summer) for comfort conditions. The Facilities operation policy is to operate the systems to provide a minimum of 68°F in winter and a maximum of 78°F in summer to occupied spaces. Comfort consideration must be given to envelop radiant effects, as describes by the mean radiant temperature.
4. Non-laboratory indoor relative humidity shall be maintained within the ASHRAE recommended thermal comfort zones, roughly between 20% (winter) and 60% (summer).
5. Laboratories shall be designed to maintain 74°F (± 2 °F) with 30% winter and 55% summer relative humidity, unless the research program requirements are different. These differences should be documented in the basis of design records.
6. Design for 60°F (Winter) in Mechanical Equipment Rooms and non-occupied space. Provide mechanical ventilation for these spaces where temperatures may exceed 85°F. Provide ventilation air per ASHRAE Standard 62.1. Mechanical Equipment Room cooling is only provided by exception with the approval of the Facilities Engineering Project Technical Representative
7. Review and document in “Basis of Design” the desired NC (decibel ratings) for all spaces in building or where HVAC equipment is to be placed adjacent to occupied spaces.
8. Attics shall not be heated without prior approval from Facilities Engineering.

B. HVAC Zoning

1. Thermostats – Avoid placing thermostats or sensors on outside walls, in direct sunlight, in the way of potential obstructions such as filing cabinets, in supply air path, or heat sources (i.e computers). **Coordinate locations of all thermostats with furniture layout.**
2. Dormitories shall be designed to have tenant accessible zone control for each living unit (i.e. one zone per suite or one zone per room).
3. Offices with similar load profiles on the same exposure, and floor, may be placed on a common zone as a cost saving measure. Corner offices, however, should be on separate zones. Review with Engineering.

4. Each Conference Room and Classroom must be unique zones separated from all surrounding spaces.

C. Considerations for Maintenance

1. Design shall allow for adequate and safe access to all mechanical equipment. In construction documents, indicate areas to be kept free of obstructions for service access, including replacement of equipment. Equipment requiring routine maintenance should preferably be mounted at or near the floor. Consider if rigging is required and provide adequate path width to building exterior. Equipment in ceilings should be accessible with an 8-ft. ladder. For heavy equipment mounted above the floor, provide access for rigging equipment. Where the opportunity arises, install equipment above hallway ceilings rather than above office or classroom space. Coordinate work with Architect to provide maintenance access including adequate access doors and clearances. Where possible consider the use of lay-in ceilings, which permit greater maintenance access and more flexibility for future system renovations. Where hard ceilings are required, review access door locations with the Architect & Engineer
2. Coordinate all MEP design work with structural system early in the design process, to ensure piping systems are drainable, properly pitched, and that piping and ductwork offsets are not excessive. Coordinate placement of louvers, plenums, and other wall/roof penetrations with structural system. The Designer is responsible for providing a workable MEP design that demonstrates a thorough coordination between disciplines.
3. Locating of equipment on roofs should be minimized. When it is required, provide adequate & safe access for maintenance.

7. Guidelines and Requirements for Documentation

Along with the Specifications, the Designer is to produce sufficient documentation to allow for code review of the HVAC project and for contract bidding of the work.

Specifications shall include the requirements listed in these Design Guidelines and Appendices. Delete equipment and references not applicable to the project.

The Design documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Basis of Design	X	X	X	X
Notes & Symbols	X	X	X	X
Floor Plans – Major Equipment and Chases		X	X	X
Floor Plans – Single Line Duct and Pipe		X		
Floor Plans – Mech Rm w/ Piping and Duct Mains			X	X
Floor Plans–Ductwork & Dampers			X	X
Floor Plans–Piping			X	X
One Line Diagrams Air Flow & Hydronic Piping		X	X	X
Plan - Utility Connection Points			X	X
Equipment Schedules			X	X
Details – equipment & piping Connections			X	X
Ventilation Schedule Compliance				X
Vertical Sections as required*			X	X
Mechanical Specifications			X	X

* Note: On projects utilizing BIM, vertical sections for the model can be communicated through a BIM coordination meeting. On projects without BIM, scaled vertical section cuts at major horizontal distribution pathways should be provided as soon as possible.

Coordination Drawings field produced by Contractor(s) – Facilities Engineering Department will review 3/8” scale Coordination Drawings of all equipment to be installed in Mechanical Rooms. This will be done as a concurrent Shop Drawing submittal or as part of a Coordination Meeting(s) which includes University participation.

8. Guidelines for System Installation and Performance

A. Campus Utilities

1. Campus Chilled Water System

a. General

The campus chilled water plant contains all chillers, distribution pumps, expansion tank, and chemical treatment equipment. Wherever possible, use campus chilled water as the preferred method of cooling and dehumidification.

b. Design Pressure

Available differential pressures vary throughout the campus ranging from 100psi to 10psi at remote buildings. Peak supply pressure varies from 200psig near the plant to 135psig at remote buildings. Return pressures vary upwards from 100psig at plant. Control valves must be capable of tight shutoff against 100psig differential. Control valve body ratings to be 250# class where used on plant-chilled water. Use 300 psi class butterfly valves at building entrance. All other CHW isolation valves may be 150# rated.

- c. Chilled Water Design Temperatures
Equipment using campus chilled water should be selected at 45°F entering water temperature from April through October, 50°F from November through March. Chilled water coils and heat exchangers, should be selected for a minimum of 20°F temperature rise (i.e. 45-65) for efficient use of primary chilled water, unless otherwise approved by Facilities Engineering.
 - d. Building Distribution Systems
The use of primary chilled water is generally reserved for air handling units and plate and frame heat exchangers producing secondary chilled water. Branch connections to mains shall be made at or above horizontal midline of piping. The use of booster pumps must be reviewed with Engineering. Three way valves or uncontrolled flow on primary chilled water are not permitted. FCI (Flow Control Industries) or Belimo pressure independent control valves should be used where appropriate. When using pressure independent valves, do not use circuit setter. Buildings that use multiple cooling terminal units such as fan coils must use a secondary chilled water system. Avoid dual temperature piping systems.
 - e. Design Velocities
Water velocity within occupied areas of buildings should be less than 6 fps. Mechanical rooms can have velocities up to 9fps. Provide consideration for future extensions of building systems.
2. Campus Steam/Condensate System
 - a. General
Steam is distributed through a network of low (nominally 15psig) and medium pressure mains (currently 65-100psig) to most buildings on campus. Condensate is collected and returned to the Cogeneration Plant. Utilities are generally installed by Princeton University from exterior up to “house” valves inside the building and project work should include extending from this point. Where project conditions require contractor to provide exterior utilities, discuss with Facilities Engineering
the details on tunnel design, insulation, inverts, etc.
 - b. Pressure Regulating Valve Stations
Medium pressure steam entering a building is reduced to low pressure (between 5 and 15psig) steam for distribution within building. Existing buildings served only by low-pressure steam mains and remote from plant may have entering pressures as low as 5psig. PRV station control valves shall be Leslie model GPK and/or model DDBOY. Contact The Edwin Elliot Company, eeco@edwinelliot.com, for specific design criteria. Note that the preferred method of overpressure protection is a Normally Closed Safety Shut-off Valve, rather than a relief valve. See details for piping arrangement.
 - c. Building Steam/Condensate Distribution Systems
 - Steam is typically used for preheat coils, hot water converters and domestic hot water generators. For the above items select equipment based on conservative 2psig. Air unit steam coils in contact with mixed or outside air,

shall be non-freeze type. Mount coils high enough to permit complete drainage of tubes by gravity thru the trap and to the condensate receiver! For floor mounted air handling units, this may require raising the unit off the floor, installing the coils above the floor of the unit, or providing trenches in Mechanical Room floor. Steam traps and the equipment they serve must both be within the same room. Consultant should make sure this is clear on Construction Drawings. Main building condensate pump receiver vents (electric or compressed air powered) may need to be vented to exterior of building. Review with Facilities Engineering at schematic design. Use Steamgard traps at all line bleeder applications. Traps should drain by gravity to condensate pump sets. Do not design traps to lift. Low-pressure traps shall be Spirax Sarco F&T model FT-15 with non-asbestos gaskets or Steamgard SG-LE##B series. For medium pressure steam, use Steamgard traps except where alternate is required by packaged equipment manufacturer. Discuss with project Technical Representative the use of Steamgard traps in modulating applications. Branch connections to steam mains shall be made at or above horizontal midline of main piping. Do not provide trap bypasses or double trapping. Engineers shall size steam traps on Design Documents. For condensate piping systems, use eccentric reducer as required with bottoms of piping level. Do not mix gravity returns with pumped returns without review by Facilities Engineering.

- Condensate pumps shall be duplex type Domestic ITT Model CB/CBE or Skidmore low NPSH type rated for 210°F condensate with steel or cast iron receivers. Do not specify package unit starters for condensate pumps. Motor starters shall be purchased by Electrical Contractor. Review with Engineering the possible use of pressure powered pumps where flooding of pumps is possible (i.e. Basement Mechanical Rooms) and where medium pressure steam or compressed air is available. Pressure powered pumps to be Spirax Sarco or Armstrong with stainless steel check valves. Where steam is used as a pumping medium, vent must be routed to building exterior. No fluids from any other source may be introduced to the steam condensate system. Review the piping arrangement to minimize the potential condensate contamination scenarios.
- Steam vacuum breakers shall be Kadant ¾” stainless steel body, ball and spring with ½” FPT tapping at inlet. See detail drawing.
- Modifications to existing building steam heating systems shall use steel fin tube convectors and self-contained Macon control valves where zone control is required. Where feasible, use hot water for comfort heating.

B. Piping and Piping Accessories

1. Piping Materials

System	Piping Material	Fitting Material	Strainer (steam. Rating)
Hot Water Heating & Secondary Chilled Water Systems 2" and smaller <i>see note (3)</i>	Type L Copper	Wrought copper with 95-5 solder 125# Cast iron threaded	Sarco bronze model BT or Keckley Style E-300
	Sch. 80 Steel <i>see note (1)</i>		TBT CI/NPT Sarco Model IT or Keckley Model B
Hot Water Heating & Secondary Chilled Water Systems 2-1/2" and larger	Sch. 40 Steel	Std. Weight Butt welded steel	Sarco CI-125 or Keckley Model A-7
Low Pressure Steam 2-1/2" and larger	Sch. 40 Steel (Std Wt 12"+)	Std. Weight butt welded	Sarco Cast iron Model CI-125 Flanged 125# or Keckley Model A-7
Low Pressure Steam 2" and smaller	Sch. 80 Steel	125# Cast iron Threaded	Sarco Cast iron Model IT or Keckley Model B
Medium Pressure Steam 2-1/2" and larger <i>see note (2)</i>	Sch. 40 Steel (Std Wt 12"+)	Std. Weight butt welded	Sarco Cast iron Flanged 250# or Keckley Style A
Medium Pressure Steam 2" and smaller <i>see note (2)</i>	Sch. 80 Steel	250# Cast iron Threaded	Sarco Cast iron 250# or Keckley Model B
Steam Condensate 2-1/2" and larger	Sch. 80 Steel	Hvy. Weight butt welded	Sarco Cast iron Model CI-125 Flanged 125# or Keckley Model B
Steam Condensate 2" and smaller	Sch. 80 Steel	125# Cast iron threaded	Sarco Cast iron Model IT or Keckley Model B
Primary Chilled Water 2" and smaller	Type L Copper	Wrought copper with 95-5 solder	Sarco bronze model BT or Keckley Style E-300
	Sch. 80 Steel <i>see note (1)</i>	250# Malleable iron threaded	TBT CI/NPT Sarco Model IT or Keckley Model B
Primary Chilled Water 2-1/2" and larger	Schedule 40 Steel	Std. Weight butt welded	Sarco Cast Iron Class 125 Flanged <i>see note (4)</i>
AC Condensate	Type L Copper PVC Sch. 40	Copper or Solvent weld PVC	N/A

Table Notes

- (1) Piping shall be type L copper, except where a minor modification to an existing steel piping system is required. Review with Princeton Engineering.
- (2) For projects using steam pressures over 100 psi review with Facilities Engineering
- (3) Discuss potential use of Propress fittings with Facilities Engineering and Grounds and Building Maintenance, where appropriate.
- (4) There may be some areas on campus that will require pressure rating above Class 125. See Facilities Engineering.

2. Strainers

Use WYE type strainers as shown above. Screen shall be stainless steel with mesh size as follows:

- Steam service - .032" perforation (20 mesh)
- Hydronic chilled water heating systems and steam condensate service 0.125" perforation

- Discuss the use of basket strainers in lieu of WYE type strainers in primary chilled water

3. Hydronic Piping Systems

Use Amtrol or equal diaphragm type expansion tanks. Provide a Watts series 007 (or Zurn Wilkins 950) backflow preventer at the makeup water line. See 3.11 Plumbing for backflow prevention details. Provide isolation valves at all control valves and equipment requiring maintenance. Layout piping to avoid or minimize air pockets. Provide and indicate, on contract drawings, sectionalizing valves, including drains, to isolate areas of main and sub-main piping runs, for servicing work and future tie-ins, for example at floor take-offs from main. See Appendix 3.10-1 for pipe support details. Hydronic heating systems and terminal heating equipment shall be sized for 135f entering HW temperature. This will accommodate a possible future delivery of low pressure (140f) hot water to the building rather than low pressure steam.

4. Fittings

Where the use of dissimilar materials is unavoidable, review with Engineering Department. Use 150# brass couplings, Victaulic “dielectric waterway”, or dielectric flanges for corrosion control. These fittings may be used only in where they are accessible for inspection, preferably in Mechanical Rooms. Dielectric unions are prohibited. For 3/4” to 2” diameter branch connections to steel mains use thread-o-lets, or 3000# forged couplings, welded nipples are not permitted. For steel branch connections 2-1/2” diameter or above in new construction, use welded tees. Use tees for all copper branch connections. All steel nipples shall be schedule 80. Close nipples are prohibited. Connections to equipment should be made with unions (up to 2”) or flanges (2-1/2” and up). New tees are required where new tap is of equal or one size smaller than the main.

5. Flange Gaskets

For all steam and steam condensate gaskets, use “Flexitallic” spiral-bound temperature-sensitive gaskets or Gar-Lok “Flex-Seal”. For hydronic service only, use Klingersil “Green Ring”, model C-4401.

6. Valves

Provide isolation valves to permit service of equipment without draindown of system. Use valves at coils, traps, control valves, strainers, etc. Provide isolation valves and riser drains at the base of each main distribution risers. Provide at least 1 set of isolation and drain valves at riser branch at each floor. Provide stem extensions as required to clear insulation.

Ball valves shall have stainless steel ball and stem, TFE seats.

Butterfly valves shall have gear operator for sizes 6” and above. Provide chain operators for butterfly valve mounted 10ft. above floor or higher.

Gate valves and plug valves may not be used on any system

Butterfly valves for chilled water at building entrance shall be 300# rated Zwick Tricon series. Butterfly valves at Building entrance for medium pressure steam to be 300# Adams MAK or Zwick Tricon. For buildings on low pressure steam use 150#

Adams MAK or Jamesbury.

Equipment isolation valves shall be specified in accordance with the following table:

System	Pipe Sizes 2" and Smaller	Pipe Sizes 2-1/2" and Larger
Steam and Condensate	Full port ball valve Apollo 82-140 series, Watts B6800-SS	High performance lug type butterfly valve Jamesbury 815L-11-22 HBMT or 815L-11-2236XZ
Primary Chilled Water	Conventional or full port ball valve Apollo 70-140/240 series Watts LFB6080-SS/6081-SS	Jamesbury butterfly (as above) Apollo 88A-140 Series
7. Heating Hot Water & 7. Secondary Chilled Water	Conventional or full port ball valve Apollo 70-140/240 series Watts LFB6080-SS/6081-SS	Jamesbury butterfly (as above), Apollo 88A-140 Series

Air Vents/Drains

Provide manual ball valve vents and drains (Apollo 70 series stainless ball and stem) at all local high/low points, and pitch piping towards drains so that system may be completely drained and purged of air. Provide automatic air vents with ball isolation valves at major piping risers and elsewhere as necessary. Pipe auto vents with (soft) copper tubing to suitable sanitary waste connection point with clearly visible air gap for inspection. Pipe manual vents clear of riser insulation. Major drain locations shall have hose adaptors. Automatic air vents shall be per table below.

System	Automatic Air Vent Type
Primary Chilled Water	Spirotherm 300#
Hydronic (other than PCHW) Systems and Equipment	Spirotherm 150#

8. Pressure Gages

Provide gages where shown on details, with 4" minimum dial. Select gage range to read near center of range during normal conditions. Provide isolation ball valve at each tap. Where differential pressure measurement is required, use single gage with isolation valves on upstream and downstream taps. P&T plugs are not permitted. Gage cocks are not permitted. Use siphon tubes and snubbers on steam service. Gages are to be visible from the floor.

9. Thermometers

Provide 5" dial adjustable angle thermometers with stainless steel wells (not brass) at building entrance and other locations useful for balancing and troubleshooting. See detail drawings.

10. Balancing Valves

Where balancing flowmeters are required, use B&G, Taco or Tour & Anderson circuit setters. Do not use circuit setters as a positive shutoff device. For larger pipes, a butterfly valve with memory stop is acceptable as a balancing device, but should have a second butterfly valve as a shutoff device. Triple duty valves are not permitted. Circuit setters must be selected to measure flows accurately at the design flow rates. In some locations "low flow" circuit setters similar to B & G "RF" series, or reduced

piping sizes would be required. **Circuit setters are not required when pressure independent control valves are used, but PIC valves shall have integral PT ports.**

11. Control Valves

See Section 3.2 Automatic Temperature Controls

12. Pressure Transmitters

See Section 3.2 Automatic Temperature Controls

13. Flowmeters

Campus Steam and Chilled Water flows are to be metered at building utility entrances. Meters and flow processors shall be connected to the campus BMS. Integrate all meter points via “Bacnet”.

Each meter **MUST BE SHOWN ON THE DESIGN DRAWINGS, AND MUST BE INSTALLED** with the manufactures required runs of straight piping at inlet and exit of meter, to provide accurate flow measurements. **DESIGN DRAWINGS MUST INDICATE AND INSTALLATION MUST PROVIDE** required clearances around meter for servicing. Meter bodies must be insulated. Provide isolation valves as required for servicing without draining building. Meter bypass lines are not permitted. Remote displays are required where meter access is limited. Sizing meters will be shown on the design documents and shall incorporate appropriate diversity factor, not peak design load, to avoid oversizing meter. Review with Facilities Engineering.

See Section 3.2 (Automatic Temperature Controls) for specific make and model information.

14. Standard Controls Details

See Section 3.2 (Automatic Temperature Controls) for Design Guidelines.

15. Expansion Joints

Avoid the use of expansion joints. Design piping with sufficient offsets to absorb expansion. Where their use is unavoidable, review with Engineering and provide service valves and drain connection.

16. Water Treatment

Flush new piping until water runs clean, remove and clean strainers. Remove temporary strainers and install new prior to system turn over.

For all new closed loop hydronic systems, water treatment will be provided by our current campus wide sole source vendor, Ondo Nalco Chemical Company, subcontracted through the Mechanical Contractor. Water treatment required due to modifications of existing closed loop hydronic systems will be arranged by Princeton University. Steam piping does not need to be flushed. When first energized, each strainer must be blown down. New condensate piping shall be cleaned by flushing condensate through the receiver tank to drain (8 hour minimum). Provide pot feeders **with removable 30 micron filter bag** for new hydronic loops.

C. Mechanical Equipment

1. Equipment Mounting

Floor mounted pumps, heat exchangers and air units shall be installed on 4" high concrete pad. Steel equipment supports subject to moisture shall be treated with rust inhibiting paint. Equipment (with moving parts) installed below noise sensitive spaces shall be floor mounted, not hung. Provide adequate service area around equipment.

2. Pumps

Base mounted pumps shall be B&G series 1510, Taco, or Grundfos. Where vibration isolation is required, use spring isolators at base and American Boa, or equal, flex connections on piping. All pumps shall have mechanical seals. In-line pumps shall be Taco, Grundfos, or B&G series 60, 80 or 90. Pumps used on primary chilled water in buildings near the chilled water plant must have a pressure rating of 250#. B&G PL series may be used for pumps below ½ hp.

3. Converters

Steam to hot water conversion shall be via shell and tube heat exchanger by B&G or Taco. Tubes shall be Cu/Ni. Alternatively, plate and frame heat exchangers may be considered.

4. Plate and Frame Heat Exchangers

For Secondary Chilled Water service shall be 304 stainless steel plate, EPDM gaskets, rated and labeled for minimum 200psig operating pressure when used with Primary Chilled Water. Review with Engineering the possibility of providing frame space for future capacity increases. Approved manufacturers are; APV, Mueller, ALFA Laval, B&G. Steam to HW exchangers may be considered where appropriate, to be approved by Engineering. Gasket material selection must account for any steam superheat.

5. Electric Heat

The use of electric heat is generally prohibited, but may make economic sense in some applications. Proposed use must be reviewed with the Facilities Engineering.

6. Fin Tube Convection

For perimeter hot water systems use copper tube, aluminum fin convection units. Use heavy gauge covers in public spaces and dormitories. Basis of design shall be Vulcan or Sterling. Runtal steel convection units may also be used. Allow adequate access to service and control valves. Specify in-place mock-ups for review by Design Team. Provide adequate access for venting, draining, cleaning, valve operation and replacement. Perimeter system must be sized to recover from night setback temperatures to occupied temperatures within 3 hours on a winter design day.

7. DX Systems

Piping shall be flare fittings for copper sizes 7/8" and smaller, brazed copper for larger piping. For systems over 5 tons, provide low ambient control, suction accumulator, filter dryer, sight glass/moisture indicator, liquid line solenoid valve and refrigerant service valves. These are typically used when central chilled water is not available. Provide Energy Star rated products where applicable.

8. Motors

Motors below 1/2hp (in fan coils) shall be 120v single phase. Motors below 1/4hp shall be **ECM type, when available**. Motors 1/2hp and above shall be 3 phase, premium efficiency type. Motors used on VSD applications must be constructed specifically for that duty and shall be reviewed by Facilities Engineering.

9. Variable Frequency Drives (VFD)

VFD's shall be specified by the Electrical Engineer. Review requirement for drive bypass with Princeton Engineering. VFD's may be provided by the Mechanical Contractor for skid-mounted equipment (ie: pressure booster systems).

VFD's for mechanical systems may require auxiliary points to control dampers, [see 3.2 Automatic Temperature Controls](#). Only ABB and Yaskawa are acceptable manufacturers.

10. Fan Coils

Fan Coils for use in occupied spaces shall be selected at low speed, or medium speed if extra capacity is needed. To minimize noise, fan coils should be ducted and installed behind an acoustic barrier such as lay-in ceilings or cabinetry. For spaces with NC 35 or lower ratings, use of fan coils will require a mock-up during construction that will be reviewed by Princeton Engineering. During layout & design, carefully consider accessibility of components requiring maintenance. Coordinate location with other trades and expected furniture placement. Controls components, including speed switches shall be provided by the controls contractor. **FCUs shall have variable speed fans with ECM motors**. Provide extended drain pan and / or cabinet as needed to permit adequate room for valves and insulation. Where possible, use fan coils for sensible cooling only.

11. Valence Units

Valence units shall consist of a heat transfer element, support structure, architectural enclosure, mounting brackets, stainless steel pan with external closed cell insulation, valves fittings, and condensate drain connection. Heat transfer element shall consist of minimum 5/8" copper tubes and 0.10" aluminum fins with minimum spacing of 6 per inch. The element shall be supported by 12 gauge aluminum members along both sides. Wall brackets shall not be greater than 12ft. apart. For longer enclosures, an intermediate cantilever bracket shall be mounted to the outside wall.

The enclosure shall be minimum 0.030" aluminum. Enclosure shall be finished with semi-gloss baked on enamel, the color and paint to be specified by Princeton. The ceiling baffle shall be aluminum painted to match the enclosure and designed to fit

tight against the ceiling. The drain fitting shall be connected to a 3/4" schedule 40 PVC drain piping system with stainless steel clamps. The invert of the drain pipe in the wall must be no higher than the lowest point of the drain pan. Provide valves, and other hydronic specialties in piping in accordance with Appendix 3.10-23. Acceptable manufacturer is Sigma Corp.

12. Chilled Beams

Chilled Beams- Active or Passive Beams may be used for areas with light thermal loads. Supply piping must be monitored and controlled to maintain water temperatures above ambient dew point. Provide integral condensate drip tray (un-piped) where possible. Where Chilled Beams are used, mock-up of first installed beam with controls and insulation in place should be reviewed by Princeton and design team. Support method and piping connection details must be reviewed with Facilities Engineering early in design.

13. Boilers

The boilers for hot water heating service will be standalone units, paired for redundant operation. The boilers will be installed with stainless steel lined flues. The auxiliary components to operate the system will be provided along with a controller. The boiler control panel shall have the ability to interface with the campus BAS. The controller shall have the capability to dial out to an alphanumeric pager as well as the ability for tuning adjustments. Boiler design capacity must be reviewed by Facilities Engineering.

Acceptable boiler manufacturers: Weil-McLain “Ultra” or “Evergreen” Model or approved equal

D. Air Distribution Systems

1. Indoor Air Quality

Comply with latest version of ASHRAE Standard 62. Provide to Princeton Engineering, backup design assumptions and calculations to verify that design meets this standard. Design systems to make use of outside air for “free” cooling where economically viable. Include airflow measuring stations to monitor and trend outside air delivery for systems supplying more than 1000 CFM outside air. Ventilation schedules must be shown on the drawings.

2. Humidification

Where humidifiers are used provide stainless steel duct section minimum 2ft. upstream and 6ft downstream of manifold. (Provide insulated stainless steel access door for inspection.) Provide duct configuration as recommended by manufacturer for proper steam absorption. Drain bottom of humidifier duct section, or air unit section by pitching or cross breaking to drain fitting. Use Armstrong series “1000” (or **Dristeem Mini-Bank or single/multiple tube or Ultrasorb series**) with modulating control valve operator and temperature switch to prevent operation before condensate is drained. **For precision, clean steam applications: Nortec NHRS. Where steam is not available, discuss the possible application of ultrasonic humidifiers with Facilities Engineering.** Do not oversize humidifiers. Humidifier shall not be placed directly up stream of the

fan drive. Provide seasonal on/off isolation valve in addition to modulation control valve.

3. Air Handling Units

Air handling units (nominally over 2,000 cfm) shall be double wall construction, with internal fan and motor vibration isolation. Direct-drive fans are preferred. Indicate fan RPM and corresponding VFD frequency on design documents. If used, belt-drive motors should be mounted on screw driven adjustable base. Include gasketed doors with large handles spaced for adequate access for service and controls installation. All power & Control wiring shall be in conduit or liquid-tight conduit and junction boxes. Exposed wires, cables, and splices shall not be allowed. For units 20,000 cfm and above specify vapor proof lighting inside access sections factory wired to an external switch. Include access sections between coils for inspection and sensor installation. The minimum access door width is 24". Provide gasketing or safing of all pipe and conduit penetrations. For belt-drive fans contractor shall furnish & install fixed pitch sheaves on fans after balancing. All electrical equipment and wiring inside air handlers shall be supplied in accordance with the NEC for inside plenum installations. Acceptable manufactures include but are not limited to:

- For Laboratory areas: Ventrol, Ingenia, Haakon, Energy Labs
- For other services: Carrier, York, Trane, Mainstream, Daikin/McQuay

4. Dampers

For outside air service shall be low leakage type with vinyl blade edge and stainless steel spring gasketing at jambs. Provide access doors for inspection and servicing. Provide damper shaft extensions, including for dampers mounted in air handling units, as required to mount operators outside of airstream. Duct mounted dampers should be provided by the Controls Contractor. Tamco 1000 or 1500 series is preferred. Where insulated blades are needed use Tamco 9000 or 9000BF with thermally broken frame. Use parallel or opposed blade based on the application and airflow patterns. Manual volume control dampers shall be Lindab DRU or equal.

5. Coils

- a. Chilled Water coils shall have copper tubes 5/8" x 0.030" minimum wall thickness, 10 row maximum depth, with aluminum fins 0.008" minimum thickness, mechanically bonded to tubing. Maximum fin density is 12 fpi. Coil casing shall be stainless steel. Drain pans shall be stainless steel, pitched to completely drain condensate from pan. Chilled water coils exposed to mixed or outside air shall be freeze protected by freeze pump for laboratory, auditorium, or equipment requiring year round cooling. Freeze pumps to be fed by standby power. Use "dry lay-up" system for other mixed or outside air-cooling coils. See Appendix 3.10-8 for details. Maximum design coil face velocity shall be 500fpm or lower to provide for a future air quantity increase.
- b. Steam Coils in contact with mixed or outside air shall be non-freeze type with 1-1/8" O.D. x 0.035" outer tube and 5/8" x 0.025" inner tube with galvanized casings. Mount coils high enough to permit complete drainage of tubes by gravity. For floor mounted air handling units, this may require raising the unit off

the floor, installing the coils above the floor of the unit, or providing trenches in Mechanical Room floor. Steam traps and the equipment they serve must both be within the same room. **Air handlers and their steam coils must be designed so that the steam trap inlets are a minimum of 15” below the coil discharge connection.** Condensate piping must pitch from trap outlet continuously towards inlet of receiver. Consultant should make sure this is clear on Construction Drawings. Where modulating control of coil discharge is required, use 1/3, 2/3 control valves **where loads are over 1000#/hr.** Avoid face and bypass arrangements. Provide adequate space for coil pull. Where appropriate, consider blenders as an alternative to pre-heat coils.

- c. Reheat Coils shall be hot water **sized for 140fentering water temperature** with 5/8” x .025” wall and galvanized casing. **To accommodate possible future delivery of low temperature hot water.** Provide access doors to inspect upstream coil face.

6. Air Conditioning Condensate

Shall be piped to storm or grade. Provide sloped drain pans, properly configured drain traps and low face velocities to prevent carry over from coil face. Consider recovering condensate for other building uses. **If pumps are used, supply with overflow protection.**

7. Filters

Pre-filters for outside air shall have a minimum (dust spot) efficiency of 35%, similar to Farr 30/30. Provide bag type final filters, as required to meet project requirements. Provide adequate access for filter service. Balance extra space requirements for low pressure drop filters with operating cost savings. In the design documents provide a filter schedule listing the clean and dirty static pressures for each type of filter.

8. Fans

Provide proper fan orientation, inlet and discharge conditions to avoid problems with system effect. Direct-drive fans are generally preferred. For belt-drive fans, after air balancing, **Contractor shall install fixed sheaves.** Volume control on VAV systems shall be accomplished by using variable speed motor drives.

9. Air Mixing

Where return air enters mixing box/ plenum from the top or side, provide space within air handling unit for air blender upstream of first coil, or demonstrate to Facilities Engineering the design geometry provides thorough mixing before contacting first coil. Where mixed air temperatures are above **35F** on design day, consider blenders in lieu of preheat coils.

10. Ductwork

Ductwork shall be constructed per latest version of applicable SMACNA duct design guidelines. All ductwork shall be seal class A. For work in occupied buildings, field applied sealants must be free of noxious fumes (water based). Design Drawings must indicate duct pressure classifications and leakage class. Galvanized duct thickness shall be as prescribed by SMACNA, except 24 gage shall be the minimum thickness permitted. For moisture laden air (laundry, shower, etc. exhaust) use aluminum grills

and registers, aluminum or stainless steel duct, pitched to drain condensate. For dishwasher exhaust use stainless steel. Discuss requirements for duct testing with Facilities Engineering.

11. Noise Control

The use of duct liner shall be minimized and reviewed by Princeton Engineering. Where used for noise control, it should have perforated internal liner, or where not possible, the lined duct should be considered to be an item requiring maintenance (provide access for inspection and maintenance). Liner shall have mold resistant acrylic coating on airstream side. Use metal nosings to protect upstream edges of liner. Provide access doors upstream of all reheat coils, fan-powered boxes, and VAV boxes to permit inspection and cleaning of coils. Sound traps shall be sized for a maximum velocity of 1200fpm.

During design, provide manufacturer sound data by octave band readings for all air handling units. If the dBA of the AHU is over 80 select the next larger AHU or prove that adequate attenuation can be achieved by other means.

Select outlet velocities and fan tip speed for quiet operation. Higher outlet velocity and static pressure result in increased sound levels. Balance cost and space against sound and efficiency.

12. Balancing Dampers

Balancing dampers shall be provided at all branch take-offs rather than at diffusers to minimize noise.

13. Fire Dampers / Fire & Smoke Dampers

Use style B dampers (blades out of airstream) wherever possible. Provide access doors for inspection and replacement of links. The use of Fire & Smoke Dampers should be minimized. Review quantity & location of Fire & Smoke Dampers with Facilities Engineering and Code Consultant.

14. Heat Recovery

For large conditioned exhaust airflows, examine the feasibility of providing heat recovery to make-up air. Where payback is marginal, provide access for future recovery system. Consult with Facilities Engineering to ensure analysis conforms to Princeton University standards.

15. Flexible Duct

Maximum length of flex duct sections shall be 6ft. Provide proper support to avoid kinking duct.

16. Louvers

Inlet louvers shall be designed at not more than 500fpm over net free area. Provide 1/4" mesh screen. Coordinate with site plan to avoid placement near or downwind from odor sources, or large deciduous trees. Coordinate with structural system so that airflow through louver to filters/coils is unobstructed. Avoid air inlets near ground level, due to excessive maintenance required to keep them free of debris. Where this is

unavoidable, review with Facilities Engineering. Inlet louvers to be storm proof design. Consider methods for catchment and drainage of any snow that may make its way past the louvers.

17. Duct VAV Boxes

Sound attenuators and lined duct must be protected from dirt and debris until installed. Provide factory installed access door to inspect reheat coil and damper operation. Install VAV boxes such that all control components and valves have adequate access. VAV boxes to be manufactured by Nailor, **Siemens**, Enviro-Tec or Anemostat.

18. Diffusers, Register and Grilles

The noise criteria level in the space must be no greater than scheduled on the drawings or in the BOD. Where the space is not scheduled the noise criteria level will be 30.

Provide a diffuser, register and grille schedule on the drawings capturing at minimum:

Size (including neck size)	Throw
CFM	Material/Finish
Noise Criteria	Frame Type

E. Insulation

Designer shall coordinate with Architect to insure that there is sufficient access around piping and ductwork in the field to install and seal joints on insulation system. It is crucial that systems operating at temperatures below ambient dewpoint have continuous unbroken vapor barriers. **Wood blocking is not acceptable for insulated pipe supports. Calcium Silicate may be used on hot piping only.** Where access is limited indicate sequence of construction on Design Documents (i.e. pre-installing insulation). This is of critical importance and must also be monitored in the field during construction. See Appendix 3.10-1. Require the contractor to provide mock-ups of insulation systems for approval during construction.

1. Piping Insulation

Use fiberglass with premolded or Zeston covered fittings. Cold piping must have a continuous vapor barrier. Pipes shall be suspended using hangers, inserts and shields outside insulation. The use of elastomeric insulation must be reviewed with Facilities Engineering. Where piping is installed less than 2 feet above floor and subject to damage cover with continuous PVC or aluminum jacket.

2. Ductwork Insulation

Exposed ductwork in mechanical spaces or other areas of heavy traffic, shall be insulated using fiberglass board with minimum 4.2#/c.f. density and foil facing. Joints shall be taped with foil tape. Secure board with welded pins and speed washers. Pins to be clipped flush after washer installation. Where ductwork is concealed and protected from damage use duct wrap blanket, minimum 1-1/2" thick, secured with welded pins and washers. Do not use lined ductwork within 10' of humidifier. **Continuous insulation and vapor barrier at standing duct seams needs to be coordinated. For insulation exposed to weather, use Venturclad finish.**

3. Equipment Insulation

Designs shall include removable and reusable blanket insulation on Steam PRVs, pressure powered pump bodies and **equipment requiring inspection and maintenance. Cut insulation to keep manufacturers labels exposed to view.**

F. Piping and Ductwork Identification

1. For all ductwork and piping, provide identification and directional flow arrows at intervals not greater than 20 ft. Ductwork ID should be stenciled showing system number. Piping ID should be adhesive film type with full circumference flow arrows. All Pipe markers and color schemes shall conform to current Facilities Engineering standards. See appendix 3.10-25 for Pipe Identification Schedule Requirements.
2. Equipment Identification: steamtraps, major valves and scheduled equipment shall have permanent stamped metallic or phenolic ID plates which must be easily visible after installation is complete. Framed valve charts must be installed in the mechanical rooms at the completion of the job by the mechanical contractor.

G. Control Compressed Air Systems

Princeton University prefers Quincy duplex air compressors with Hankinson air dryers and water separators as needed. See also Section 3.2 – Automatic Temperature Controls and Energy Management Systems. Most control devices will be electric, consult with Facilities Engineer if there is a need for compressed air for certain steam devices, etc.

H. Laboratory Systems *See additional information in 2.10 Laboratory Systems*

1. Laboratory Waste Systems

Piping shall be Enfield, Orion or Fischer polypropylene with mechanical or socket welded heat fusion joints. Do not use fuse-seal joints Provide unions at traps.

2. De-ionized Water

De-ionized water system use Hydro Services, Inc. processing equipment. Piping is polypropylene with mechanical unions (where exposed) or socket welded joints (where concealed). Piping must be supported in a continuous channel. Shutoff valves are polypropylene ball valves.

3. Process Cooling Water

Also referred to as Laser Water Systems. These systems are recirculating 100k ohm-cm clean water loops cooled by Primary chilled water. Piping is PVC schedule 80. Supply water temperatures are typically 60°F. Insulation is required where piping is exposed to wet bulb temperatures above chilled water temperature. Provide system back-up with domestic or local chiller.

4. Laboratory Compressed Air

Various science buildings have central laboratory compressed air systems. Compressed air systems shall be Beacon Medaes Model LPS-15Q – SD240-H single point scroll air compressor system (or Atlas Copco SF-MED). The system shall have the number of 15 horsepower compressors needed for the system plus spare capacity to allow future compressor overhauls or replacements. Piping shall be copper Type L.

5. Nitrogen

There are several different N₂ systems on campus of varying levels of purity and pressure. Unless otherwise indicated use 304 or 316L stainless steel tubing with Swagelock tube fittings. Tubing and fittings to remain capped and sealed until installed. **Orbital welding may be required on larger high purity systems.**

6. Vacuum

Various science buildings have central laboratory vacuum systems. The vacuum system shall be self-contained, oil-less, fully re-circulated, water sealed vacuum packaged unit as manufactured by Gardner Nash. The system can be duplex, triplex, quad-plex, etc. as needed to provide ample vacuum capacity with spare capacity when repairs must be made to a vacuum pump. Vacuum piping shall be copper Type L. Valves shall be ball valves per hydronic specifications.

7. Laboratory Exhaust Systems

Accessible branch ductwork may be galvanized steel, unless the extra cost of stainless steel or PVC coated steel can be justified. All concealed exhaust duct risers to be welded stainless steel. Exhaust boxes and all moving components shall be stainless steel. Provide general exhaust boxes in parallel with variable volume hood exhaust boxes. Heat recovery shall be considered based on cost factors provided by Princeton Engineering.

I. Underground Utilities

See Section 3.6; for information on campus utility systems. Review project impact on utilities with Facilities Engineering. Consultants must update Facilities Engineering on estimated utility loads during various design phases in order to assist University utilities planning functions.

J. Temporary Heating and Cooling

The use of new equipment, to provide heating, cooling, or ventilation during construction must be reviewed with project team during design so that the appropriate steps are taken to protect the equipment and minimize energy use. During construction, the Construction Manager shall present a plan for the use of this equipment and campus utilities for review by the Project Team. The equipment must be turned over to the University at occupancy in like new condition with full warranty, extending from the occupancy date. Steam and chilled water usage must be metered during periods requiring temporary heating and cooling. Include these requirements in project specifications.

9. Requirements for HVAC System Testing & Commissioning

A. Testing, Adjusting, Balancing

Consulting engineer shall consider and review with Princeton during design, the necessity of expanding the scope of traditional TAB work to include the likes of vibration/sound testing, or IAQ testing. The TAB Contractor shall be hired directly by the Construction Manager. Specifications shall indicate that before TAB work begins, TAB contractor shall meet with Owner & Design Engineer to develop and approve TAB strategies, procedures and reporting format. TAB reports shall be reviewed and approved

by Design Engineers to verify that the design intent has been met. As these reports are essential tools for Facilities during troubleshooting, the reports shall include single line schematic diagrams showing locations of HVAC system components, balancing devices, measurement locations. Also include make, model and settings for drive components. Balancing devices shall be marked by the Balancer to indicate final settings. Provide single line system schematic with pressure profile.

Specifications shall provide a minimum ½ day service from Balancing Contractor to demonstrate and reproduce measurements shown in balancing report. The system measurements will be selected by Facilities Engineering. **Discuss the need for additional seasonal testing with Facilities Engineering.**

1. If recheck yields measurements that differ from the final report measurements by more than the tolerances allowed, the measurement shall be noted as “FAILED”.
2. If the number of “FAILED” measurements is greater than 10% of the measurements checked during this final inspection, the balancing report shall be rejected.

B. Piping Testing

Test new hydronic systems or modified sections of existing systems with water at 1.5 x design operating pressure for 1 hr. (Small sections of steam piping may be tested with campus steam, provided there are isolation valves for modified sections.) Engineering shall be notified 2 days before scheduled test so that we have the opportunity to witness tests. See also Building Commissioning Standards Section 3.13. Test pressures are to be specified by the A/E.

C. Commissioning

1. Commissioning shall be performed in accordance with section 3.13 of this manual
2. The extent of Commissioning shall be determined during the schematic design phase of a project, either using in-house, or a four party commissioning agent.
3. Tech Team representatives from Engineering and Grounds Building Maintenance shall be an integral part of the commissioning process
4. The procedure for testing shall be followed closely in accordance with the Project Specifications and Pre-Functional and Functional tests as outlined in section 3.13 of this manual

10. Requirements for As-built Drawings

The Designer is responsible for checking the accuracy of as-built drawings prepared by the Mechanical Contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the Contractor and University personnel to review progress and to ascertain that the Contractor is keeping accurate records of systems installation. Designer will verify during these regular meetings that the Contractor is maintaining record drawings to convert to as-builts.

The mechanical/HVAC As-Built Drawings shall include the following information as a minimum:

1. All major pieces of equipment accurately located.
2. Location and identification (valve chart) of major isolation valves, vents and drains, including sub-main isolation valves.
3. Location of control valves and balancing valves.
4. Access panels and access doors.
5. Sheetmetal dampers, fire dampers, filters and flow measuring stations.
6. Main runs of piping and ductwork with labels and flow arrows.

See Section 1.5 (Documentation and Archiving).

11. O & M Documentation

In addition to the requirements shown in Section 1.5 (Documentation & Archiving) and Section 4.8 (Mechanical Rooms), O&M documentation for Mechanical equipment shall include the following;

Approved submittals

1. Performance curves for fans & pumps showing design operating points.
2. Written sequence of operation with final commissioned control set points.
3. Maintenance information including safety & performance information, start up & shutdown procedures, detailed servicing requirements.
4. Other project specific information determined by the Facilities Engineering and design team

Information provided by the contractor shall be reviewed and supplemented as required by the design engineer.

END OF DOCUMENT

internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development;
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Procedural Guidelines - Preliminary Design and Design Development

During preliminary design, designer is to consult with University project manager to ascertain the requirements for plumbing use and installation. The designer is to coordinate his work with other disciplines so a cohesive set of documents is produced for the mechanical/plumbing work (include considerations for any specialty lab system and or specialty gases). The Designer is reminded to refer to Section 3.13 Commissioning for requirements, including submittals for schematic and design development phases, particularly as they relate to design intent and Basis of Design.

During preliminary design and design development the designer is to consult with the project manager and with University Engineering Department to define system distribution strategies and to discuss any obstacles that might be existing in a building, or problems inherent in a particular design or structural system.

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7. Guidelines and Requirements for Documentation

Along with the Specifications, the designer is to produce sufficient documentation to allow for code review of the plumbing system and for contract bidding of the work.

Specifications shall include the requirements listed in the Princeton University Design Guidelines and Princeton University Engineering Specifications. Delete equipment and references not applicable to the project.

The Design documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Design Intent	X			
MEP Basis of Design		X		
Notes & Symbols	X	X	X	X
Floor Plans – Plumbing Equipment		X	X	X
Floor Plans–Piping Routes			X	X
Riser Diagrams Sanitary & Vent Piping			X	X
Riser Diagrams Domestic Water Piping			X	X
Plumbing Fixture Schedule			X	X
Details – equipment & piping Connections (including pipe chase layouts)			X	X
Vertical Sections as required			X	X
Plumbing Specifications			X	X

Coordination Drawings field produced by Contractors – Facilities Engineering Department will review 3/8” scales Coordination Drawings of all equipment to be installed in Mechanical Rooms. This will be done as a concurrent Shop Drawing submittal or as part of a Coordination Meeting(s) which includes University participation.

8. Guidelines for System Installation and Performance

A. Domestic Water Systems

1. City water meter at building entrance will be provided by New Jersey American Water Co. See Appendix 3.11-2. Use Watts 909 backflow preventer (or **Conbraco RP4A SBF**), 2” & smaller, Watts 994 *lead free* (or **Conbraco RPLF4A with Apollo 6P ball valves, flanged**) for sizes 2 ½” & larger, where required by codes (no substitutions). Trap primers should be avoided, use deep seal traps where possible. Use Watts for domestic water pressure reducing service. Domestic water pressure booster pump package by **Goulds Aquavar**. Contact DC Pump Services, LLC. (609) 923-9865, for specific design criteria. Dormitories and lab buildings require two backflow preventers in parallel (see appendix 3.11-3). All domestic water valves to have extended stem-sized pipe insulation thickness.

B. Domestic Hot Water Systems

1. Wherever possible consistent with demand, use campus steam for hot water generation. Use ACE Boiler Company (or **A.O Smith, model HWI**) semi-instantaneous water heaters with Cu-Ni tubes, single wall design, DDC control valve, Sarco traps, Taco circulator. See piping detail (appendix 3.1-11). Contact Diversified Thermal Equipment, dte47us@yahoo.com, for specific design criteria. Include recirculation loops where feasible. For low demand remote usage where steam usage is impractical, use electric heaters as specified below. Avoid the use of mixing valves.

Include balancing valves between HW piping and HW recirculation piping at the end of the run. Use Johnson (or Sarco) vacuum breaker (stainless steel).

C. Sewage Ejectors & Sump Pumps

1. Sewage ejectors shall be Gorman-Rupp (or Grundfos) Super T series motor coupled with optional self-cleaning wear plate and gauge kit. Sump pumps shall be Gorman-Rupp (or Grundfos) with optional gauge kit. Provide adequate floor drain coverage with proper floor slope in mechanical spaces. Provide hose bibs in mechanical rooms for use during maintenance. High temperature sump pumps for steam condensate pits to be Zoller M3098 or Little Giant HT10.

Include dry contacts on level controls to accommodate BMS system reportability. Use Apollo series 80 or 6P ball valves for pump isolation. Gate valves not permitted.

D. Plumbing Fixtures & Accessories

Variations from approved products below will require review with Engineering:

Shut off valves are required at the branch take-offs (where accessible) as well as individual plumbing fixtures listed below.

For lavatories, tank water closets and kitchen sinks install 1/2" sweat by 3/8th IPS copper coupling with a 3/8th IPS chrome nipple and a 3/8th chrome stop valve (see manufacturer below). This is to avoid hot work.

Lavatories – American Std. “Lucerne” American Std. #0355012.020 or “Roxalyn” #0195.073 as required for wall hung installations.

Lavatory Faucet – American Std. #5402.142H blade handles, 4” o.c. or #5401.142H.002 (or Moen #8210 F12) with pop-up drain for residential applications. Where “touchless” (motion sensor) type faucets are used, specify Sloan EFB 650-0607, American Std. “Innsbrook” #6057205 (0.5 gpm) or Moen CA8301.

Kitchen Sink – Single bowl 18ga. Elkay #2521 (or American Std. stainless steel, model TBD) with American Std. Monterrey #6408.141 faucet with spray, #6408.140 faucet without spray, or #4175501.002 single lever kitchen faucet. Use Elkay LK-99 or Wolverine drain assembly #807.

Aerators – 1 gallon/ minute maximum

Lavatory/Sink Traps – McGuire #8902C P-trap with chrome PT 17 ga., seamless trap

Slop Sink Faucet – Commercial - American Std. #8344.112 with vacuum breaker or Moen #8124 with integral check valve
Residential – Gerber #49-244 or Moen 8277

Sink Drains – Grid type only for campus buildings – McGuire #155-A or Elkay #LK8 – 304 stainless steel.

Instantaneous Hot Water Heater – Are to be installed in all kitchen sinks and water fountains, where requested. ISE (In-Sink-Erator) “Instahot” C1300 under sink type Kohler K-9607-R-CP

Water Fountain – Elkay HEWDL or EHWZ14C
Filtrine #107-14-HL with optional bottle filler; non-refrigerated

Hydration Station – Elkay - #LZWSMDK non-refrigerated

Water Cooler – Quench 720 – non-refrigerated

Tub – Americast cast iron tub or Kohler Expocrylic

Shower Base – Terrazo base with internal drain

Shower Stall – Consider one-piece unit as alternative for residential applications (Best Bath or approved equivalent).

Shower Valve –Delta R100000 UNWS with trim kit T13091 or Moen #62370 with Trim #T8370. If exposed in shower compartment, include shroud for protection of pipes.

Shower Head –Kohler G-90 Awaken 1.5 gpm or Niagra Earth low flow shower head

Urinals – Sloan SU-1009-A (or American Std. #6590001.020 (1.0 gpf); Manual Flush Valve -Use Sloan model WEUS-1001.1001-0.25 (or American Standard –see GBM for model #); Automatic Flush Valve - Sloan 186-0.25 SFSM (or American Standard – see GBM for model #)

Water Closets – Floor mount: Sloan 1.28 flush WETS 2000.1001 or ADA equivalent 2020.1001-1.28 (or American Std. #3461001.020); Wall hung: Sloan 1.28 flush WETS 2050.1001 or ADA equivalent (or American Std. #2257101.020) all with Sloan #111 flush valve (or American Std. #6065565.002) and Sloan Royal 111-1.28 SMO automatic flush operator. Floor mounted tank – round front: American Standard 3061001.020, (or Sloan tank #52109013 or bowl #ST9023-A (1.6gpf)). Floor mounted tank: American Standard 3063001.020 (or Sloan #ST-2029-A top spud)

Water Closet Seat – Church or Bemis Color: White

Water Heaters – A.O. Smith, Rheem or Bradford White. The University Mechanical Engineer shall specify to the designer the model(s) of water heater(s) on the project.

Instantaneous Tankless Water Heater – For under sink: Chronomite or Bosch
For larger applications: Hubbell Tankless or Bosch

Water Hammer Arrestors – Smith or Amtrol

Floor Drains – Smith, Zurn or Josam nickel bronze or stainless, to be installed in all commercial bathrooms per National Standard Plumbing Code. University preference is for deep seal traps in locations that will see infrequent use.

Grease Trap – Selection is based on specific Project requirements, either Ashland Polytraps or Endura Poly Grease. Review municipal regulations for water temperature and waste treatment requirements with Engineering, GBM and the University Code Analyst.

Stop Valves – Wolverine or Brass Craft with brass stem

Wall Hydrant –Zurn #1321 lead free (or JR Smith #5560QT lead free)

Ground Hydrant – Jay R. Smith non-freeze (or Zurn #Z1360 or #Z1361)

Flanges – 150# brass sweat flanges

Trap Adaptor – Install trap adaptors on all “P” traps for lavatories, sinks, water fountains, etc.

Thermometer – Dial type with stainless steel wells; 2” diameter

Laundry Washing Machine Hoses – 6’ braided stainless steel.

Laundry Box – Water-Tite Box – Watts valve mounted in box; model #W2800 (or Oatey #38529)

Slop/Mop Sink Base – American Standard or Fiat

Emergency Eye Wash – Speakman or Guardian

Emergency Shower – Speakman or Guardian

Hangers and Supports – No metal hanger or supports with copper pipe. Use **ONLY** cushion clamp, rubber isolation, Copper Guard coated split ring for copper pipe.

Roof Drains – JR Smith 1010 with cast basket – coordinate method of connection with the Project Manager, Building Envelope

Water Filters- Supply an Aqua-Pure (AP717 or AP217) water filter at the following locations:

Hydration Stations

Ice Machines

Water Fountains

Bottle Fillers @ Sinks

E. Plumbing and HVAC Valves – refer to Apollo Index Sheet for sizing (Appendix 3.11-4)

System	Pipes 2" or smaller	Pipes 2 1/2" or larger
Domestic Hot & Cold Water	N/A	Flanged Ball Valve 2 1/2" and up; Apollo 6P Series or Watts G4000M1 quarter turn & G4000M1FDA manual (epoxy coated for potable water)
Domestic Hot & Cold Water	Solder Full Port; 3 Piece Part # 82LF-240-00 or Watts LFB6801	Flanged Ball Valve 2 1/2" and up; Apollo 6P Series or Watts G4000M1 quarter turn & G4000M1FDA manual (epoxy coated for potable water)
Domestic Hot & Cold Water	Threaded Full Port; 2 Piece Part # 77LF-140-00 or Watts LFB6080G2-SS	Flanged Ball Valve 2 1/2" and up; Apollo 6P Series or Watts G4000M1 quarter turn & G4000M1FDA manual (epoxy coated for potable water)
Domestic Hot & Cold Water	Sweat Full Port; 2 Piece Part # 77LF-240-00 or Watts LFB6081G2-SS	Flanged Ball Valve 2 1/2" and up; Apollo 6P Series or Watts G4000M1 quarter turn & G4000M1FDA manual (epoxy coated for potable water)
Domestic Hot & Cold Water	Sweat Standard; 2 Piece Part # 70LF-240-00 or Watts LFB6081G2-SS	Flanged Ball Valve 2 1/2" and up; Apollo 6P Series or Watts G4000M1 quarter turn & G4000M1FDA manual (epoxy coated for potable water)
Heating Hot Water	Threaded Full Port; 3 Piece Part # 82-140-00 or Watts LFB6800G2 1/4"-2"	Apollo Series 88A240
Heating Hot Water	Solder Full Port; 3 Piece Part # 82-240-00 or Watts LFB6801G2 -SS 1/4"-2"	Apollo Series 88A240
Heating Hot Water	Threaded Full Port; 2 Piece Part # 77-140-00 or Watts LFB6080G2 - SS	Apollo Series 88A240
Heating Hot Water	Sweat Full Port; 2 Piece Part # 77-240-00 or Watts LFB6081G2-SS	Apollo Series 88A240
Heating Hot Water	Threaded Standard; 2 Piece Part # 70-140-00 or Watts LFB6080G2-SS	Apollo Series 88A240
Heating Hot Water	Sweat Full Port; 2 Piece Part # 70-240-00 or Watts LFB6081G2-SS	Apollo Series 88A240
Natural Gas	Threaded; Apollo 80-100 or Watts GBV	N/A

F. Plumbing Piping Materials

Note: In limited application Pro-press fittings can be used (ie: off site housing and certain process water applications in labs). The use of pro-press fittings MUST be discussed and approved by GBM during design.

Note: In limited applications the University will consider the use of PEX tubing for domestic water piping. The use of PEX MUST be discussed and approved by GBM during design.

System	Piping Material	Fitting Material
Domestic Hot & Cold Water (Above Ground)	Type L Copper	Wrought copper with water safe solder 2.5" or larger to have Victaulic or Grov lok fitting
Sanitary Waste, Storm (Above Ground)	Cast Iron, hubless, service weight, or PVC DWV	C.I – No Hub extra heavy couplings or PVC DWV
Sanitary Vent (Above Ground)	C.I. hubless, service weight or PVC DWV	C.I. No Hub extra heavy couplings or PVC DWV
Sanitary Waste, Vent, Storm (Below Ground within bldg and 5ft of ext wall)	C.I. extra heavy weight, hub and spigot, neoprene gasket OR D.I. with rubber gasket, hub and spigot, or SDR21PVC, or PVC DWV	C.I – No Hub extra heavy couplings D.I Neoprene Push Joint, DWV glue fittings
Sanitary or Storm Pump Drainage	2" and under –PVC pipe, PVC compression check valve 2 ½" and above – Copper pipe with Apollo 6P ball valves and flanges counter weight check valves	2" and under – glue fitting (with compression check valve) 2 ½" and above – Victaulic
Domestic Water 3" & larger (Below Ground)	Ductile Iron, rubber gaskets, ¾" rods	Ductile or gray iron
Domestic Water 2" & smaller (below ground)	Copper Type K	Cast Bronze, or Wrought Copper Brazed or Compression Joint
AC Condensate	Type L Copper or PVC sch. 40	Copper or Solvent weld PVC
Natural Gas 2" & smaller 2 ½" & larger	Schedule 80 steel Schedule 40 steel	Threaded Malleable –Extra Heavy Welded

9. Requirements for Plumbing System Testing, Sterilization & Commissioning

- A. At the completion of all piping work, and before any insulation is applied, all piping shall be tested in accordance with the following schedule:

Service	Duration	Pressure
Domestic Water Service Piping	(4) hours	100 psig
Cold Water Piping	(4) hours	100 psig
Hot Water Piping	(4) hours	100 psig
Hot Water Return Piping	(4) hours	100 psig
Sanitary Sewer Lines	(1) hour	10' of water

- B. All new water piping and equipment shall be thoroughly flushed to remove foreign material. A University approved plumbing Disinfection Company shall be hired to sterilize all plumbing piping in accordance with the National Standard Plumbing Code.

C. Commissioning

1. Commissioning shall be performed in accordance with section 3.13 of this manual

2. The extent of Commissioning shall be determined during the schematic design phase of a project, either using in-house, (Single Party) or a Four party commissioning agent.
3. Tech Team representatives from Engineering and Grounds Building Maintenance shall be an integral part of the commissioning process
4. The procedure for testing shall be followed closely in accordance with the Project Specifications and Pre-Functional and Functional tests as outlined in section 3.13 of this manual
5. Witness and sign off for floor drain flow testing.
6. Where tying into a sewer main, an additional video of the line is required from the building perimeter to the connection point with the sewer main.

10. Plumbing System Electrical Alarm Requirements

The University Plumbing Shop requires the alarming of certain critical plumbing system areas.

Off Hour Alarm Management (Remote Notification) - Alarms that require off hour response need to be set up to notify appropriate Princeton personnel via email and phone call. A meeting with the appropriate users shall determine which alarms require off hour response and where the appropriate notifications will be sent.

The following areas may have alarm and/or standby electrical power requirements:

- Elevator Sump Pumps
- Storm Sump Pumps
- Sewage Ejectors
- Domestic Booster Pumps

Refer to Sections 3.2 (Automatic Temperature Controls) and 3.12 (Electrical).

11. Requirements for Attic Stock

While attic stock is generally not required for plumbing fixtures, the need may arise should non-standard fixtures be specified. If so, any attic stock requirements will be required to be stored in the building.

12. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built drawings prepare by the Plumbing Contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the Contractor and University personnel to review progress on the system and to ascertain that the Contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the Contractor is maintaining record drawings to convert to as-builts.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design;
- B. Completion of Design Development
- C. At 50% completion of construction documents;
- D. At 85% completion of construction documents;
- E. At 100% completion of construction documents, if required, at the discretion of the Tech Team.

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

6. Requirements for Documentation

During preliminary design and design development the designer is to consult with the project manager and with University Engineering and Campus Energy Department to define system distribution strategies and to discuss any obstacles that might be existing in a building, or problems inherent in a particular design or structural system. ✓PS-24

Along with the Specifications, the Designer is to produce sufficient documentation to allow for code review of the electrical project and for contract bidding of the work.

The documentation will include, as a minimum:

Required Documentation	SD	DD	50% CD	85% CD
MEP Design Intent	X			
MEP Basis of Design		X		
Notes & Symbols	X	X	X	X
One Line or Riser Diagram - Power	X	X	X	X
Power Plans		X	X	X
Lighting Plans		X	X	X
OIT Plans		X	X	X
Security Plans (CACs/CVMS)			X	X
Equipment Schedules			X	X
Panelboard Schedules			X	X
Lighting Fixture Schedule			X	X
Electrical Specifications			X	X
Details				X
Vertical Sections as required				X
Short Circuit and Coordination Study, Arc Flash Study				X

7. Design Guidelines – General Programming Issues

- A. Criteria for building load evaluation including elevators
 - Design to NEC
 - Compare peak demands to projected load
 - Determine proper service and feeder protection in conjunction with Manager of Electrical Engineering
- B. Existing Site Utilities Review
 - Use existing site Utility layout in order to optimize the best possible feeder location and minimize relocations.
 - Coordinate feeder location with architectural design process.
- C. Service Entry Points
 - Locate substation near service entry point to minimize cable runs.
 - Separate OIT communications cable entry point from electric service entry point.
 - Basement is preferable for Mechanical/Electrical Equipment Rooms. Should Designer not be able to accommodate, state reason.
- D. Utility vs. Princeton University Distribution System
 - Size of Building and location affect decision.
 - Timing of maximum load (day vs. night)
 - Location of other site utilities
 - If Building will be on University power, Designer needs to specify a Princeton University approved electric meter (with data connection). See Appendix 3.12-3
 - All of the above need to be discussed with Manager of Electrical Engineering.

- E. **Life Safety (LS), Standby (SB) or Legally Required Standby (LRSB) Service Needs Assessment**
- At minimum, **legally required stand-by and life-safety** power required by Code
 - Discuss whether power **source** comes from local (within building) or regional source.
 - Discuss
 - Discuss which equipment receives **LRSB, LS or SB**.
 - Mechanical sump pumps, **sewage ejector pumps, condensate stations, circulator pumps, building controls** and freeze pumps shall be on standby power.
 - Discuss fire pumps on generator with Facilities Engineering Department.
 - Avoid elevators on generator if possible. If multiple elevators are required on **LS** power, sequence such that only one elevator at a time operates to reduce the load on the generator
- F. **Event Power Needs Assessment**
- Contact Grounds and Building Maintenance Electric Shop supervisor to assess whether event power is needed for exterior events and lighting.
 - If power is required it usually will be recessed on the exterior of the Building with a brass box cover. Verify if in-ground location may be preferable.
 - If event power is deemed necessary, the main distribution panel shall accommodate these requirements.
- G. **Daylight Harvesting Assessment**
- Dim lighting in Atriums or other areas where daylight provides necessary light levels. Use occupancy sensor in conjunction with photocell to achieve this function. See Section 3.5 Lighting Design for additional information.
- H. **Specialty Power Assessment (UPS, Surge Protection, etc.)**
- Surge Protection Device (SPD) required on building incoming electrical service and on power panels serving sensitive electronic equipment.
 - Assess with all users and Engineering Department representative which systems require computer grade power (UPS). (Normal power supplied from the campus electrical distribution system is utility grade.) **Consider a centralized UPS. Maintain building infrastructure requirements separately from user infrastructure.**
 - Determine which systems need to be on UPS or standby emergency generator power.
- I. **Grounded Conductor (Neutral) Line Loading/Harmonic Current Assessment**
- University preference is to reduce harmonics instead of using ‘K’ rated transformers.
 - Determine ‘K’ rating. If high (areas of many computers) size **grounded conductor** accordingly.
 - **Grounded conductor** shall be doubled for loads with significant third harmonic content.
 - Separate neutral conductor for all circuits. No shared **grounded conductors**.

8. Design Guidelines – Schematic Design Phase

- A. **Power Distribution Configuration**
- Determined by type of Building
 - Residential – 120volt

- Non-Residential – 277volt lighting 480volt equipment
 - Voltage class based on Building typology, residential vs. non-residential.
- B. Service Point Design
- Generally deep Basements come in with feed overhead and include junction box on wall.
 - First Floor or shallow Basements come in with feed below slab.
 - If on PSEG power grid, follow their design criteria.
- C. Double vs. Single Ended Services
- Where continuity of power is required (such as Laboratory Buildings, large Buildings, Computer Centers, area substations), service shall be double ended.
- D. Switchgear Lineup Determination
- 5kV systems bring (2) feeders into Building (A&B) using a primary selective scheme.
 - Reference Appendix 3.12-3
 - Preference is for a line-up of switchgear.
 - No secondary fused disconnects.
 - Install switchgear on housekeeping pads. Switchgear/substations installed below grade in vaults or directly underground (plazas, etc.) shall have drip pans installed over the switchgear.
- E. Transformer Types
- Discuss efficiency and temperature rise requirements
 - 5kV Substation – liquid filled **seed oil** transformer
 - Low Voltage Transformers shall be – dry type, 115° rise, Transformer efficiency shall meet or exceed DOE **2016** ratings.
- F. Electrical Room Locations (see Section 4.5 Electrical Rooms for additional requirements)
- Basement preference vs. upper Floors
 - If multiple Electrical Rooms required, disburse on multiple Floor Levels.
 - Discuss during programming
 - Design for future expansion including panels, transformer, ATS, control panels (ie: lighting, FA, ATC, CACS, etc.) sleeves and/or spare conduits.
 - Maintain all working clearances (spaces about electrical equipment) in accordance with NEC.
 - Natural ventilation shall be used to cool electrical room. Discuss with Facilities Engineering the rare cases when CHW cooling is required.

9. Design Guidelines – Design Development Phase

- A. Separate Subpanel Feeds vs. Riser Panels
- No riser panels without University approval.
- B. Subpanel Distribution through Building
- Minimize distance between panels for future circuit expansion requirements.
 - Maximize future subpanel expansion capabilities by allowing sufficient wall space in electrical rooms for additional future panels.

- Review normal and emergency panel locations during Design reviews.
 - Review locations with Architect as well for aesthetic continuity.
 - Preference for horizontal vs. vertical circuit distribution.
- C. Requirements for Spare Circuits
- 20% spare capacity minimum per panel (30% at main distribution panels).
 - All spaces equipped to accept circuit breakers including distribution panels.
 - Lighting panels fully equipped with breakers; no “blank spaces”.
- D. Conduit vs. Greenfield or ENT With THHN Stranded Wire Pathway Parameters
- Specify conduit to individual rooms, or to individual devices.
 - If room has accessible space/hollow wall, Greenfield or ENT raceway is then allowable.
 - Aluminum MC cable is **NOT** allowed
 - For non-residential buildings the preference is to not allow for MC cable.
 - When MC cable is used for wiring to receptacle the following shall apply:
Each room or office shall have two feeds (whips) per circuit into the room. Each cable entering the room shall feed half of the receptacles on that circuit in the room (office). Use stranded conductor cable only. Wiring from panel to the junction box shall be in conduit. (See Appendix 3.12-9)
 - Use MC cable for whips and for “fishing” in existing walls. Use stranded conductor cable only.
 - Use steel set screw fittings for all connections. Die-cast type fittings will not be allowed.

10. Design Guidelines – Construction Documentation of Equipment and Devices

- A. Wire and Cable
- Wet locations/below grade – 600volt to be U.S.E.-2. All below grade cable splices shall be accessible and protected with heat shrink kits.
 - All wire #14 and larger shall be copper stranded, type THHN
 - No pole lights shall be fed with UF cable, use 1¼” PVC with U.S.E. – 2 wire.
 - 5kV feeder cable type MV-105 copper minimum 500KCMIL full copper taped shield. 5/8kV rating manufacture shall be by “Okonite”.
- B. Conduit
- All below grade conduit to be PVC where allowed by code.
 - Limit degrees of bends to 270 below grade.
 - Transition to rigid steel before rising above concrete.
- C. Panel boards, Fuses and Transformers
- Fuses only for control, not power circuits.
 - All panelboards shall be circuit breaker type, 225 Amp. bus minimum.
 - Panel trim (lockable) shall have “door-in-door” double hinged construction.
 - No aluminum bus
 - General Electric, Square D, (Cutler Hammer acceptable in residential installation)
 - In renovation work: rebalance 3 phase electric power and list amperage at panel board.
 - Transformers – for noise considerations use dim matting ILO springs.

D. Receptacles and Devices

- Discuss color with Design Team and Grounds and Building Maintenance Department (GBM) to standardize in Building.
- Stand-by receptacles – red
- Isolated ground receptacles – orange
- Cover plates standardize to ivory/brown/stainless steel, or as agreed to by GBM.
- Non-metallic cover plates shall be nylon not plastic.
- Dormitory Bathrooms shall have nylon plates and screws.
- Receptacles rated at 20amp., may be specified for branch receptacle circuits. In this case the minimum gauge wire shall be #12 copper stranded.
- Mounting heights – may vary in renovation work. Requires field verification during layout.
- Receptacles in laboratory buildings shall be labeled with panel and circuit feeding receptacle.

E. Motors and Drives

- Variable frequency drives should be utilized for energy savings or system control requirements. Use ABB ACH550 or Yaskawa Series Z1000. Bypass and alternating capability requirements should be reviewed by PU Engineering. All VFDs should have integral MCP disconnects, door-mounted keypad, HOA/bypass selector switches, and direct communications interface to either Siemens APOGEE system or Automated Logic. Line and output reactors should be used per manufacturer recommendations.
- For VFDs, use of 18 pulse drives is recommended for everything 20hp and greater unless IGBT low harmonic technology is employed to provide equivalent performance. A secondary option is to perform a harmonic study to show harmonics are within NEC code compliance.
- Motors 3-phase for 1/2hp and above. For fraction HP motors in fan coil units single-phase allowable.
- Pump motors shall be 3-phase (480volt if available) with premium efficiency.
- Motors on 208volt shall be rated at 200volts (not 230volts)
- Motors for use on drives shall meet NEMA Design Standards Part 31. Definite purpose motors for use on inverters should withstand repeated voltage peaks of 1600volts with rise times of 0.1 microseconds and greater.
- All starters shall be minimum size #1 with hand - off – auto and red run lights (Use NEMA starters), no IEC type starters, use motor circuit protectors, no fuses. Motor starters shall be purchased by Electrical Contractor. GE Series 300 or SquareD Starters preferred.
Consult Engineer for package unit with starters.

F. Grounding

- All ground conductors shall be installed with non metallic or non continuous metallic hardware.
- Installation in PVC pipe preferred
- All ground bus connections shall be bolted lug type with double bolts.

G. Motor Control Centers Parameters

- An MCC shall be specified in areas where 3 or more starters are located.
- MCC shall be used for distribution centers, if a main distribution panel is not available.
- Elevators fed from MCC should not have starter, only breaker.
- Install MCC units on housekeeping pads.
- Protect all MCC's from direct sprinkler discharge.
- GE Series 9000 or SquareD preferred.

H. Hand Dryers

- Consider in Buildings of large public access.
- Hands-free type

I. Arc Flash / Short Circuit and Coordination Studies

- Arc Flash, Short Circuit and Coordination studies are to be completed and submitted with the 85% CD package.
- If available, existing arc flash studies will be provided to the Designer for modification in conformance with final design. If no study exists, the Designer **must perform** their own study per NFPA/NEC and IEEE standards and submit to the Facilities Manager of Electrical Engineering for review. ETAP format preferred.
- All equipment requiring Arc Flash studies is to receive a permanent and durable Arc Flash Protection label which includes all of the information as required by the NEC.

11. Design Guidelines – Life Safety (LS) Stand-By (SB) and Legally Required Stand-by (LRSB) Power Systems

A. Fuel System Requirements

- Diesel fuel only.
- Base tanks preferred (shall be agency listed).
- Supplemental fuel filter with water separator shall be supplied.
- Fill location to be accessible by truck.
- Preferred to be within Building/discuss early with all parties.
- Fuel vent shall have a line whistle and be located close to fill cap.
- Fill cap shall be manufactured by Scully.
- Digital fuel tank level gauge is preferred.

B. Generator Equipment

- Metering
- Blockheater
- Load Banks
- Sound Attenuation
- All exterior fastening hardware to be stainless steel.
- Generator and its enclosure must be UL listed from the factory. If this cannot be accomplished it is to be discussed with the University Code Analyst and Facilities Engineering early in the design process.

C. Exhaust Issues – Location, Noise, Exercising

- Location to be determined early during programming.

- Air Dispersion modeling Study to be considered.
- Exercising time may impact location of unit.
- Exhaust system shall use a critical grade muffler and welded iron pipe.

D. Transfer Switches

- Zenith with MX250 controls, A1-E contact, and Modbus TCP/IP interface for remote monitoring capability. The minimum size ATS should be rated at 80 amps.
- Conduits for communication to fire alarm panel with 6 conductors and to the campus electric SCADA via OIT outlet in switchgear room.
- Critical applications (Labs, Computer Centers) use transfer switch with by-pass switch for maintenance.

E. Connected Items on System

- Half stairwell fixtures on LS Power – half on Normal Power, connect diagonally.
- One fixture over each bathroom sink.
- All outdoor egress fixtures, use LED lamps.
- Select receptacles in mechanical and electrical spaces – use red devices (i.e. sump and sewage ejection pumps).
- Fire alarm and card access systems.
- Elevator cab, shaft and Machine Room lighting.
- Labs – one fixture by each entrance door.
- Use only fluorescent and LED light sources on LS systems. (incandescent in special circumstances)

F. Transformers and Panelboard Requirements

- Install in locked locations. Install emergency service labeling on equipment.

G. Start-Up

- During startup the power needs to be stable enough so that power meters do not reboot.

H. Optional Stand- By Systems

- Typically the University does not supply standby power on academic research and other items than those listed above. The need for project specific needs should be reviewed early in the design process with Facilities Engineering.

12. Procedural Guidelines – Other Design Considerations

A. Requirements for Labeling

- All equipment to be labeled with engraved lamacoid fastened with mechanical fasteners.
- Each label shall include; panel designation, voltage and where panel is fed from.
 - Normal Power - black background with white lettering
 - Life Safety Power – yellow background with white lettering
 - Legally Required Standby Power – orange background with white lettering
 - Optional Standby Power – green background with white lettering
 - OIT – blue background with white lettering
 - Fire Alarm – red background with white lettering

- Panel directory labeling to be done after final Room number designations established. (See Appendix 2.8-2 “Room Name Spreadsheet”.)
 - All electrical distribution equipment shall be labeled per the accepted arc flash analysis. Equipment shall include (but not be limited to) switchgears, switchboards, panel boards, motor control centers and transformers.
- B. Maintenance Accessibility
- All fixtures in stairwells shall be accessed with a ladder, without requiring scaffolding.
 - All Electrical Rooms shall be designed and utilized for electrical equipment. Storage for other use is not permitted.
 - Allow space for removal and replacement of equipment.
- C. Keys and Security Issues
- All cores by Princeton University. All mechanical and electrical spaces EM core. All Generator and Elevator Rooms AS core. Substations and HV Distribution Buildings use HV core.
 - Determine need to secure equipment not located in separate Electric Rooms.
- D. Snow Melting
- DDC point required from snow melting panel to Building Automation System (BAS).
 - The Contactor for snow melting shall have a 3 position switch “hand-off-auto”.
 - Install current transformers to verify function and feedback indicating status.
- E. Lightning Protection
- The Designer should review with the Project Manager the need for lightning protection on the building. If a system exists, or if a new system is proposed, the Designer should recommend the preferred method of installation.
- F. Vehicle Battery Charging Stations
- Typically at Dormitory or other entryways.
 - Discuss need for exterior outlets to charge vehicles with GBM.
 - Each charging location shall have a dedicated 20amp. duplex GFI receptacle.

13. Procedural Guidelines – Commissioning, Warranty Notification

- A. Commissioning
- Commissioning shall be performed in accordance with section 3.13 of this manual
 - The extent of Commissioning shall be determined during the schematic design phase of a project, either using in-house, (Single Party) or a third party commissioning agent.
 - Tech Team representatives from Engineering and Grounds Building Maintenance shall be an integral part of the commissioning process
 - The following electrical systems will be included in the commissioning process
 - Power Distribution
 - Auto Temp Controls
 - Lighting
 - Generators
 - UPS

Motors & Drives
Grounding & Testing
PV

B. Warranty Period Notification

- Establish/notify Shops of date of substantial completion. If multiple phases are constructed, Contractor to provide comprehensive list of all dates per individual piece of equipment. Typically, this is a one-year process.

14. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of As-built Drawings prepared by the Construction Contractor and any systems installer.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the Contractor and University personnel to review progress on the system and to ascertain that the Contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the Contractor is maintaining record Drawings to convert to As-Built.

Provide Switchgear Drawings on AutoCAD. See also as-built requirements in Section 1.5 (Documentation and Archiving), and Section 4.5 (Electrical Rooms).

END OF DOCUMENT

1. Introduction

The University Commissioning Process is designed to validate University construction project's functional and performance requirements. The process includes procedures for achieving documented targets, verifying facility performance, coordinating commissioning documentation and facilitating the turn-over to the University through coordination of facility training. This chapter deals specifically with MEP systems commissioning.

The process implements methods and tools to verify that the project achieves the University's Project Requirements (OPR) throughout the delivery of the project.

Sustainable and Environmental Design, LEED, IEQ, Energy Use and Management, and Life Safety are prime design drivers in Facilities and as such, each weighs heavily in the commissioning processes procedural requirements.

A successfully implemented commissioning process will achieve the following objectives;

- Implement and Exemplify the Facilities Design Standards Manual (DSM)
- Document and Develop the OPR
- Implement procedures to validate and improve the quality of project deliverables
- Verify and document the project meets the OPR during and at project completion
- Collect and verify accurate documentation of all project commissioning deliverables
- Provide training to all stakeholders in preparation for facility turnover that will include ongoing programs for Engineering and Energy Management, and Operations and Maintenance.

2. Contacts

- A. The Project Manager (will be assigned at project inception from a specific University Department)
- B. University MEP Project Engineer 200 Elm Drive, 609-258-8589
- C. Program Manager of Standards 200 Elm Drive, 609-258-1330

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

<u>Cx Reference Document</u>	<u>PDF</u>	<u>MS Word</u>
A. OPR Template	Appendix 3.13-1	Appendix 3.13-1
B. Cx Guide Narrative	Appendix 3.13-2	Appendix 3.13-2
C. Cx Document Matrix Template	Appendix 3.13-3	Appendix 3.13-3
D. Cx Roles and Responsibilities Matrix	Appendix 3.13-4	Appendix 3.13-4
E. Cx Scope Template	Appendix 3.13-5	Appendix 3.13-5
F. Commissioning Plan Template	Appendix 3.13-6	Appendix 3.13-6
G. MEP Basis of Design	Appendix 3.13-7	Appendix 3.13-7
H. Final Commissioning Report	Appendix 3.13-8	Appendix 3.13-8
I. Index of Pre-Functional Tests	Appendix 3.13-9	Appendix 3.13-9
J. Index of Functional Tests	Appendix 3.13-10	Appendix 3.13-10
K. Plumbing Cx Specifications	Appendix 3.13-11	Appendix 3.13-11
L. Mechanical Cx Specifications	Appendix 3.13-12	Appendix 3.13-12
M. Electrical Cx Specifications	Appendix 3.13-13	Appendix 3.13-13

N. BAS Cx Specification	Appendix 3.2-1	Appendix 3.2-1
O. Fire Alarm Cx Specification	Appendix 3.13-14	Appendix 3.13-14
P. Fire Protection Cx Specification	Appendix 3.13-15	Appendix 3.13-15

4. Commissioning Process

The Commissioning Narrative document in the DSM Appendix describes in detail the requirements of all parties in the Cx Process (Appendix 3.13-2).

✓PC-1 The Office of Design and Construction and the Facilities Engineering and Campus Energy are responsible for initial OPR development, pre-project planning and preliminary design. At this early project stage, the Commissioning Authority (CA) rests with the University MEP Project Engineer. The University MEP Project Engineer, acting as the CA, creates a new OPR document from the OPR Template to begin the process of populating it with the project requirements and defines the Commissioning Team (Appendix 3.13-1). The CA then coordinates the updates to the OPR and performs all Cx roles and responsibilities as this phase proceeds, or until a consultant CA is brought into the process. The first development revision of the OPR is the primary output of this phase.

The **Pre-Contractual Phase** begins the inclusion of the A/E and possibly other subject matter experts into the process. During this phase the OPR will be refined and further developed to include the A/E project outputs, Commissioning Team outputs and necessary changes as required and defined within this DSM. The CA is responsible for coordinating and capturing these outputs into the OPR. The second development revision of the OPR is the primary output of this project phase.

✓PS-10 The **Pre-Schematic Phase** completes the OPR design revision process. The CA working with all University project stakeholders and the A/E coordinates and completes the initial production version of the OPR. This production version is considered the first version that will fully conceptualize all of the functional and performance requirements of the project. It is the collection and documentation of the multiple meetings, surveys, objectives, considerations, design and design parameters, performance criteria, schedules, etc., that will be used to judge the quality of all future project design and installation efforts. It is the A/E directive document that guides their development of the Basis of Design (BOD). It and the BOD will be the basis of review for all CA review sessions to occur in the successive project phases.

The **Design Phases (Schematic and Design Development)** require the project team to develop and refine all project documents in support of the OPR. During these phases, the Commissioning Team led by the CA will use the OPR and BOD to manage the process of confirming all requirements in order to validate the quality of all project outputs of these phases. In some cases, one or both of the OPR and BOD will be revised and refined as needed, coordinated by the CA and A/E respectively, assisted by the Commissioning Team. The Commissioning Plan, Schedule, Scope and Cx Document Matrix will be finalized. The CA will review multiple project outputs during these phases, as outlined in the Cx Document Matrix (Appendix 3.13-4).

The **Construction and Acceptance Phases** include the actual physical construction activities. The CA will coordinate and manage the Cx Process during this phase with the assistance of the Commissioning Team. All project outputs will be tested, reviewed and judged against the OPR, BOD and all other construction documents for quality verification. Anomalies noted in the Issues Log will be documented and remediated by the Commissioning Team. Contractor installed

systems training will be coordinated by the CA but responsibility for the training will fall to the construction contractors.

The **Occupancy, Operations and Warranty Phase** will conclude the CA involvement in the project. The CA will coordinate and provide services, training and workshops that will educate and prepare the user and operations teams for facility activation. The CA may return to the project within the warranty period to perform opposite season testing, training or assist with major warranty work. The CA is responsible for all documentation updates in this period. The CA will complete the Commissioning Process Final Report, which may include a Systems Manual, Facility Guide and LEED documentation and submissions.

5. In-House or Third Party Cx Process Model

During the initial OPR development, the Owner team will review the project requirements to prepare the preliminary Commissioning Scope. Depending upon the outcome of this exercise, one of two possible commissioning models will be chosen, either In-House Commissioning or Third Party Commissioning. The chosen commissioning model will define the roles and responsibilities to be executed during the project but do not change the commissioning process.

In-House Commissioning defines the University as the project Commissioning Authority for the project. The Office of Design and Construction will assign a Commissioning Agent, generally this will be the University MEP Project Engineer. The A/E role is expanded when the In-House commissioning process is chosen. The A/E will actively participate in commissioning document development and in some case create commissioning documentation.

Third Party Commissioning defines an outside party as the project Commissioning Authority for the project. This model choice is dependent upon many factors including project size, University scheduling and project complexity among many others. The University will create a formal Commissioning Services RFP detailing the Commissioning Scope outlined in the OPR. The A/E is required to coordinate all required Cx related contract documentation with the chosen Commissioning Authority.

The Commissioning Process Roles and Responsibilities Matrix outlines the difference between the two commissioning models. The A/E is responsible for coordination and cooperation with any adjunct professionals providing assistance to the University while commissioning documents are produced.

6. Commissioning Scope

The Commissioning Scope will vary according to project requirements and the Cx Process model chosen. If the scope has not been defined, the A/E should work as if the In-House model is applied to the project.

Generally, all Mechanical, Electrical and Plumbing project components and features are included in the typical Cx Scope.

Central MEP systems will be commissioned at a 100% sampling rate, whereas zone level MEP may use a sampling rate of no less than 25%.

Depending upon OPR, the following building systems may be included in the Commissioning Scope. However, these systems are typically commissioned by a sub-contractor or system integrator. These Cx efforts are to be conducted and coordinated within the project Cx Process owned by the CA. The CA shall witness and in some cases validate these systems are functional.

Audio-Visual Systems:	(2.2 Audio-Visual Standards)
Building Envelope: During Pre-Schematic Phase determine the need for an Envelope Consultant. If required, the consultant should be brought on board by the end of schematic design.	
Fire Alarm System: <i>Based on code requirements</i>	(3.4 Fire Alarm Systems)
Fire Protection Systems: <i>Based on code requirements</i>	(3.7 Sprinklers & 3.8 Chemical)
Building Security Systems:	(3.1 Access Control Systems)

7. Review Guidelines

The Commissioning Process requires multiple review sessions within all phases of the project. The Cx Document Matrix outlines the responsibility of each team member within the review process. At no time will any defined document review requirement be bypassed without the Office of Design and Construction approving the deviation from the process in writing.

As the project moves through the design phases, the project documents will be submitted for review to the Office of Design and Construction for compliance with the DSM, OPR, BOD and any suggested best practices, design considerations or alterations. The University Project Manager will coordinate review sessions to include multiple University disciplines to provide departmental specific review comments. All University commentary will be collected by the A/E in a standard commentary format provided by the A/E or the CA. Any formal review meetings arranged by the Project Manager will require the A/E and CA to attend and for both to be responsible for meeting minutes.

The CA will review the project documents in comparison to the OPR and BOD. The CA will provide any best practice or design suggestion that will increase the quality or improve the design documents in relation to the OPR and BOD. The CA will include discrepancies identified and communicate the commentary to the Office of Design and Construction and the A/E.

The A/E will collate all commentary and communicate a response in a timely standardized format. It is the A/E responsibility to ensure the CA commentary is always included during each review session.

All variances to the OPR and BOD identified and implemented through the review process shall require these documents to be updated by the CA and A/E respectively.

8. Commissioning Documentation

The Commissioning Document Matrix Template, in the DSM Appendix, is the authoritative process document regarding all University Cx documents. Each project will require the matrix to be customized to meet the project requirements and inserted into the OPR during Commissioning Scope development. Once the Cx Scope has been confirmed, the University Project Manager must provide written approval to parties requesting a variance to the Project Cx Document Matrix. The CA will manage the Cx Process and all relevant Cx Documents created by all Commissioning Team members.

During construction, all commissioning activities will be documented using the University proprietary PCS BIM360 interface. Third party commissioning agents may use their own internal system, but final project documentation must be transferred to the University PCS interface.

END OF DOCUMENT

Standards for Communication Closets-
Office of Information Technology

The need for communication closets must be addressed in the early stages of design in a Building project. Designer shall meet with the Project Manager, OIT and Telephone Departments to determine the number and size of the closets. This will be determined by the location and number of outlet devices in the Building.

1. Communication Closets

Princeton University designates Communication Closets as either BDF (building distribution frame) or IDF (intermediate distribution frame). BDF is the initial entry point for communication wiring into the building which takes “entry” cables for telephone and data wires and decentralizes them into “feed” cables sent to IDF Closets for further processing into individual “station” cables sent to respective Rooms. BDF Closets may also be considered IDF or have “station” cables running to them if there is a minimal load required in the building. For larger loads, several IDF Closets may be required in addition to the main BDF Closet. An important consideration is that no more than 295’ of cable is allowed between termination points and the IDF Closet location, including all bends. See section 2.6 Office of Information Technology for building wide technology systems design.

A. Construction and Fire Rating: Review need for fire-rated enclosure and door assembly, including door closer

B. Finishes

1. Walls – Masonry: Block/Gyp Bd. – Water protection on outside wall for new construction. Existing construction, water seal exterior wall .
2. Floor – Concrete, Sealed or Finished Floor
3. Ceiling – Exposed structure is preferred. If rated ceiling is required; plaster ceiling should be specified.
4. Door – 36” minimum width; outward swinging doors are preferred to preserve floor space

C. Utilities/Equipment

1. Power – Quad receptacles with (4) dedicated 20 amp. circuits – 18” A.F.F. (new) may be higher than 18” A.F.F. (renovation). Two (2) quads are to be placed on stand-by power supply; two (2) quads on standard building power. No separate UPS required.
2. Lighting – All lighting shall utilize energy efficient LED fixtures. Lighting shall be switched at each door into room.
3. Ventilation – Exhaust ventilation with make-up air based on size of closet and careful evaluation of total equipment heat load and its configuration/concentration within the closet. Coordinate all HVAC issues with OIT. (2 air changes per hour minimum)

4. Piping, etc. – Maintain headroom of 9'-0"; piping, conduit, ductwork, etc. to be installed above that level.
5. Detector – Smoke detection may be required; review use.
6. Sprinklers – Provide upright pendant with wire cage in Buildings with suppression.

D. Equipment Requirements (BDF or IDF)

1. New construction – No other systems, storage or Janitor's equipment allowed in these rooms.
2. Renovation – Coordination with other utilities during renovation projects is essential.
 - Eliminate high voltage (440 volts or higher) including pass thru lines. OIT cable/raceway must have a minimum of 10' clearance from high voltage systems.
 - Avoid installation of OIT cable near or thru Elevator Machine Rooms.
 - OIT termination panels should have a minimum of 20' clearance from high voltage systems.
3. Overhead Cable Tray – As designed by OIT
4. Floor-mounted Racks (Preferred) – Minimizes cross-connections (patch cords) between equipment. Must be floor bolted for certification. Typically used for video boxes, UPS and surge protectors.
5. Wall-Mounted Racks – For telephone cut-down blocks. Locate closer to door to minimize OIT interference.

E. Miscellaneous

1. Door lock – Doors are to be on the University's SALTO keyless lock system.

END OF DOCUMENT

Standards for Corridors-
Grounds and Building Maintenance
Building Services

Hallways/Corridors/Stairwells

A. Construction and Fire Rating

Building use and occupancy load on corridors affect the fire rating requirements for a corridor or hallway. The New Jersey Uniform Construction Code (UCC), the New Jersey Uniform Fire Code (UFC), and the International Construction Code (ICC) must be reviewed for these requirements. Note that the installation of a fire suppression system in a building may reduce the requirements for fire rating of exit components.

B. Finishes

Maintainability and appearance over time are key concerns.

Finishes are project specific and should be determined within the context of the building design, and with the consensus of the project team and the University's review committee. Preferences for finishes from a maintenance and housekeeping perspective are:

1. Walls -
 - masonry: brick, ground-face or painted block, glazed block, ceramic or stone tile, plaster-finished masonry;
 - frame: with plaster finish over lath, rock-lath, Imperial board, or abuse-resistant gypsum board decorated with a level 5 finish in corridors and common spaces (refer to Appendix 4.13-2). The Designer should attempt to incorporate breaks, reveals, or other architectural details to divide large expanses of painted surface, particularly in the vertical direction. This is especially true in high traffic areas, areas using high pigment paints, or locations that are especially subject to abuse.
 - To avoid cracking above door frames along corridors, include a control joint at door hinge side, refer to ASTM C840 System XIII
2. Floors -
 - masonry: concrete, terrazzo, stone, quarry or ceramic tile (**all properly sealed to resist staining**);
 - vinyl composition tile, rubber tile;
 - carpet (in a color and pattern that can hide wear);
 - wood: oak, maple, or vertical grain Heartwood Southern pine strip flooring with (VOC-compliant) water-based finish for halls and corridors. Parquet floors have been problematic at Princeton.
 - entrance mats: specify polypropylene carpet-type walk-off mats with flexible vinyl backing.

3. Ceilings - exposed masonry, steel, or wood (meeting code requirements);
concealed spline acoustic tile (in areas with no, or very low, requirements for access above ceilings);
lay-in acoustic tile (in non-dormitory use);
framed plaster (preferred) or gypsum board, with all required access panels indicated on reflected ceiling plans and MEP plans where minimal systems exist; all public-area access panels below 9'-0" A.F.F. are to have Best cylindrical locks (refer to section 4.4).
4. Trim - There should be some form of base in corridors for housekeeping purposes, compatible with floor finish; tile, stone, wood, rubber; review with Project Manager.

Rubber base is preferred over vinyl base, where appropriate. Manufactured inside and outside corners are not to be used. **Provide a straight base for carpet and a cove base for resilient flooring.**

C. Utilities

All utility piping and conduits should be concealed within finishes. Points requiring access should be 'centralized' as much as possible -- group valves, junction boxes, etc. near one another to minimize the need for multiple access doors or panels.

Designer is to produce typical corridor cross-section Drawings to illustrate all typically required coordination of piping, duct, and conduit runs, and installation of devices. Maximize ceiling heights while providing for utility runs.

1. Power Outlets -Maximum 25' between outlets in corridors; provide outlets in stairs at each floor level. 20 amp. dedicated circuit per corridor.
2. Lighting - Coordinate normal ambient lighting with emergency lighting; use campus emergency power network where available for emergency lighting. **Care shall be taken when selecting lamp types to reduce the number of different lamps.** A list of replacement lamps is to be included in the closeout documentation required of the contractor.
3. Ventilation - Determine requirements and need for heating and ventilation in corridors early in project; review with Project Manager.

Plan duct runs for ventilation and make-up air and coordinate with ceiling installation and other utilities. Consider impact of duct distribution on structural frame depth in corridor.

New Jersey code review agencies normally request a written ventilation schedule showing compliance with fresh air requirements on the approved Drawings. Make-up air is generally required to be tempered.
4. Fire Alarm - Provide required smoke detection, pull stations, and alarm signaling devices. Maintain required clearance between smoke detectors and HVAC supply diffusers. Coordinate device placement with other

corridor systems and with architectural finishes by preparing elevation Drawings showing pull stations, horn/strobes, hold-open devices, exit fixtures, etc. with other required devices, systems, and elements.

5. Sprinklers - Concealed pendant heads preferred; concealed sidewall heads are an option.

In new construction and major renovation, exposed piping and exposed sidewall heads are not acceptable.

6. Extinguishers - Coordinate location of hand-held fire extinguishers with standpipe hose cabinets. Provide recessed cabinets for storage of extinguishers, **fire rated – where required**. Review proposed locations with Project Manager, and with local fire official as directed.

D. Doors and Hardware

Stair openings typically require rated assemblies (frame, door, and hardware); doors must meet temperature-rise requirements. Provide detector-activated wall or floor hold-opens on stair doors and smoke doors to eliminate use of wedges and chocks. Coordinate hold-open devices with fire alarm system design.

Review the need for rated assemblies in corridors in buildings with fire-suppression systems.

See Section 4.4 (Door Hardware) for requirements for hardware in corridors.

E. Miscellaneous

Designer should be aware of security and safety concerns: limits on dead-end corridors in codes; control of access to remote areas; provision of emergency phones in appropriate areas. **Designer shall provide adequate space for trash receptacles.**

Review the need for signage and accessories such as message boards in corridors.

Drinking fountains are required by code, and water chillers are desirable; consider the possible inclusion of hot-water dispensers with water chillers. Water resistant floor materials should be used at drinking fountain locations. Consider use of splash guards at wall surfaces as well.

END OF DOCUMENT

4.3 Custodial Closets, Storage and Special Facilities

Standards for Custodial Closets and Storage-

Building Services

Grounds and Building Maintenance

The need for space for custodial purposes must be addressed in the programming phase of design in a building project. It is important that early design review of custodial closets in storage rooms occur with the Director of Building Services (609) 258-3713. Each building will require a custodial storage room of approximately 150 square feet (and possibly larger in larger buildings) for paper products and cleaning supplies and equipment. Ideally, custodial storage rooms should have a door width of 40" or greater to allow for passage of larger cleaning machines. These closets are not to be programmed with building mechanical and electrical spaces. Exact janitorial requirements for each building are a program issue to be resolved during design development.

Buildings up to 10,000 square feet will require at least one janitor's closet of approximately 35 square feet, and one of equal size on each additional floor level of the building.

Buildings up to 50,000 square feet will require two to three janitor closets, a minimum of one per floor level.

Buildings up to 100,000 square feet will need three to four janitor's closets minimum, at least one per floor level; larger buildings should be programmed for additional closets at the rate of one per 25,000 square feet.

1. Custodial Closets

- A. Construction and Fire Rating: review need for fire-rated enclosure and door assembly, including door closer.
- B. Finishes
 1. Walls - masonry: brick, block, glazed block, ceramic tile
frame with plaster finish: smooth finish, gloss painted finish
frame with level 4 GWB finish, gloss painted finish
NOTE: stainless steel backsplash above floor receptor
 2. Floor - concrete (properly sealed), terrazzo, ceramic or quarry tile
coved base to match floor; no floor drain required
 3. Ceiling - exposed structure is preferred if rated ceiling is required, plaster finish should be specified
- C. Utilities/Equipment
 1. Receptor - floor receptor with raised rim is preferred, 36" square, with 24" high stainless steel backsplash wall-mounted sink only; if receptor cannot be used faucet with hose connection, short length of hose; provide water-tight connection at receptor
 2. Power - GFI receptacle on wall away from water supply
 3. Lighting - 4' utility LED w/ protective guard at ceiling, wall switch
 4. Ventilation - exhaust ventilation with make-up air; review requirements for tempering make-up air

5. Piping, etc. - maintain headroom of 90"; piping, conduit, ductwork, etc. to be installed above that level.
6. Detector - smoke detection may be required; review use
7. Sprinklers - provide upright pendant with wire cage in buildings with suppression
8. NOTE - in dormitory bathrooms not within vicinity of a janitor's room, provide hose bibbs with hot and cold water under lavatory. Use hose bibbs with key stops.

D. Miscellaneous

- Accessories - friction-type mounting brackets for mops, brooms, etc. on wall over receptor (not under chemical dispenser)
12" - 14" stainless steel shelving high on third wall, 8' total if possible

2. Custodial Supply Areas

- A. Construction and Fire Rating (same concerns as with janitor's closets)
- B. Finishes - durable finishes, painted walls and ceiling
- C. Shelving - provide metal shelving, 16" deep minimum, 48' length (+/-), provide a minimum of 22" clear between shelving; maintain required clearances for sprinklers
- D. HVAC - meet minimum requirements for heating and ventilation
- E. **Equipment - provide clear floor space for cleaning machines and electrical outlets for charging equipment.**

Standards for Special Facilities Shop Space- Grounds and Building Maintenance

A series of buildings on campus are maintained by dedicated Grounds and Building Maintenance crews. These groups known as Special Facilities work in buildings due to the special programmatic needs of the respective facilities. During the Pre-Schematic phase the design team will receive direction from the Project Manager about Special Facilities programming requirements as approved by the Grounds and Building Maintenance Special Facilities Manager (609) 258- 8539.

It is important that early design review of special facilities needs be conducted with the Project Manager and representatives of GBM as designated by the Manager of Special Facilities. Programming of the Special Facilities space should be discussed as well as proximity similar spaces in adjacent buildings. It is important to understand what services can be shared between buildings and what are the unique needs for this project. Exact Special Facilities size and program requirements are defined by:

1. Equipment needs
2. Finishes
3. Special safety/ fire protection
4. Lighting/power and OIT
5. Plumbing requirements
6. Other project-specific issues

END OF DOCUMENT

**Standards for Door Hardware -
Grounds and Building Maintenance**

1. General

Early in the planning stages of the project, the Designer must meet with the University Project Manager and with Facilities Grounds & Building Maintenance Department Lock Shop Supervisor to review both the design standards and the program needs for locks and hardware in the proposed project.

Also early in the project, a determination must be made regarding the need for or desirability of including a card access system in the building. If card access is to be part of the building program, the system must be designed to meet University standards (see Section 3.1 Access Control Standards). It must also be determined whether Facilities Grounds & Building Maintenance’s Lock Shop or Oak Security will be supplying and/or installing the cores and providing the operating keys. All locksets are to be cylindrical unless otherwise recommended by the projects security consultant in writing for review by the project team.

Due to the historically high incidence of errors in hardware schedules, every effort must be made by the designer to have a “first pass” of the door hardware schedule and hardware specifications prepared by the issuance of 50% construction document submission. A complete hardware schedule with full hardware set specifications is required for the 85% construction document submission.

Documentation will include, at a minimum:

Documentation	SD	DD	50% CD	85% CD
Security Programming Document	X	X		
Door Schedule		X	X	X
Details – Head, jamb and sill conditions			X	X
Security Layout - Zoning/Elevation			X	X
Outline Specifications		X		
Full-Length Specifications – First pass with hardware sets, manufacturers, etc.			X	X
Full-Length Specifications – Complete				X

Prior to shop drawing submission, a hardware coordination meeting is to be scheduled with the Project Manager, User groups, Facilities Lock Shop Representative and Construction Manager to discuss project-specific issues related to lock functions, coordination, and delivery.

Princeton University utilizes hardware from a number of manufacturers; because of ongoing maintenance needs, and normal modifications within buildings, it is important that the Designer specify the standard manufacturers.

2. Standard: Non Electrified Hardware

For renovation work, the Designer shall not reduce the level of quality or service provided by existing hardware when specifying replacements without prior approval by the Tech Team.

- A. Cylindrical Locks - Best Locking Company, 7-pin removable core, #14 or 16 heavy duty lever handle as a standard; the majority of locksets used in projects on campus are to be of the cylindrical type. Any deviation must have the approval of the Facilities Grounds & Building Maintenance Lock Shop Supervisor.
- B. Panic devices - non-electrically operated - Von Duprin - Exposed vertical rods (not concealed) are to be used at paired doors. Von Duprin – RIM device to be used on single doors.
 - 1. Panic Device Function – to be established on a door-by-door basis by hardware supplier in conjunction with the Lock Shop Supervisor (and Site Protection Systems Engineer where electronic card access applies).
- C. Hinges - Stanley, full-ball bearing type, brass for exterior, steel for interior. The hinges for all doors with access control and/or any type of closer are to be of the brass type with ball bearings and non-removable pins, or approved non-electric continuous type (in special cases).

Pemko heavy duty or Roton heavy-duty non-electric continuous type (see section 3.1 Access Control Standards)
- D. Closers - LCN overhead (4040XP)
Rixson recessed floor closer. Specify heavy-duty for doors $\geq 2\frac{1}{2}$ " thick.
- E. Miscellaneous - door bumpers by Ives, Rockwell; security peepholes by Ives; dead stops by Glynn-Johnson

3. Key Schedule and Core Installations

Where it has been established that the cores will be combined and installed by Oak Security or Facilities Grounds & Building Maintenance's Lock Shop, the Project Manager is to arrange a meeting with the Designer, the departmental representative for the project, the Facilities Grounds & Building Maintenance Lock Shop Supervisor, and a representative from Oak Security during the shop drawing submittal phase of the project. The purpose of the meeting is to determine requirements for lock function, keying and for levels of master keying and sub-masters, and any access control issues as well as any University concerns.

Room numbers are to be finalized prior to this meeting, and the numbering and room designations used in the key schedule are to be consistent with those used in fire alarm nomenclature (see 3.2 Automatic Temperature Controls and 3.4 Fire Alarm Systems). Oak Security (or Facilities Grounds and Building Maintenance Lock Shop, if contracted) is to prepare the key schedule for review by the other parties, and is to proceed with setting up lock cores upon receipt of the approved key schedule. All key system designs and key schedules must be approved by the Lock Shop Supervisor.

During or before this meeting of the project, whichever group is contracted to combine and install the cores shall be given sufficient notice to schedule the installation of the cores in the finish hardware. It is critical that the specification require that the contractor retain all factory-supplied lockset tailpieces needed for lock core installation; tailpieces are to be turned over to the contracted party for core installation.

Specifications are to include requirements for employing only experienced, qualified mechanics for installation of finish door hardware.

4. Electrified Hardware and Access Control Considerations

Refer to Section 2.7 Security for guideline to establish general security goals for the project.

See Section 3.1 for Access Control Systems guidelines. If an access control system is required, all exterior doors, including mechanical room and mechanical penthouse doors which allow access to other parts of the building, must be incorporated into the CACS design. Inclusion of access control hardware may limit door design possibilities. Card readers are generally installed on the building exterior, with conduit and door/frame preparation integrated with the envelope design. While desirable for ease of system maintenance, card access readers installed in vestibules may pose a security concern, depending on the design of the vestibule. Review proposed installation with Project Manager and the systems administrator from Site Protection and the Site Protection Systems Engineer.

Campus Access Control System (CACS) Hardware Specifications – Electro-mechanical as follows:

A. Panic Hardware

All electro-mechanical Panic Hardware shall be manufactured by Von Duprin. Exceptions, e.g., Blumcraft (CRL) may be considered **if reviewed with Site Protection Systems Engineer early in the design process**. All aspects of the specialty door and frame installation must be able to be properly secured without racking/forced opening.

1. Panic Bar with Electric Trim Release (24V Fail -Secure Operation)

This type of hardware has the locking function in the outside lever trim. Electrical solenoid activation releases the locking mechanism allowing the lever handle to withdraw the door latch. This type of locking hardware is standard on all exterior dormitory doors. Key override shall be “Night Latch” function (NL). ” Request to Exit” switch shall be provided (RX-LC).

Door mounting configurations shall be RIM, Surface Vertical Rods (SVR) or Concealed Vertical Cable (CVC).

Typical RIM model number: RX-LC98L-E996-US26D-3’ (Von Duprin)

Typical SVR model number: RX-LC9827L-E996-US26D-3’x7’ (Von Duprin)

Typical CVC model number: **RX-LC9849L-E996-US26D-3’x7’ (Von Duprin)**

A Power Transfer Device (EPT-10 – Von Duprin or CEPT 10 – Sargent; **note – Sargent not to be used with offset pivots**) shall be included with each panic bar installation. **Other devices such as an electric hinges may be considered with prior**

approval from the Site Protection Systems Engineer. SVR type installations will require a “Panic Threshold”, e.g., NGP 800 series.

Panic bar, trim styles and finishes to be specified by the Architect.

2. Panic Bar with Electric Latch Retraction (24V Fail-Secure Operation)

This type of hardware has the locking function in the bar. A special high current power supply is required to retract the door latch. This allows for the use of standard pull handles as outside trim. Commonly used on the exterior doors of Administrative and Academic buildings. Required on all ADA motorized doors. Key override shall be “Night Latch” function (NL).” Request to Exit” switch shall be provided (RX-LC).

Door mounting configurations shall be RIM, Surface Vertical Rods (SVR) or Concealed Vertical Cable (CVC).

Typical RIM model number: RX-LCEL98NL-US26D-3’(Von Duprin)

Typical SVR model number: RX-LCEL9827NL-US26D-3’x7’(Von Duprin)

Typical CVC model number: **RX-LCEL9849NL-US26D-3’x7’(Von Duprin)**

The following equipment shall be included with each EL panic bar installation:

- a) Von Duprin Power Supply (PS914)
Double leaf doors only require one power supply.
- b) Von Duprin Power Transfer Device (EPT-10)
Sargent Power Transfer Device (CEPT-10)
- c) SVR type installations will require a “Panic Threshold”,
e.g., NGP 800 series **or approved equal.**

Note – the Von Duprin QEL panic bar installation can be substituted for all EL applications. When installing a QEL panic the door will no longer require a power supply.

Panic bar, trim styles and finishes to be specified by the Architect.

3. Panic Bar with Delayed Egress function

This type of hardware has all the same requirements of a standard Latch Retraction panic bar but with a “Delayed” action release scheme when exiting. Building code requires that the hardware must be interconnected with the Fire Alarm System for immediate release in case of fire.

Door mounting configurations shall be RIM, Surface Vertical Rods (SVR) or Concealed Vertical Cable (CVC).

Typical RIM model number: CX98L-07-US26D-3’(Von Duprin)

Typical SVR model number: CX9827L-07-US26D-3’x7’(Von Duprin)

Typical CVC model number: **CX9849L-07-US26D-3’x7’(Von Duprin)**

The following equipment shall be included with each CX panic bar installation:

- a) Von Duprin Power Supply (PS873-2)
Double leaf doors only require one power supply.
- b) Von Duprin Power Transfer Device (EPT-10)
Sargent Power Transfer Device (CEPT-10)
- c) SVR type installations will require a “Panic Threshold”,
e.g., NGP 800 series **or approved equal.**

Panic bar, trim styles and finishes to be specified by the Architect.

B. Mortise Lockset Hardware (24V Fail-Secure Operation)

Electrified mortise locksets are the preferred hardware for all Access Controlled doors that don't require panic egress. "Request to Exit" (RX) switch shall be provided as well as a "Door Status" monitor switch (DSM). The manufacturer of choice can be:

1. Sargent – RX 70-8271-24V LNB x 26D
2. SCHLAGE - RXL9080BEU series.

Trim styles and finishes to be specified by the Architect.

C. Cylindrical Lockset Hardware (24V Fail-Secure Operation)

Electrified cylindrical locksets are only to be used on Access Controlled doors in place of the mortise type when there are specific Architectural constraints.

"Request to Exit" (RX) switch shall be provided. The manufacturer of choice is:

1. SCHLAGE - RXND80BEU series, and modified by COMMAND ACCESS TECHNOLOGIES as typical model #CLN80BEU-RHO-626-24V-REX.

Trim styles and finishes to be specified by the Architect.

D. Motorized Door Operators (ADA)

The LCN 4600 series is the overhead operator of choice.

Exceptions, e.g., **Dorma** may be considered **if reviewed with Site Protection Systems Engineer early in the design process**. Concealed underground operators will be considered only as a last resort and must be reviewed/approved by the Site Protection System Engineer.

E. Combination locks - 'Trilogy' battery powered programmable lockset by Alarm Lock is currently being used. These are typically installed by the university Lock Shop, but are to be specified by the Designer.

F. Keyless Locks – Keyless locks by Salto is the campus standard. Refer to Facilities Site Protection for an update on specific recommendations (including the potential need for Hot Spots and/or WIFI).

5. Requirements for Mechanical Rooms, Penthouses, Roof Access

Specify cylindrical lockset with storeroom function. If padlocks are to be used (on roof hatches, e.g.), specify Best Locking interchangeable-core padlocks; use weathertight locks for exterior application.

6. Millwork and Cabinetry Locks

Specify "Best" deadbolt or dead latch cabinet locks for custom dormitory cabinetry or millwork. Use Best 5L7RD2 for all custom applications which includes interchangeable cores.

Specify "National", "CCL", "Olympus" or "Best" deadbolt cabinet locks for non-dormitory applications of custom and, wherever possible, contract furniture.

Media Services lecterns and media cabinets are to be keyed with the *National (915)*.

7. Access Panel Locks

Access panels are commonly used for the maintenance of building utilities and are typically required to be locked. Those which exist in maintenance (non-public) areas do not require locks; those in public spaces are required to be lockable. Exceptions may be made in the case of very high ceilings (above 9'-0" A.F.F.) or other unusual locations and should be reviewed by the Building Maintenance Tech Team Coordinator.

Depending on the access panel manufacturer, locks should be either Best rim cylinder (model 1E72) or mortise cylinder (model 1E74).

8. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the contractor.

On the as-builts, the contractor is to highlight changes made to submittals and approved documents.

The as-builts are to include as a minimum: Door & Hardware schedule with all installed items (mfg. model, finish), details of doorways (sections).

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

Standards for Electrical Rooms -

Building Services

Grounds and Building Maintenance

Electrical Rooms must be considered in the early stages of the Design Phase, and consideration must be given to location, size and number of Electrical Rooms. Service Entrance to Building usually determines location for Transformer Vault. All Transformer Vaults must remain free of other systems not associated with electrical distribution systems.

Main distribution with switchgear shall be designed in a separate room if the building program allows the space and location.

1. Design Review – Facilities Engineering Department and Maintenance Department shall review electrical systems at the following phases.
 - a. Design Development – Major Equipment to be Shown
 - Switchgear
 - Transformers
 - Distribution Panels
 - Generator
 - Motor Control Centers
 - Automatic Transfer Switches
 - Feeder Distribution
 - b. 50% CD – Major Equipment to be Shown
 - Schematic Phase Equipment Plus:
 - Branch Panels
 - Panel Schedules
2. Room Construction
 - a. Walls: Masonry, Block/Concrete: Preferred for transformer and switchgear.

Gypsum Wall Board: Can be used for Distribution Closets.
 - b. Floor: Concrete: Preferred. Concrete slab in Basement shall be sealed. Above grade epoxy seal slab. Check with Project Manager for any other proposed floor construction/finish.

Sleeves in slabs above grade shall be raised 1". **Below grade sleeves to transition from PVC to rigid.**

See Appendix 4.11-2 for pipe sleeve and firestopping requirements based on wall/floor materials.
 - c. Ceiling: Exposed structure or if sound attenuation is a consideration, sheetrock with insulation above.
 - d. Door: 36" minimum size. Transformer/Switchgear Vaults size as dictated by code requirements.

Door lock shall have University core “EM”. Area Substation, Elevator Machine Rooms and Generator Rooms shall be cored with “AS”.

3. Distribution of Electrical Rooms

- a. Location: Careful consideration shall be given to Transformer Vaults and Switchgear Rooms. If the building program allows, locate away from program space.
- b. Quantity: Minimum (1) panel per floor and each panel shall serve that floor. No feed-through or riser panels. (Individual feeds required to each panel)

4. Clearances Between Equipment

- a. Code Minimums: 3’-0” minimum for branch distribution panels. Transformer Vaults and Switchgear Room clearances vary. Refer to code requirements.
- b. Working Clearances: Consider back access for equipment, code driven requirements.

Dry type transformers, floor mounted. Use dim pads for vibration isolation.
- c. EMF: Locate Transformer Vaults and switchgear away from program spaces. Project Manager to coordinate with program.

5. Housekeeping Pads

- a. Size/Strength: 4” high, rounded edges, minimum 2500psi. Doweled to existing slab. Include WWF for reinforcement.
- b. Type of Equipment on Pads:
 - Generators
 - Motor Control Centers
 - Transformers
 - For multiple pieces of switchgear lay channel frame on edge and pour concrete around.
- c. Liquid filled transformers require a spill containment trench in lieu of curbing.

6. Equipment Mounting

- a. Recessed/Surface:
 - Surface mount in Mechanical Rooms
 - Recessed in finished areas. (Spare conduits run to above ceiling. Enough conduits to fill-out spare circuits. Box or trough at end of conduit stubs. Must be accessible)
- b. Unistrut Channel – On exterior walls or existing walls not plumb.

7. Coordination Between Other Services

- a. HVAC
 - Equipment
 - Ductwork
 - Piping
- > Not allowed in Transformer/Switchgear Rooms

- b. Sprinkler Piping (Protect critical electrical equipment from water damage)
 - c. Elevator Equipment Rooms and Shaft – No other equipment not associated with Room or Shaft.
 - d. OIT – Provide standard OIT station outlet at any new Switchgear and transfer switch for SCADA requirements. **Provide 1 house phone for main equipment rooms.**
8. Heating and Ventilation Requirements
- a. Exhaust/Ventilation. Review code requirements to meet standards. Maintain ambient outside temperature or 55° in Winter.
9. Lighting Type, Convenience Receptacles and OIT outlets
- a. All lighting shall be utilize energy efficient **LED** fixtures. Lighting shall be switched at each door into room.
 - b. At least one light shall be circuited to the emergency panel. Light shall be switched and handle shall be lighted in the “Off” position. Locate switch closest to door frame. **Coordinate quantity of fixtures with size of room.**
 - c. One 20 Amp. convenience receptacle per 150 sq. ft. floor space or not more than 25 feet apart. One receptacle (red) on stand-by circuit in Main Mechanical Rooms, Switchgear Rooms. Each space shall have a minimum of one receptacle or more.
 - d. At least one OIT outlet required for connecting selected equipment to the campus electric SCADA system.
10. Scaled vertical section cut(s) at major horizontal distribution pathways (such as horizontal pipe chases and above congested hallway ceilings), showing a coordinated depiction of all MEP systems at multiple locations;
11. Refer to Section 3.12 (Electrical Systems Design) for allowable electrical pathway and conduit equipment.
12. Requirements for As-Built Documentation
- a. On the as-builts, the contractor is to highlight changes made to submittals and approved documents.
 - b. The as-builts are to include the following as a minimum:
 - Switchgear and related switches
 - Electrical riser Diagrams
 - Electrical power and lighting floor layout plans with conduit and circuits shown as-built.
 - Electrical fixture schedule with actual mfr. data.
 - Electrical panel schedules including mfr. data.
 - Motor Control Center schedule
 - **Arc Flash Coordination Study**

END OF DOCUMENT

**Standards for Elevators -
Grounds and Building Maintenance**

The following standards set forth the criteria to be utilized by Designers for the installation of new elevators at Princeton University. The standards have been prepared for use by Designers to properly specify in-ground hydraulic elevators and geared traction elevators in a manner satisfactory to Princeton University. The Technical Guide Specifications for hydraulic and geared traction elevators in Appendix 4.6 shall be utilized to prepare the Contract Specifications for the elevators. The Technical Guide Specifications are available through the Index of References (below). Although the standards apply specifically to new elevators, they should be used as a reference for upgrading existing elevators as well.

1. Contacts

- A. The Project Manager (in Office of Design and Construction, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. University Code Analyst MacMillan Building, 609-258-6706
- C. MEP Systems Manager MacMillan Building, 609-258-2540
- D. Elevator and Electrical Shop Supervisor MacMillan Building, 609-258-3991

2. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

	<u>PDF</u>	<u>MS Word</u>
A. Technical Guide Specifications for a Conventional In-Ground Hydraulic Elevator at Princeton University	Appendix 4.6-1	Appendix 4.6-1
B. Technical Guide Specification for a Geared Traction Elevator at Princeton University	Appendix 4.6-2	Appendix 4.6-2
C. Elevator Emergency Telephone Detail	Appendix 3.9.2	

3. Codes and Standards

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. ASME A17.1 Elevator and Escalator Code

4. Review and Procedural Guidelines

Early in design development the Designer should arrange a meeting with the Project Manager, the MEP Systems Manager in Grounds and Building Maintenance, the Elevator and Electrical Shop Supervisor in Grounds and Building Maintenance and the University elevator consultant to discuss the programmatic requirements of the proposed elevator, and to begin to set technical requirements. The meeting should be followed up with a review session with the same attendees and the University's Code Analyst.

At 50% completion of contract documents for the project - when the second round of internal reviews generally takes place for a new building or renewal project -- the mechanical design of the elevator should be nearly complete and the architectural and MEP coordination required for the installation of the elevator should be near completion as well. The elevator documentation should be included with the contract documents in the 50% review.

Shop Drawings are to be submitted to the construction manager, who is to forward the submission to the University's Project Manager. Note that elevator plan review and inspections in the Municipality are performed by the State DCA Elevator Safety Unit.

The University's Project Manager will turn the shop Drawings over to the University Code Analyst who makes the official review submittal to the State DCA. Shop Drawings for permit review must be signed and sealed by a licensed professional Engineer (or Architect).

A copy of the shop Drawings is also to be provided to the Project Manager for review by the MEP Systems Manager and the Elevator and Electrical Shop Supervisor.

5. Design and Installation Guidelines – General

- A. Elevators shall service all floors of a building. Access to floors may be limited, if necessary, by key switches or access control card readers. Review requirements for limiting access with Project Manager.
- B. Two- to Six-Floor Structures, maximum rise of sixty feet: Use of an in-ground hydraulic elevator or geared traction elevator is required.
- C. Seven-Floor Structures and above, or greater rise than sixty feet: Use of a geared traction elevator is required.

6. Design and Installation Guidelines - Elevator Machine Rooms

- A. The Elevator Mechanical Room shall be adequately ventilated and accessed by means of an outwardly swung fire rated door measuring at least 3'-0" x 7'-0". The door must be outfitted with a spring closer and lockset. The lockset installed on the Elevator Mechanical Room doors shall be keyed like the University's other Elevator Machine Rooms and shall automatically lock when closed.
- B. Non-elevator related equipment; piping and conduit shall not be located in or run through the elevator mechanical room.
- C. The elevator mainline electrical disconnect and the mechanical room light switch must be located adjacent to the mechanical room door and arranged so they may be accessed without entering the room.
- D. Clearance shall be provided for all control panels and equipment cabinet doors to open at least 90 degrees, and at least a three feet area free of obstructions shall be provided in front of control panels and equipment cabinets. Access to hydraulic pump units and geared traction machines shall be adequate for maintenance and shall meet code requirements.
- E. The mechanical room must be provided with a minimum of one wall mounted ten- pound fire extinguisher. The extinguisher is to be mounted adjacent to the door on the exterior of the Elevator Control Room.

- F. Provide 30-foot candles of lighting in elevator machine rooms. Lighting shall be positioned so it will not create shadows while service personnel are working on major equipment items.
- G. Two elevator hoistway door keys shall be provided to the University Elevator Shop. On site key requirements to be discussed with the MEP Systems Manager and the Elevator and Electrical Shop Supervisor and the University Code Analyst.
- H. Paint elevator mechanical room floors with two coats of light gray semi-gloss oil based paint. Paint elevator room walls and ceiling with two coats of white paint.
- I. Elevator Machine Rooms are required to be ventilated and cooled as necessary to maintain a room temperature not exceeding 78 degrees F or lower as recommended by the equipment manufacturer. Utilize chilled water if available or specify “stand alone” unit.
- J. Elevator machine rooms shall be located in areas not susceptible to flood water damage.

7. Design and Installation Guidelines - Elevator Hoistway and Pit

- A. A pit ladder is to be installed.
- B. Non-elevator related equipment, piping and conduit shall not be located in or run through the elevator hoistway or pit.
- C. All lighting shall utilize energy efficient fixtures. If selected, a 3000K color temperature **dampproof** light fixture on the hoistway wall at each Floor Level, in the refuge space at the top of the hoistway and in the elevator pit. Light fixtures must have lense covers. The lighting shall be operable from a switch located in the pit and at the top floor.
- D. A duplex GFCI electrical receptacle is to be installed three feet above the finished pit floor for use by elevator mechanics.
- E. Provide a 24” by 24” deep sump pit in the elevator pit with a rigid aluminum grating. Install an oil-sensing sump pump in the sump pit. The effluent from the sump pit shall be **pumped to grade**. Note the discharge must be into open air; sump pit effluent piping must be piped **to grade**. (This requirement may vary depending on municipality.)
- F. **Single Non-GFCI receptacles on independent dedicated circuits** must be installed for the sump pump and elevator scavenger pump (hydraulic elevators) coordinated to the location of the pump equipment.
- G. Provide alarm signal wire to Engineering Department Energy Management section to alert personnel of a shutdown of the sump pump due to oil in the sump.
- H. Ensure proper venting of the elevator hoistway in accordance with ASME A17.1 Elevator and Escalator Code.
- I. Ensure proper refuge space is provided on top of the car enclosure in accordance with ASME A17.1 Elevator and Escalator Code.
- J. Paint elevator pit floor and walls (up to the sill) with two coats of light gray semi-gloss oil based paint. Paint all exposed metal in hoistway (except guide-rails) with two coats of rust inhibitive paint.

8. Design and Installation Guidelines - Related Work

For proper installation of an elevator, appropriate related work must be included in the project. The following list, not necessarily all-inclusive, contains some of the work needed to be included in other sections of a project specification.

- A. Smoke and heat detectors shall be installed per the American National Safety Code for Elevators, ANSI A17.1 (latest edition accepted by the State of New Jersey) and interconnected with the fire fighter provisions of the elevator's control system. Smoke detectors shall be installed at the top of the shaft, in the elevator machine room and at the interior elevator lobbies and shall be the sole devices to initiate Phase I Elevator Recall. Heat detectors shall be installed in Elevator Machine Room, at top of hoistway and in hoistway pit.
- B. A shunt trip circuit breaker shall be provided on the main power feed to the elevator any time the hoistway and or elevator machine room is sprinklered. Anytime the elevator hoistway or machine room is sprinklered, a fixed temperature heat detector (with a temperature rating lower than the sprinkler head) shall be installed in close proximity to each sprinkler head and wired to the main power shunt trip circuit breaker. Activation of a heat detector shall cause the main power to the elevator to disconnect.
- C. Fire service key switches will be available at each elevator inside of key lock boxes. Fire department will have key to lockboxes (all keyed alike).
- D. Cab Telephones – All cabs must be equipped to accept an elevator telephone as specified by the elevator guide specifications, which have been coordinated with the Telecommunications Office. Accommodation for mounting the telephone must include holes tapped to accept standard mounting machine screws.
- E. The preference for cab lighting is fixtures connected to the emergency system.

9. Requirements for Testing and Training

- A. The elevator subcontractor is responsible for conducting the final acceptance test with the local or State inspector, with a representative of the University's elevator maintenance shop in attendance. Project Manager is to be advised of the schedule for inspection and testing.

The procedure for testing shall be followed closely in accordance with code requirements.

The construction manager is responsible for witnessing and approving the acceptance test. The elevator subcontractor shall certify the report of the test data, and shall deliver a signed and sealed copy to the Project Manager prior to final payment.

- B. At a minimum, prior to seeking final acceptance of the completed project as specified by the contract documents, the contractor shall conduct a four (4) hour training program on-site with University elevator maintenance personnel. The session shall provide instructions on the proper safety procedures to be utilized in assisting passengers that may become entrapped inside the elevator car. The session shall also provide instructions on the use of each control feature and its correct sequence of operation. Control features covered shall include, but not be limited to, the following:

1. Independent service operations;
2. Emergency fire recall operations, Phase I;
3. Emergency in-car operations, Phase II;
4. Emergency power operations, if applicable;
5. Emergency communications equipment;
6. Security operating features;
7. Interactive systems management, if applicable;
8. Remote monitoring/controls, if applicable.

10. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings and documentation prepared by the elevator contractor. On the as-builts, the contractor is to highlight changes made to submittals and approved documents.

The as-builts are to include details of any tie-ins to other systems, such as fire alarm and electric systems, including elevator shaft wiring and details. At the time of final testing, the contractor is to turn over to the Project Manager three copies of the bound maintenance manual and operating instructions. The manual is to contain wiring Diagrams, parts list, list of recommend spare parts, and list of manufactures of major components of the elevator, along with operating and maintenance recommendations.

The Project Manager is responsible for distributing copies of the as-builts to the appropriate University representatives for review prior to project closeout and final payment. These representatives include members of the Facilities Engineering and Grounds and Building Maintenance Departments.

See Section 1.5 (Documentation and Archiving).

11. Non-conformance with Standards

Any requests for exceptions to elevator standards at Princeton University shall be presented to the Project Manager, with written argument detailing the reasons for the requested exception. The Project Manager will review the request with the MEP Systems Manager, University Code Analyst, the Elevator and Electrical Shop Supervisor, and with the University's elevator consultant if deemed appropriate. The exception will be granted only if such action is in the best interests of the University.

END OF DOCUMENT

**Standards for Laundry Rooms -
Building Services**

These standards apply specifically to laundry rooms in dormitories and similar residential facilities; departments, such as Athletics, which include laundry facilities, establish standards individually. The Designer should consult with the client-department for applicable requirements.

Laundry facilities are included in each upper-class dormitory and in residential colleges. Access to the laundry room must be through the interior of the dormitory. Particular attention must be paid to the “nuisance factor” of a laundry room - the effect of noise and heat on nearby rooms.

Laundry rooms are to have durable epoxy floor finishes or stained and sealed concrete and must have adjustable floor drains in proximity to washers and in any other critical area.

Typically, laundry rooms will contain the following:

- A. Heavy-duty washers with optional pedestal, *non-coin/digitally operated in dormitories*. Number will vary with space available, but there should not be fewer than three washers. Consider vibration isolators under unit feet in wood frame structures. See Appendix 4.7-1 for current model cuts; current model is MAYTAG "Neptune" high efficiency front-loading non-coin washer. The ratio of students to washers/dryers is 25-1.

Recessed combination supply and drainage boxes should be used, with integral shut-off valves for hot and cold water lines (see section 3.11 Plumbing for valves and box). Standpipe should not be set lower than 34” above floor or base of washer. Washing machines should sit on optional pedestal.

- B. Stacking electric dryers should be used. Current model is MAYTAG stacked, non-coin, digital timer 240V/60 Hz-flat front (This requires two (2) - 30 Amp outlets at each stack); see Appendices 4.7-2 and 4.7-4 for current model cuts.

Gas dryers are not used in dormitories, due to requirements for carbon monoxide monitoring in installations in residential occupancies. *The dryers should not be coin operated in dormitories.*

A bulkhead should be designed around ganged dryers to alleviate visual, acoustic, and safety concerns. 4’ of maintenance and access space is needed behind the dryers.

Dryers should be fitted with individual vents running to a plenum located at the discharge point. There should be no additional screening added between the dryer and the plenum. All plenums must be accessible for cleaning. Clean outs to be supplied at all elbows. Discharge hoods should be fitted with gravity louvers if possible; even large-mesh screening tends to become clogged with lint.

Care should be taken to avoid discharging vents near student room windows.

Plan to install one electric dryer (stacked) for each washer in the laundry room. Please note that one stack dryer is actually = two dryers. Consult Building Services to confirm current model numbers, and for clearance requirements for maintenance of units.

Laundry storage “cubbies” will be installed at a 1:1 ratio with dryers. The dimensions should be approximately 2’w x 2’h x 2.5’d. Additionally, a white board will be mounted in each laundry room, the dimensions should be approximately 3’hx 5’w.

See Appendix 4.7-3, Typical Ganged Dryer Exhaust Isometric.

- C. A fiberglass floor-mounted laundry sink with a hose bib should be provided in the facility.
- D. Motion sensor-activated light fixtures should be used, with an unswitched fixture in each room, on the emergency lighting circuit.
- E. A fixed table or counter with hanging rod for folding, with built ins for bins
- F. Large-volume trash receptacles
- G. Waiting/study area is desirable; visual connection with adjacent space or corridor is desirable.
- H. Room ventilation system is necessary; review requirements for tempered make-up air for ventilation and dryer exhaust.
- I. An emergency wall phone should be installed in the laundry area. (A panic-button may be necessary for remote location; review with Project Manager and Department of Public Safety.)
- J. A fire extinguisher in an extinguisher cabinet; recessed cabinets are preferred. See appendix 3.8-2.
- K. A university standard roll-type paper towel dispenser and a university standard soap should be installed in each Laundry Room. These dispensers are supplied by Princeton University and to be installed by the contractor.
- L. Coordinate installation of Laundry View laundry monitoring system with OIT
- M. Attention to detailing of a shelf like structure that prevents items from falling and accumulating behind the machines is preferred.

END OF DOCUMENT

Standards for Mechanical Rooms -

Building Services

Grounds and Building Maintenance

Mechanical Rooms must be considered in the early stage of the Design Phase, and consideration must be given to location, size and number of Mechanical Rooms. Adequate Mechanical Room space will be achieved only through regular review of the required spaces. All equipment must have enough space around it for maintenance work.

1. Design Review – Facilities Engineering Department shall review Mechanical Rooms and associated systems at the following phases.
 - a. Design Development – Major Equipment
 - Air Handlers, Fan Coil Units
 - Air Compressors
 - Heat Exchangers
 - Pumps
 - Water Heaters/Converters
 - Condensate Handling Systems
 - Fire Pumps
 - Building Services Backflow Preventer
 - Backflow Preventers
 - b. Construction Documents
 - Large Bore Piping 4” and Above
 - Ductwork Sizing
 - Wall-Mounted Equipment and Controls
 - Remainder of Equipment, Piping and Distribution
 - Scaled vertical section cut(s) at major horizontal distribution pathways (such as horizontal pipe chases and above congested hallway ceilings), showing a coordinated depiction of all MEP systems at multiple locations.
 - c. Coordination Drawings – Field Produced by Contractor (s)
 - Facilities Engineering Department will review scaled coordination Drawings of all equipment to be installed in Mechanical Rooms. This will be done as a concurrent Shop Drawing submittal or as part of a Coordination Meeting(s) which includes University participation.
2. Room Construction
 - a. Walls: Masonry, Block/Concrete – Preferred wall system. Check with Project Manager if other materials are to be used. Specify fire safing systems and sleeving per attached schedule.
 - b. Floor: 6” Concrete – Sealed in Basement, epoxy painted or broadcast slabs above grade.
 - c. Ceiling: Exposed structure (no ceiling)

- d. Door: Metal or kickplate on push side. Minimum 36" width. Double doors at major equipment rooms.

Penthouse elevator shall have rooftop access for removal/replacement of equipment.

3. Distribution of Mechanical Rooms

a. Location and Quantity: Related to Site Conditions and Program

- Basement – Preferred for heating and hydronic equipment.
- Penthouse – Noise consideration for spaces below Penthouses. Equipment Rooms in Penthouses must have elevator rooftop access.

4. Clearance Between Equipment – All final equipment designs must demonstrate that equipment clearances have been considered and function per the equipment layout.

a. Code Minimums – Electrical Panels - 3'-0" min. clearance. Mechanical equipment - refer to manufacturer recommendations. Review all clearances and access to equipment during design.

b. Working Clearances – Fans, min. 2'0" clearance to bearings/belts/motors.

Refer to manufacturer clearance recommendations for:

- Coil removal
- Filter replacement
- Tube bundle replacement for heat exchangers
- VAV box

Minimum 2' to 3' clearance around pumps and compressors

Designers to indicate no fly zones on documents.

5. Equipment Mounting –

Discuss floor vs. ceiling mounted during Design Development.

Do not hang equipment from wood frame construction. Basement area and all equipment should be floor mounted to eliminate vibration above.

Mount air handling units high enough to allow for adequate trapping and condensate pitch.

Check seismic requirements.

a. Unistrut Channel –

Bolt to pads where possible.

Consolidate near, like systems.

- b. Housekeeping Pads – 4” high min., rounded edges, minimum 2500 psi. Doweled to existing slab. Include woven wire fabric for reinforcement.

Install concrete curbs around duct penetrations or multiple pipe penetrations.

Sleeves shall be 1” above slabs, for vertical pipe penetrations.

See Appendix 4.11-2 for pipe sleeve and firestopping requirements based on wall/floor materials.

6. Coordination Between Other Services

- a. Electrical – Motor Control Centers shall be in Mechanical Rooms. Coordination for MCC/starters by Electrical Contractor. Electrical Contractor shall provide all starters. This coordination must be shown on electrical documents.
- b. Telephone – (1) house phone per Building in Major Mechanical Room.
- c. OIT – Must be kept away from high voltage (440 volts and over). OIT closets shall be dedicated for OIT equipment only.

7. Heating & Ventilating Requirements

- a. Exhaust/Ventilation. Review code requirements to meet minimum standards. Equipment heat loads and make-up air requirements must be considered.

8. Lighting Type and Convenience Receptacles

- a. All lighting shall utilize LED fixtures. Lighting shall be switched at each door into room.
- b. At least one light shall be circuited to the emergency panel. Light shall be switched and handle shall be lighted in the “Off” position. Coordinate quantity of fixtures with size of room.
- c. One 20 Amp. convenience receptacle per 150 sq. ft. floor space or not more than 25 feet apart. **Min.** one receptacle (red) on emergency circuit in Main Mechanical Rooms and Switchgear Rooms.
Min. one 50 Amp. 208 volt 3-phase dedicated receptacle circuit in Penthouse Equipment Rooms for welding purposes. Coord. qty and location with room size and equipment layout.
Type of receptacle shall be NEMA approved.

9. Miscellaneous

- a. Floor Drains – In all Mechanical Rooms
 - At floor level piped to sanitary
 - Raised floor drains/sink piped to storm for AC condensate

- b. Install floor trenches in Basement Mechanical Rooms where needed for; condensate drains from air handlers and steam condensate drains.
- c. Provide hose bib in all Mechanical Rooms (key stop).
- d. Provide fire extinguisher in all Mechanical Rooms, preferably within a glass-fronted cabinet, recessed preferred.
- e. 6' clear working headroom preferred.

10. Requirements for As-Built Documentation

- a. On the as-builts, the contractor is to highlight changes made to submittals and approved documents.
- b. The as-builts are to include the following as a minimum:
 - Scaled layouts based on coordination Drawings.
 - Sump pump details (mfg., serial number).
 - Exterior hose bib locations.
 - Waste, water and vent riser Diagrams.
 - Storm water and roof drain riser Diagram.
 - Schedule of plumbing components including backflow preventers (mfg., model number, size).
 - All HVAC Drawings with final component (including motors) sizes and locations (unit mfg. and model #, serial #).
 - HVAC components in each room labeled with source number (Valve Tagging Chart).
 - HVAC piping riser Diagram.

END OF DOCUMENT

Standards for Painting -
Grounds and Building Maintenance

Paint finishes, once a new building or a renovation project has been completed and occupied, may require frequent maintenance if a building is to be kept presentable. The frequency of maintenance depends on the type of facility, the quality of the finishes, and the nature of use - or abuse - the occupants subject the building to. Regardless of the frequency of maintenance required, the task of repainting a space or a building most often falls to the Maintenance Paint Shop, rather than to a contractor.

It is important for the Designer to know that Princeton's Paint Shop stocks a limited number of paint colors, has the capability of mixing a fairly wide range of colors, but should not be expected to provide an infinitely varied palate. The University employs a number of standard colors that are to be used for "common" spaces such as corridors, offices, classrooms, laboratories, dormitory rooms, and the like. The Designer is normally allowed greater latitude in selecting colors for "special" spaces such as lobbies, lecture halls, lounges, and similar spaces.

The Designer should attempt to incorporate breaks, reveals, or other architectural details to divide large expanses of painted surface, particularly in the vertical direction. This is especially true in high traffic areas, areas using high pigment paints, or locations that are especially subject to abuse. Consider locations of items such as trash / recycling containers relative to accent paint locations, as these areas are subject to frequent marring and require a higher degree of maintenance.

Regardless of the colors used in a project, the Designer is expected to produce a color schedule for approval by the University (through the Project Manager). This schedule is to be updated at the end of the project and converted into a record of color selections that is turned over the Maintenance Paint Shop foreman. Record should be provided on the as-built Room Finish Schedule, updated per project conditions, as well.

Unless otherwise requested in writing by the Facilities Grounds & Building Maintenance Paint Shop Supervisor, all excess paint shall be removed from the construction site.

1. Interior

The Designer should be aware of New Jersey's requirements for minimizing the volatile off-gassing compounds (VOCs) in products such as paint finishes, and should specify products accordingly. The preferred manufacturers used for paint are; **Muralo**, Benjamin Moore or Sherwin-Williams.

- A. Preferred finishes: see the chart below titled "Interior Paint Finish Recommendations for New Buildings and Major Renovations."
- B. Refer to Appendix 2.4-3 Memo: Standard Dormitory Paint Colors dated 1/18/2000 for dormitory projects.
- C. In areas of heavy traffic, such as hallways and corridors, consider the use of a wainscot finish (with or without appropriate trim), which would allow for an easily cleaned and maintained finish on the lower surface, and lower-luster finish on the upper, reflective area.
- D. For wood flooring, finishes must meet New Jersey requirements for volatile organic compound compliance. Water-based finishes **are recommended to be used in all conditions..**

Meet or exceed manufacturer's recommended minimum number of coats. To achieve color match, consider staining prior to the application of water-based protective coatings.

- E. Interior wood finishes require careful review of sanding and sealer procedures as they relate to staining and finish coating. Long-term UV protection is essential.
- F. If interior walls are exceptionally high (such as atriums or loft areas), consider the installation of a "break" in the upper wall, such as a picture rail or second contrasting color, to allow for less maintenance painting over time.

2. Exterior

- A. Proper preparation, cleaning, and priming of surfaces are essential to a durable exterior paint application. Proper techniques should be specified and stressed during construction.
- B. Exterior wood: for exterior wood trim, doors, and windows painting is preferred over a clear finish with stain; high-gloss or semi-gloss preferred for longer life of finish and substrate. If a clear finish is specified, a gloss spar varnish should be used; satin or matte finishes exposed to the elements typically require refinishing within the year.
- C. Exterior metal: again, proper preparation is critical, as is the primer. Insure that primer is compatible with the finish specified. Gloss finishes are preferred on metal as well as wood for longevity of finish.

3. Special Coatings

Long-lasting exterior finishes are encouraged, and special coatings may be specified as part of a planned low-maintenance building project. Among the special coatings that can be used are anodized finishes, tneomic paints, and epoxy paints. Shop-applied special finishes are preferred to site-applied, due to better control of conditions.

Exterior metals must be coated if not naturally weather-resistant such as copper and brass. Steel should be galvanized prior to receiving finishes, unless the specifications for a special coating will not permit galvanizing.

Regardless of finish used, manufacturers' instructions for on-site application and touch-up of finishes are to be followed. As part of the submittal process, those instructions are to be provided to the Project Manager, with a copy for the Maintenance Paint Shop foreman.

4. Requirements for As-Built Drawings

Prior to completion of construction and occupancy, the painting subcontractor is required to provide the university Paint Shop a detailed schedule of actual paints used in each space of the project, including manufacturer, color name or formula, sheen applied, etc.

Additionally, provide an electronic version of the final room paint schedule as part of the "As-Built" documentation for the project.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

Interior Paint Finish Recommendations For New Buildings and Major Renovations

<u>Building Type</u>	<u>Walls</u>				<u>Ceilings</u>	
	<u>Plaster/ Veneer Plaster</u>	<u>Taped Sheetrock</u>	<u>Brick/ Masonry</u>	<u>C.M.U.</u>	<u>Painted Wood (1)</u>	<u>Stained Wood</u>
<u>Dormitories (2)</u>						
Halls	eggshell	N/A	stain or semi (3)	semigloss	semigloss	satin
Public Spaces	eggshell/semi	N/A	stain or semi (3)	semigloss	semigloss	satin
Student Rooms	flat	N/A	N/A	semigloss	semigloss	flat/eggshell
Bathrooms (4)	semigloss	N/A	N/A	semigloss	semigloss	semigloss (5)
<u>Academic/Administrative</u>						
Halls	eggshell	eggshell	stain or semi (3)	semigloss	semigls/satin	satin
Public Spaces	eggshell	eggshell	stain or semi (3)	semigloss	semigls/satin	satin
Classrooms	eggshell	eggshell	stain or semi (3)	semigloss	semigls/satin	satin
Offices	flat	flat	stain or semi (3)	semigloss	semigls/satin	flat
Bathrooms (4)	semigloss	semigloss	N/A	semigloss	semigls/satin	semigloss (5)
<u>Laboratories/Research Facilities</u>						
Halls	eggshell/semi	eggshell/semi	stain or semi (3)	epoxy/semi	semigls/satin	satin
Public Spaces	eggshell/semi	eggshell/semi	stain or semi (3)	epoxy/semi	semigls/satin	satin
Laboratories (6)	epoxy/semi	epoxy/semi	N/A	epoxy/semi	semigls/satin	satin
Lecture & Classrooms	eggshell	eggshell/flat	stain or semi (3)	epoxy/semi	semigls/satin	satin
Bathrooms (4)	epoxy/semi	epoxy/semi	N/A	epoxy/semi	semigls/satin	satin

- (1) Consider oil base for painted wood to increase durability
- (2) See memo dated 1/18/2000 from Committee for Standard Dormitory Paint Colors (to Jon D. Hlafter) regarding dormitory paint colors; see Appendix 2.4 – 3.
- (3) Recommend leaving brick and masonry in natural finish, unless there is an aesthetic concern or, for existing masonry, there is an excessive amount of soil, stain, or mismatched patching.
- (4) Use mildew-resistant paint in bathrooms with showers
- (5) Smooth ceiling finishes only are to be used in bathrooms
- (6) Use Latex-based paint for areas with lab animals that might be affected by volatile paints

**Standards for Masonry, Roofing and Waterproofing -
Grounds and Building Maintenance / Facilities Operations**

These standards apply to new and replacement roofs for academic, administrative, athletic, and residential buildings on Princeton's campus. For buildings off campus, the Designer should consult with the Project Manager or the Facilities department involved for requirements.

1. Contacts

- A. Project Manager for department initiating project
- B. Project Manager, Building Envelope; MacMillan Building, (609) 258-6607
- C. Preservation Architect, Building Envelope; MacMillan Building, (609) 258-0499
- D. Office of Environmental Health and Safety (for on-site safety); (609) 258-5294

2. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

	<u>PDF</u>	<u>AutoCAD</u>
A. Built Up Roofing, Construction Details	Appendix 4.10-1	Appendix 4.10-1
B. Detail of Ridge for Slate Roofs (3pp)	Appendix 4.10-2	Appendix 4.10-2
C. Rooftop Drainage Requirements and Details	Appendix 4.10-3	Appendix 4.10-3
D. Typical Flashing Details (wall/roof, curb/roof) (2pp)	Appendix 4.10-4	Appendix 4.10-4
E. Tremco Roofing Reference Guide, 3rd Edition	Appendix 4.10-5	
F. Roofing for the Design Professional, Tremco Roofing Division	Appendix 4.10-6	
G. Contractor Safety Advisory, Princeton University	Appendix 4.10-7	
H. Stone Parapet Cap with Mortar Joint	Appendix 4.10-8	Appendix 4.10-8
I. Through Wall Flashing at Parapet Details	Appendix 4.10-9	Appendix 4.10-9
J. Typical Ornamental Coping Detail	Appendix 4.10-10	Appendix 4.10-10
K. Sheet Metal Coping	Appendix 4.10-11	Appendix 4.10-11
L. Garden Wall Stone Cap with Mortar Joint	Appendix 4.10-12	Appendix 4.10-12
M. Below Grade Waterproofing – Concrete and CMU Foundations	Appendix 4.10-13	
N. Below Grade Waterproofing - Rubble Stone Foundations	Appendix 4.10-14	

	<u>PDF</u>	<u>AutoCAD</u>
O. Selected Sarnafil Details	Appendix 4.10-15	Appendix 4.10-15
P. Roof Penetration Details	Appendix 4.10-16	
Q. Below Grade Penetrations	Appendix 4.10-17	

3. Codes and Standards

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)
- D. Various standards by the U. S. Occupational Safety and Health Administration (refer to Appendix 4.10-7 for information)
- E. NRCA Roofing and Waterproofing Manual
- F. SMACNA Architectural Sheet Metal Manual (details for soldered lock-seam joints, e.g.)

4. Review Guidelines

Initial planning and preliminary design of a project may be conducted with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it becomes important that the project be submitted to the Engineering Department, the Grounds and Building Maintenance Department, the Office of Design and Construction, and the Department of Public Safety for review of compliance with University standards. Proposed roofing systems, in particular, are to be reviewed with the Preservation Architect/Building Envelope and the PM/Building Envelope in the schematic design phase when the roof shape and general type are determined.

Any proposed plazas, terraces, or balconies over occupied areas, all green roofs and roof gardens are to be reviewed as roofing projects by the University Grounds and Building Maintenance Department. Similarly, any below-grade building or a portion of a building constructed with a ceiling/roof structure waterproofed to prevent water infiltration is to be reviewed as a roofing project.

Roof plans are to be reviewed with the departmental Project Manager and the Project Manager for Building Envelope early in the project in order to locate areas of particular concern and agree upon an approach to best address them. Through-wall flashing for the project is also to be reviewed with the PM/Building Envelope.

The design approach for the exterior envelope is to be reviewed during schematic design with the departmental Project Manager and the Preservation Architect. Proposed techniques for waterproofing and flashing cavity backup wall and/or the drainage plane for rainscreen systems are to be presented by the designer for review and discussion.

5. Guidelines and Requirements for Documentation

Along with the specifications, the Designer is to produce sufficient documentation to allow for internal review, any required code review of the roofing project, and for contract bidding of the work. This documentation will include, at a minimum:

- A. Roof plans showing roof layout and drainage, and any projections through the roof or equipment mounted on the roof; plans for any waterproofing work in the project;
- B. Project-specific details of the roofing/waterproofing systems and any modifications required for the new work;
- C. Details of flashing systems, details of each flashing type required for the project, and details of any roof penetrations or below-grade penetrations;
- D. Details showing U.L. assemblies required to meet fire rating requirements for roofing system.
- E. Roofing and flashing shop drawings are to be submitted to the PM/Building Envelope in the normal course of submittals during a project. Shop Drawings for any roofing accessories, such as skylights and hatches, **and miscellaneous projections, such as lightning or fall protection**, are also to be submitted to the PM/Building Envelope. Shop drawings for wall flashings and flashings for stone trim, windows, architectural features, etc. are to be submitted concurrent with submittals for masonry materials and other envelope materials.
- F. **A pre-installation meeting and a** shop drawing review meeting shall be required. The meetings will held with the CM, sub-contractor, Designer, PM/Building Envelope as well as other University personnel to coordinate details, a thorough review of mock-ups and responses.

Designers are to respond to review comments of University personnel, either in revision of documents to comply with comments, or in writing if there is an overriding rationale in not complying with University standards.

Requirements for specific areas of documentation are as follows:

Documentation	SD	DD	50% CD	85% CD
Roof Plans – General	X	X	X	X
Roof Plans – Location of drains, vents and other <i>MEP</i> penetrations		X	X	X
Roof Plans – Locations of equipment, <i>ductwork</i> and <i>MEP</i> projections		X	X	X
Details – Parapets and copings			X	X
Details – Through Wall Flashing			X	X
Details – Sheet metal or other				X
Below Grade Waterproofing			X	X
Utility Penetrations				X
Outline Specifications		X		
Full-Length Specifications			X	X

6. Guidelines for Installation and Performance – Roofing

A. Installation

Of prime importance to the University is the quality of the initial roof installation and the provision of a long life warranty for any roofing system installed on campus. For **low slope** roofs in particular, and for waterproofing systems used under plazas and for green roofs, it is imperative that the roofing manufacturer provide full-time supervision during the roofing work, and that a twenty-year system warranty be provided to the University upon completion. Standards for roofing include the following:

1. **Low Slope Roofs (Conventional):** University Facilities Operations overwhelmingly supports the use of petroleum-based built-up roofing systems on flat roofs. The use of single-membrane systems is discouraged, and must be explicitly approved by the PM/Building Envelope before being allowed for a project.
A four-ply built-up system with a two-ply vapor barrier (where appropriate) is the University standard for a low-slope roof.
 - a) **Hot System:** a hot-applied system is preferred but may not be suitable for use on existing or new buildings where fumes during installation might affect occupants or those nearby. If a hot-applied system is to be used, Therm-50 with hypalon flashing by Tremco meets Princeton University requirements for maintainability.
 - b) **Cold System:** Burmastic-200 with hypalon flashing by Tremco meets Princeton University requirements for maintainability and is the preferred system for flat roofs. **On occupied buildings a low or no VOC adhesive should be considered.**
 - c) **Surfacing:** White aggregate surfacing meeting the manufacturer's specifications is to be applied as part of the roofing system. ½" arctic white granite chips from the George Schofield Co. provide the desired level of reflectivity. Exposed surfaces of hypalon flashings are to be covered with Double Duty Aluminum, a reflective coating.
2. **Green Roofs:** vegetation-covered roofs, whether employing loose growth medium or trays, are to be treated in a similar manner to plazas, balconies, etc. Grounds and Building Maintenance recommends **self-adhered** single-ply PVC membrane, such as that produced by Sarnafil. See requirements for waterproofing systems and review proposed product with the Project Manager and the Roofing Shop. Refer to Appendix 4.10-15 for approved Sarnafil installation details.
3. **Below-grade structures as described below in waterproofing systems:** When applying a horizontal membrane over below-grade structure (particularly in cases where plantings or "soft" cover are planned as a top surface) a 4" concrete protection slab should be applied over filter fabric and drainage mat, which in turn is installed over the waterproofing system. This will ensure protection of the treated areas from penetration by fencing, tent spikes or the like. The added depth of the slab should be taken into consideration when planning grades and planted areas.

4. Structure, Accessories, Miscellaneous:

- a) Roof decks: concrete is the preferred decking material, sloped to drain. If sloped concrete cannot be used, concrete with tapered insulation or another material meeting the construction classification required for the building may be considered. Consult with the Project Manager.

If there is a mechanical penthouse in the project, the floor of the penthouse should be concrete; a steel roof or roof deck is acceptable over the penthouse.

- b) Insulation: Roof insulation is to be part of the roofing system and is to be covered by the roofing warranty. Point loading and uniform loading requirements must be considered in the choice of insulation material and method of installation. Insulation is to be installed in two layers with staggered joints; insulation is to be fastened to vapor barrier using 'fastenfree' adhesive, and successive layers of insulation are to be fastened with the same adhesive. Isocyanurate insulation should be covered with ½" minimum SECUROCK (or equal). On flat decks, insulation is to be tapered to 0" at roof drains; drains are to be installed level with the deck in 4'-0" x 4'-0" sumps to provide positive flow to the drains.
- c) **Any roof penetrations (i.e.: conduit, lightning protection, fall protection, MEP system, ductwork supports, etc..) should be on roof plan for coordination of constructability.**
- d) Do not use pressure treated wood blocking, use Douglas fir, or where damp conditions are anticipated, wood blocking is to be cedar to prevent decay. Alternately, consult with roofing Tech Team representative for project specific options.
- e) Through-wall/counter flashing is to be receiver-type to allow for re-roofing. Flashings are to be locked and soldered at seams and corners. Flashings at roof penetrations, curbs, and transitions should extend up a minimum of 8" above the surface of the roof. Copper and Freedom Gray copper are the preferred material for flashings; 20 oz weight is standard. Coordination of through-wall flashing is very important. For through-wall flashing, details shall eliminate the need for sealants; sealants or caulking are *not* to be relied on for water-tightness.

At parapets all drains shall have an overflow scupper to divert water off the roof in times of drain blockage. Overflows shall be 2", minimum, below lowest point of base or wall flashing.

- f) Copings: Metal copings should be designed to allow for expansion without bending or flexing. Expansion joints should be installed within four feet of corners and at every third joint along walls (at twenty feet on center +/-). Use loose-locked-and-caulked joints or use splice joints for expansion. All other joints are to be locked and soldered. Copper and Freedom Gray copper are the preferred material for copings; 20 oz weight is the standard.

- g) Installation of equipment on a low-sloped roof is to be avoided if possible. Where equipment must be installed on a roof, NRCA design considerations are to be followed. Clearance requirements for ease of re-roofing are to be met; equipment supports are to be detailed so that re-roofing can be easily accomplished. Curbs are to be 12” above the finished roof surface and use of pitch pockets is to be avoided. To the extent possible, equipment and supports should be located a minimum of 6’-0” from drains. Prefabricated walks are to be provided with the roof for maintenance access to the equipment and to roof hatches or access points.
 - h) Warranty: The entire roofing system is to be covered by the manufacturer’s warranty including, without limit, the insulation and any recovery board, the roofing material, the flashings, any through-penetration systems or fabrications, equipment mounting curbs or saddles, etc.
 - i) Temporary Waterproofing: During construction, a two-ply vapor barrier applied directly to the concrete deck has been used successfully as a temporary roof. Such a surface can bear construction traffic. Any damage must be repaired and completed at the time the permanent roof is installed.
5. Pitched Roofs: The majority of on-campus buildings at Princeton University with pitched roofs are finished with slate. There are a number of buildings at the University that have metal roofs; the typical metal roof at Princeton is standing-seam copper or Freedom Gray copper, with all joints locked and soldered. Finally, there are a few roofs with synthetic roofing materials (terracotta or ceramic tile, e.g.); if a synthetic roof is used, an adequate supply of replacement tiles or shingles should be specified. If synthetic surface roof is proposed, or a metal different from copper, review selection and system requirements with the Project Manager, Building Envelope and the Preservation Architect in the schematic design phase of design.
- a) For new roofs, slate is to be a minimum 3/8” - 1/2” thickness and meet requirements for Vermont slate, S-1 architectural grade. The Designer should note, on repair projects in particular, the thickness of the existing slate to insure that the new material is compatible with the existing.
 - b) Copper for standing-seam roofs should be 20 oz. Hard drawn. Lead-coated copper has been used extensively in the past at the University, but is now considered problematic; Freedom Gray copper by Revere is an acceptable alternative.
 - c) Flashings are to be copper (for both slate and copper roofs), 20 oz. minimum for standing vertical flashings, valleys, through-wall flashings, and areas subject to excessive wear. Materials, including slates, shingles, felts, metals, fasteners, etc. are to comply with the requirements of the NRCA Roofing and Waterproofing Manual and the SMACNA Architectural Sheet Metal Manual, and be fabricated and installed in compliance with good practice and the details listed in Appendices 4.10-3 and 4.10-4.
 - d) Saturated asphalt felts or an approved synthetic underlay with a rosin slip sheet are the typical underlayment for most pitched roofs, with a rosin slip

sheet used between felts and metal roofing material. GAF Deck Armor is **NOT** permitted to be used. Codes require eaves and other areas subject to the effects of ice dams to be protected with cemented underlayment or waterproofing membrane. A self-adhering, self-sealing membrane is the preferred ice shield.

6. **Lightning Protection:** The Designer should review with the Project Manager the need for lightning protection on the building. If a system exists, or if a new system is proposed, the Designer should investigate the method of installation, if any, suggested by the roofing manufacturer. The Designer should review the options for installation with the departmental Project Manager and the PM/Building Envelope, and prepare proper details and other installation information for the system. Provide details at and through roof assemblies.

B. Performance

The interest on the part of Princeton University in using the quality materials listed above is in producing a facility that will provide long years of service with a reasonable maintenance effort. The materials listed have in the past produced such results, but only with the proper care taken during the initial installation.

As noted above, roof warranties are to cover the installed system, not simply the roofing material. For membrane roofs, full-time jobsite inspection by the manufacturer's trained representative is required.

7. Guidelines for Installation and Performance – Waterproofing

- A. **Plazas, balconies, etc.:** for areas, over sub-grade structures, finished with pavers or other traffic surface, Grounds and Building Maintenance recommend a self-adhered single-ply PVC membrane, such as produced by Sarnafil. Review proposed product with the PM/Roofing. Refer to Appendix 4.10-15 for approved Sarnafil installation details.

This is the preferred method of waterproofing horizontal areas below grade.

- B. **Below-grade structures:** When applying a horizontal membrane over below-grade structure (particularly in cases where plantings or “soft” cover are planned as a top surface) a 4” concrete protection slab should be applied over drainage mat and filter fabric, which in turn is installed over the waterproofing layer. This will ensure protection of the treated areas from penetration by fencing, tent spikes or the like. The added depth of the slab should be taken into consideration when planning grades and planted areas.
- C. **Below-grade penetrations:** for piping, conduit, and similar services, individual sleeves for each pipe are to be installed in new construction, and individual cores for each pipe in existing construction are to be used. Penetrations are to be spaced to allow a minimum of 6” clear area in all directions for proper application of waterproofing assembly; a four-inch conduit, for example, will require a frame approximately 16 inches in diameter. Clear space requirements for adjacent penetrations are allowed to overlap one another.

Space between core or sleeve and conduit or pipe is to be sealed with a mechanical link-type seal. Any deviation must meet with the approval of the Facilities Operations Project Manager. The exterior wall at the penetration is to be primed and coated with a bitumastic waterproofing membrane, such as Bituthane. The membrane is to be formed

around the pipe or conduit, and outward 4" (+/-) to allow a stainless-steel clamp to be installed around the extended membrane. Termination bars are to be applied, picture-frame style; **channeled stainless steel**, to finish the edges of the membrane. Review proposed product and details with the PM/Roofing.

Refer to code requirements as needed for utility penetration spacing where these pass through foundation walls. Where University requirements exceed code requirements, spacing is to meet the more stringent requirement.

D. Concrete or CMU and Rubble stone foundations:

1. Concrete or CMU foundations: when concrete or CMU foundations are part of the waterproofing design, insure proper curing, cleaning and preparation of the wall prior to the application of the bituthane waterproofing system and subsequent mirror drain fabric.

Refer to Appendix 4.10-13 for requirements for below grade waterproofing of concrete or CMU foundation walls.

2. Rubble stone foundations: when existing rubble stone foundations are part of the waterproofing design, careful evaluation of existing conditions must be made to accommodate new waterproofing. Include provisions for sandblasting, parging and mirror drain fabric in addition to the membrane.

Refer to Appendix 4.10-14 for requirements for below grade waterproofing of rubble stone foundation walls.

- E. If masonry work is planned as part of a 'rainscreen' system (or if metal or glass panels are planned as part of a combined masonry/metal/glass rainscreen system, the designer is to review proposed system and proposed waterproofing techniques with PM/Building Envelope. It is expected that redundant systems will be included as part of the design, so that the failure of the primary water-shedding system will not result in total system failure.

Particular care is to be taken in designing interfaces of masonry anchors and waterproofing membrane and in placement of through-wall flashings to bring any water that penetrates the system out to the exterior. A reliable weep system is to be designed for the wall, including mesh to prevent mortar build-up in the cavity and at the weeps. The designer is to specify water-testing of the weep systems during construction at approximately four foot vertical intervals.

In specifying masonry walls, the designer is to consider the permeability of the veneer or facing material used. If a relatively porous material is to be used to face the building (such as limestone, brownstone, and some types of brick), a nonporous material (such as granite) is to be used as a base course, extending approximately eight inches above finish grade.

8. Guidelines for Protection and Maintenance

- A. Roofing specifications are to contain the following statement:

"The Construction Manager, roofing contractor, or any of the contractor's agents shall not move equipment or materials over, or in any way modify the existing roofing that will

remain during or after the completion of roofing work unless the roofing is fully protected from damage. In renovations, alterations and additions: It is required that an infra-red roof scan be performed prior to commencement of work so that pre-construction conditions may be recorded, with a second scan performed at the completion of construction to verify the roof has been adequately protected. The Construction Manager will be responsible for repair or replacement of defective material, improper installation, or damage resulting from work performed through the project prior to the University accepting the roof as completed”.

A third party infra-red roof scan shall be completed at the completion of the job and 10 months after the completion of a new construction project on all low slope, overburden, plaza, and green roofs in order to verify the integrity of the roof system.

Other forms of testing (other than infra-red) may be deemed acceptable pending consultation with the University’s Project Manager of Roofing Trades.

- B. All new roofs are to be designed for ready access to all areas during adverse weather conditions with a minimum use of portable ladders or other lift conveyances.

9. Design Guidelines for Safety in Roofing Maintenance

The Designer is to consider requirements for safety in the maintenance of the building in designing the roof for the building. Early consideration is to be given to providing parapet walls for low slope roofed areas so that OSHA recommendations for roof work can be met. **Skylights with large glazed areas shall be rated for fall protection or shall have a curb height such that workers cannot fall onto the skylight.** Fall protection systems, where needed in the absence of parapet or other structural components, are to be installed in all new construction projects and in major renovation/alteration projects. An alternative may be a built-in system of permanent mounting points for safety railing; see Appendix 4.10-1. In recent projects a post and cable system that allows maintenance personnel to continuously move across the roof has been proven successful. The Designer is encouraged to review proposed solutions with the Project Manager and the PM/Building Envelope, along with the Office of Environmental Health & Safety.

The Designer is to be aware that the University considers the installation of safety-line tie-offs insufficient for the promotion of roofing safety.

For slate roofs, a detail has been developed that provides for both venting at the ridge and for securing ridge slates to the assembly. See Appendix 4.10-2. Review with the Project Manager the need for diverters installed over building entries where roof slope is not directed away from entry.

10. Garden or Landscaping Walls – Exterior Masonry

Garden or landscaping walls should have thru-wall flashing under coping caps to prevent water penetration and prematurely destroying the wall. Review proposed flashing details with the Project Manager for Roofing and Masonry (see Appendix 4.10-12). Cross joints to be caulked, head & bed joints are then pointed. The installation of weeps to be discussed during design. On stone walls specify thru-wall flashing near the top of wall under stones, using lead flashing to conform with irregular shapes. If over an occupied space (below) set thru-wall flashing at waterproofing level in addition to coping detail.

11. Non-conformance With Standards

Occasionally the use of new products is found to be in the best interest of Princeton University. Requests by the Designer to use new or non-standard products or techniques will be evaluated based on comparison of the following characteristics:

- Flexibility/Elongation Coefficients
- Durability
- Wear Characteristics under traffic
- Repairability
- Quality Control in manufacture and application
- Warranty - for labor and material covering completed roofing system as installed, including roofing materials, flashings, accessories, etc.

Use of a new product at a specific facility does not mean its use in other similar cases will be automatically approved. An unspecified testing period will be employed for new products.

A Designer who desires to use a non-standard or new product on a project should approach the Project Manager with the proposal. The Project Manager, after review will consult the PM/Roofing on the proposal. In support of his proposal, the Designer should prepare his argument, listing the above characteristics, as applicable, and present a clear and concise rationale for using the non-standard product.

12. Requirements for As-Built Drawings

The Designer is responsible for checking the accuracy of as-built Drawings prepared by the roofing contractor.

The Designer is responsible, at regular intervals during the construction process, for scheduling and attending meetings with the contractor and University personnel to review progress on the system and to ascertain that the contractor is keeping accurate records of system installation. Designer will verify during these regular meetings that the contractor is maintaining record Drawings to convert to as-builts.

On the as-builts, the contractor is to highlight changes made to submittals and approved documents.

The as-builts are to include, as a minimum, roof plans with:

- Location of roof drains and expansion joints
- Flashing details
- Location of roof hatches (including mfg., model and serial number)
- Roofing System sections (including mfg., product number)

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

Standards for Toilet Rooms -

Building Services

Grounds and Building Maintenance

Toilet rooms will typically be designed as part of the core building space in new construction. Location of bathrooms in alteration or renewal projects may be limited by building configuration or utility location, but should nevertheless be located for easy access in a logical location in the building.

1. Index of References

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|---|-----------------|
| A. Pipe Sleeve and Fire Stopping Requirements | Appendix 4.11-2 |
| B. Shower Base Detail | Appendix 4.13-3 |

2. Toilet Rooms

The minimum number of plumbing fixtures required for a project can be determined by the New Jersey Uniform Construction Code and the National Standard Plumbing Code. The code-mandated minimum count is just that - the minimum. The Designer, working with the Project Manager and the end user, is to determine the number of fixtures that should reasonably be included in the project.

The Designer should consider acoustic isolation techniques in the choice of walls surrounding bathrooms, and in piping materials and enclosures. This is particularly important in dormitories, where high bathroom usage can be a nuisance factor for adjacent rooms.

Ideally, there will be women's and men's facilities on each floor of a building. Moreover, these facilities will be accessible and barrier-free. In some instances, a building may be too small to have facilities for each sex on each floor. A review of the proposed use of each space, and the disposition of staff, should then be done in order to place facilities in the most useful locations.

In new construction and major renovation work, new single-fixture unisex toilet rooms **shall be incorporated into the design. Accommodations for single fixture unisex toilet rooms should be discussed in smaller renovations.** Single-fixture toilet rooms should be designed to be barrier-free.

See Section 3.11 Plumbing for specific model information for all plumbing fixtures.

A janitor's closet should be located in the vicinity of toilet rooms. See Section 4.3 (Custodial Closets and Storage) for additional information.

The Designer should review the requirements of the plumbing code for other fixtures such as drinking fountains.

Bathroom Design Considerations

The following list includes items that the Designer should take into consideration when planning a project that includes toilet rooms:

1. Fixture Requirements

This section deals primarily with multiple-fixture bathrooms.

At a minimum, requirements of the NJUCC and National Standard Plumbing Code must be met for number of fixtures (including drinking fountains). It is prudent to maximize the fixture count of bathrooms in academic spaces, particularly if large lecture facilities are provided that might be used by the general public for special events. The same is true of any buildings that include performance spaces. The code-required minimum fixture number is often unrealistically low for number of toilets and lavatories in particular, and the Designer should review the user's preferences during the programming phase.

For dormitory bathrooms, Princeton University Housing Office has developed the following ratios as a desirable goal: students per shower – 5.5/1; students per toilet – 5.5/1; students per lavatory - 4.5/1. Bathtubs are generally not installed in dorms at Princeton.

At least one floor drain should be installed in each bathroom, more if layout dictates. Floor drains should be installed in each barrier-free shower.

In bathrooms that are not adjacent to a janitor's closet with a service sink, hot and cold hose bibbs should be installed for custodial use. The hose bibbs should have key stops rather than handles. The preferred location is under a lavatory, approximately 18" above the finish floor.

2. Preferred Fixture Types and Fittings

See Design Standard Manual Section 3.11 Plumbing. This section contains information beyond that presented here regarding fittings and fixtures for use in University projects.

- a) Toilets - flush valve preferred (rather than tank). If headroom in room below is problematic or there are other overriding concerns, wall-mounted toilets may be considered. Review with the Project Manager in preliminary design stage.
- b) Urinals - wall mounted. (Urinals are not typically installed in dormitories, due to the need for flexibility in gender distribution in the buildings [on a yearly basis, a dormitory men's room may become a women's room, and vice versa]).
- c) Lavatories – preferred generally over vanities for institutional-type use in dormitories; no pop-up drains (strainer only). In **dormitories**, provide shelf or ledge above each lavatory mounted high enough to permit to service of the faucet below.
- d) Showers - a precast terrazzo shower base is preferred **in dormitories**, with masonry or frame walls with ceramic tile finish for the surround. One option is to provide a back wall or demising wall to contain valves and piping, with partitions forming the other wall or walls.

If frame walls are utilized, the substrate should be plaster on metal lath, or a **water resistant wall panel**. Consider requirements for rated assemblies if the shower wall is part of a corridor wall.

Provide shower stalls with curtains, and a drying area which is, at a minimum, screened. Princeton traditionally used marble for partitions, but most recently has used the solid color reinforced composite (SCRC). Metal partitions have been found to be too susceptible to damage and corrosion and are generally not used. Specify soap dishes for shower stalls (preferably ceramic recessed). **Provide hooks in dry off areas outside of shower.**

Princeton University Building Services will provide custom-cut shower curtains; Designer should specify length to adequately cover terrazzo curb. Any other special requirements should be brought to the attention of Building Services. Full-length heavy-duty tubular shower rods (typically stainless steel) should be specified for shower stalls. Rods should be securely mounted in retaining cups fastened to shower substrate. Make note of any blocking required for this purpose in frame construction.

The Designer is to be conscious of waterproofing requirements for these bases at all wall, floor and drain locations, especially where occupied spaces may be below the showers. Install underlayments incorporating integral waterproofing membrane, pre-formed inside/outside corners meeting ANSI 118.1, **and a system that integrates with floor drains**. System to match Schluter's "Kerdi/Ditra" or (see appendix 4.13-3). The University suggests a preconstruction meeting with the University, sub-contractor and the waterproofing membrane manufacturer to go over means and methods of installation.

- e) **Misc Fixtures / Fittings - See Section 3.11 Plumbing:**
 - (i) Wall stops
 - (ii) Valves
 - (iii) Hose Bibbs – with keyed handles.
 - (iv) Floor Drains
 - (v) Cleanouts
 - (vi) Drinking Fountains

3. Waterproofing

The Designer is to be conscious of waterproofing requirements for these bases at all wall, floor and drain locations, especially where occupied spaces may be below the showers. Install underlayments incorporating integral waterproofing membrane, pre-formed inside/outside corners meeting ANSI 118.1, **and a system that integrates with floor drains**. System to match Schluter's "Kerdi/Ditra" or (see appendix 4.13-3). The University suggests a preconstruction meeting with the University, sub-contractor and the waterproofing membrane manufacturer to go over means and methods of installation.

4. ADA and Adaptability Requirements

The Designer must become familiar with the barrier-free requirements in the NJUCC and the sub-code ICC/ANSI A117.1. Some latitude in the provision of and location of

barrier-free baths is allowed. The University's goal is to have accessible bathrooms in areas served by accessible entries and along accessible routes, but it may not be practical to make every bathroom barrier-free. The project design review committee will review the proposed location and layout of accessible baths on a case-by-case basis, for continuity with the University's master plan for accessibility.

5. Security

Bathroom entry doors may be equipped with combination-lock hardware to provide a measure of security within buildings. See section 4.4 Door Hardware. This requirement is to be reviewed with University prior to documentation.

6. Finishes

Provide washable finishes; floors are typically ceramic tile or stone, as are walls to at least the height of mirrors. Specify 10% attic stock for each type of **custom or specialty** tile to be delivered to University shops. This is to include field tile(s), coves, accent and each type of bullnose. Ceramic soap dishes should also be included.

Materials must be water-resistant; at a minimum, use water-resistant gypsum board for walls and ceilings. A smooth plaster finish is preferred. At tiled walls, backer materials to have a glass mat facing with a moisture resistance gypsum core at a minimum. Plan carefully for access doors that are often needed in bathroom walls or ceilings. Coordinate access panel locking requirements with section 4.4 Door Hardware.

7. Lighting and Power

Provide area lighting for the room, and (generally) a light at each fixture or compartment. Motion detectors may be used for control of selected light fixtures, with at least one unswitched fixture per room on an emergency circuit. Ideally the emergency fixture is to be located above the sink.

Provide ground-fault-interrupted receptacles at lavatories, one centered between every two lavatories, or at individual fixtures.

Provide back-box and power for future electric hand dryers in the vicinity of the lavatories, where towel dispensers are to be located.

8. Partitions

Provide toilet partitions with doors, shower stalls with curtains or doors, and a shower drying area which is, at a minimum, screened. In addition to traditional metal/stainless partitions, solid color reinforced composite (SCRC) dividers have been installed.

9. Accessories

- a) Vendors for Building Services provide many of the accessories used in Princeton's toilet rooms, including soap and paper towel dispensers and large-roll toilet tissue dispensers. Building Services provides shower curtains for the dormitory bathrooms. Consult Project Manager and Building Services for current information.

- b) The following need to be specified by the Designer: trash disposal units (recessed units in academic buildings, large volume baskets in dormitories); feminine napkin disposal units; mirrors (typically standard units, individually framed for ease of replacement, often with attached stainless steel shelves); full-length mirrors can be considered in most uses; surface mounted soap dishes for shower stalls; heavy-duty one-piece tubular shower rods; heavy-duty robe and towel hooks (in dormitories; discuss material and style with Project Manager) Shelves for purses or pocketbooks are often requested in toilet stalls and at lavatories in academic/administrative uses, and should be considered by the Designer.
- c) The University may install electric hand dryers in multiple-fixture bathrooms in lieu of paper towel dispensers. Paper towel dispensers may be temporarily installed over dryer outlets, until the decision on hand dryers is finalized.

10. Heating and Ventilation

Exhaust ventilation with make-up air is generally needed; review code requirements for providing fresh air, for tempering make-up air, and for providing heat to the bathrooms. In-floor radiant heat has seen limited but successful use in bathrooms, but must be carefully coordinated with fixtures and any subsequent mounting hardware for partitions, etc.

See Section 1.5 (Documentation and Archiving).

END OF DOCUMENT

**Standards for Waste Removal & Loading Docks -
Building Services**

Waste removal must be considered in the site planning phase of building design, and consideration must be given to the way materials and equipment are received at a building.

Requirements for loading berths are included in the land use ordinances of both Princeton municipalities, and must be indicated on site plans presented to the local zoning and planning boards. Typically, local officials will expect to review plans for all services during site plan approval; vehicular movement on the site will be reviewed, as will enclosures or screen plantings for dumpsters and recycling containers.

Princeton University is currently implementing options for controlling traffic in the historic section of campus. Of concern are the size of waste-hauling vehicles and the frequency of pick-up required for recycling and garbage removal. The use of smaller vehicles for trash pickup is being employed, and sites have been developed as part of a regional waste management plan for regional compactors to control volume. The Designer should consult with the Project Manager to ascertain the current status of this issue. ✓PS-27

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A. Standard Recycling Receptacle

Appendix 4.12-1

2. Guidelines for Installation and Performance

A. Waste Removal Services within Building

Trash storage within buildings is minimized.

Access to small semi-concealed trash holding areas from within building is important.

Housing and Building Services are trying to end the practice, in dormitories, of the permanent placement of trash containers (from each dorm room) in hallways. Trash chutes have proven to be an effective tool in trash removal and are the recommended method of handling trash removal and recycling. Chutes are to be the type that allows access for cleaning. Other possibilities include the placement on each floor of a trash/recycling 'center' that students will be required to use for their trash disposal. Another possibility would be the creation of a trash room(s) in the building, with the requirement that students take their trash there. Such a facility would need to be emptied daily, at a minimum.

The Designer should be prepared to review the possible solutions to trash handling and removal.

The University utilizes a standard recycling bin, see [Appendix 4.12-1](#).

B. External Trash Staging Areas

There is a movement afoot to reduce the number of dumpsters visible on campus, and to reduce the size and visibility of dumpster enclosures. At the same time, as noted above

there is a desire to reduce traffic and the size of vehicles that have access to the historic area of campus.

Trucks currently used by Building Services for servicing dumpster areas have a turning radius of forty-five feet; paths to dumpster enclosures should be planned to accommodate these trucks, unless smaller vehicles are to be used.

As stated, there is a desire to make dumpster enclosures smaller, and to make them less visible. Enclosure to consist of shadowbox type fencing and a pad min of 210 SF (21'x10').

C. Area Trash Compactors

Compactors are being considered as possible means to reducing the number of dumpsters required, and thus the number of vehicle trips required to remove trash and recycling. Compactors would need to be limited to the perimeter of campus, due to the fact that the containers are significantly heavier than a standard non-compacted dumpster, and a full-size removal vehicle is needed. Depending on size (over 3 cubic yards), vehicular access would need to be straight on to the compactor, because the containers are too heavy to be rolled into place for pickup. If a compactor is to be included in a project, the Designer should consider placing it near the loading dock to minimize access needs for the building (although volume of use at the dock might preclude this). Where space permits, install a self-contained compactor. **Coordinate selection of appropriate unit manufacturer and size with the University.** This scenario is best used in complexes wither they could serve to tidy a dock area in creating a smaller footprint in a larger facility/complex with larger trash demands.

Compactors would need to be placed away from dormitories to minimize noise complaints.

2. Loading Areas

In academic uses, if there is a custodian dedicated to the new or renovated building, the optimal custodial office location should be determined during the early stages of design. In dormitories, the same is true, but an overriding concern is that the custodian be available and accessible to the students in the building.

The building custodial supply room location should also be given careful consideration based on the needs for access.

A. At-grade Facilities/Loading Berths

1. Area requirements - minimum determined by local zoning ordinances; see Section 1.4 (Regulatory Agencies) for information regarding municipal regulations.
2. Elevator dock/leveler - typical for dining facilities and for science buildings.
3. Access to/from building - with limitations on big trucks in much of main campus, Building Services is turning to small scooters, with 4' by 8' beds (at a minimum). The Designer should discuss the need for any larger vehicular access with the Project Manager, Building Services, the project design committee, and the Landscape Coordinating Committee.

B. Loading Docks

1. Area requirements - minimum area requirements at dock may still apply; review local zoning regulations.
2. Height above grade - varies according to truck or trailer type to be used; review needs with Project Manager and client user.
3. Width/Depth/Overhead clearance requirements: consider number of deliveries per hour to determine need for more than a one-position dock. Review unloading techniques and any pallet-moving equipment to be used; insure adequate depth for maneuvering loading equipment and personnel, as well as size of anticipated crates, boxes, etc. for delivery.

Doors from the dock to the building should be as high as the trailers to be received, if possible. Double doors should be used, to provide at least a six-foot wide opening.

If overhead clearance is to be less than fourteen feet, review with Project Manager and client user for any precautions to be taken.

4. Automatic dock leveler – locate with proper clearance from any building projection to prevent vehicle damage to building; provide “docking clamp” to secure trailer to dock during loading operations.
5. Access to/from building – full-fledged loading docks require proper approaches and turn-around areas. Turning radius of large vehicles must be accommodated; review requirements with Project Manager and client user.

In planning the location of a loading dock, the truck approach should be considered carefully. Preference should be given to providing a pull-up space to driver’s side to reduce blind spots during the backing-up process. Pull-up space needs to be approximately sixty feet long, if a tractor-trailer combination is to service the building.

Any railings need to be carefully placed so they are not in the back-up path.

Likewise for bollards and guards. Bollards and railings should be painted a light color so they are visible in low light conditions, or they should have reflective bands on them.

The loading dock should incorporate a stair to grade (if there is not one provided convenient to the dock within the building). The stair must be placed to avoid conflict with parked vehicles.

6. Material - sealed concrete with a non-slip finish is recommended for the dock surface. The leading edge should have a steel nosing.

Bumpers should be provided to protect the leading edge of the dock, and the building, if necessary. Lighter colors are preferred, for visibility at night.
7. Lighting: provide adequate lighting at and around the loading dock for safe operation. See Section 3.5 (Lighting Design) for information. Exterior lighting such as that for loading docks will generally be reviewed by the Landscape Coordinating Committee (LCC).

8. Drainage: provide for storm water drainage from the loading area; this is particularly important for areas that are at depressed grade. The drains need to be able to bear the accumulation of dirt and debris that are often generated during the loading process. Trench drains might be considered for greater drain area. Any drain type must be easily cleaned, and cleanouts for the storm drainage piping should be placed in the immediate area. Provision should also be made to provide a screening device within the trench drain to limit pipe blockages. For more information, contact the Facilities Grounds and Building Maintenance Roof Shop Project Manager.
9. Coordinate requirements for water and electrical service to the loading dock.
10. Consideration of exterior temperatures shall be given when designing sprinkler systems in loading docks within partially covered areas

C. Off-loading/Storage Area

If a loading area serves more than one building, or if the building storage room is not adjacent to the dock, an off-loading and temporary storage area may be needed. The area should be carefully designed so that it does not turn into a catch-all.

3. Vehicular Access

- A. Access by large vehicles to the Historic Campus is to be limited. See Appendix 2.5-2 Campus Delivery Map for access routes for deliveries. Daily delivery and pickup needs for main campus should utilize the perimeter road systems as much as possible.
- B. Traveling on or crossing pedestrian paths should be minimized, particularly during backing-up operations.

END OF DOCUMENT

1. Introduction

While the Design Standards Manual covers basic principles of several different project elements and building blocks, considerations for a host of other issues related to the construction and maintainability of facilities continues to develop. The Grounds and Building Maintenance Department's missions concerns the upkeep, maintenance, and continued performance of the buildings on campus. As a result, there is considerable interest in the use of abuse-resistant and sustainable materials as well as methods of assembly which allow for long-term maintenance and corrective procedures.

This section addresses preferred construction practices, material selections and methods of assembly which have repeatedly arisen in carpentry Tech Reviews and reflect the experience gained in maintaining and servicing scores of campus facilities. These items are not intended to be limiting or prescriptive, but rather to eliminate some of the guesswork for the Designer by giving better insight into what the University has found to be successful for its use and demands.

2. Contacts

- A. The Project Manager (in Office of Design and Construction, Office of the University Architect, the Engineering Department, Grounds and Building Maintenance, or as applicable).
- B. Program Manager – Design Standards 200 Elm Drive, 609-258-1330
- C. Architectural Engineer 200 Elm Drive, 609-258-2094
- D. Building Trades Coordinator, Architectural Trades MacMillan Building, 609-258-9791

3. Index of References

<https://facilities.princeton.edu/sites/default/files/DSM-Appendix.pdf>

PDF

- A. [SSMA - Steel Stud Manufacturers Association](#)
- B. Recommended Levels of Gypsum Board Finish Appendix 4.13-2
- C. [Gypsum Association Fire Resistance Design Manual, 20th Edition \(or latest\) GA-600-12](#)
- D. Shower Base Detail Appendix 4.13-3
- E. Wood Entry Door Standards and Details Appendix 4.13-4
- F. [Tile Council of North America Installation Handbook, 2016 Edition \(or latest\)](#)

4. Code References

- A. [New Jersey Uniform Construction Code \(NJUCC\)](#)
- B. [New Jersey Applicable Codes and Standards](#)
- C. [New Jersey Uniform Fire Code](#)

5. Review Guidelines - General

Initial planning and preliminary design will be conducted thru the Office of Design & Construction with the University department responsible for project initiation. As the project moves toward the construction documentation and code review phases, it is required that the project construction documents be submitted to the University for an internal “Tech Team” review process thru the Office of Design and Construction for compliance with University standards. Plans are to be submitted for review at:

- A. Completion of Schematic Design, if required;
- B. Completion of Design Development;
- C. 50% completion of construction documents;
- D. 85% completion of construction documents;
- E. 100% completion of construction documents, if required, at the discretion of the Tech Team

With the assistance of the Project Manager and Facilities Tech Teams, discipline review meetings will be held with respective University shops, University Project Engineers, and other Tech Team representatives as required. The A/E is responsible for documenting minutes of all these meetings. There, review comments or recent revisions will be discussed and documented. The Designers shall provide timely and coordinated responses to all review comments. The purpose of the Tech Team review process is to confirm A/E compliance with the current version of the Facilities Design Standards Manual including each respective section and associated appendices.

Additional requirements for specific areas of documentation are as follows:

Required Documentation	SD	DD	50% CD	85% CD
Floor Plans	X	X	X	X
Millwork (on plans)		X	X	X
Millwork (details)			X	X
Partition Types			X	X
Window Types		X	X	X
Window Details			X	X
Screen Details			X	X
Blocking and Framing Details			X	X
Wall / Floor Assemblies and Details				X
Finish Schedules			X	X
Color Selections				X
Outline Specifications		X		
Full-Length Specifications			X	X

6. Considerations for Design

A. Cold-Formed Metal Framing Assemblies

- 16” centers required
- Cold-formed metal assemblies, 20 gage typical. **Designer shall take into account all applied loads, height of wall, sound attenuation, fire rating, etc. when designing assemblies.**
- Refer to SSMA limiting height tables and provide intermediate bracing as required

B. Rough Carpentry Requirements

- Fire-resistant wood grounds, furring, blocking, nailers, etc required within rated interior steel stud framed partitions to facilitate fastening of interior wood window and door frames
- Supply specified fastening methods for Tech Team review

C. Millwork Fabrication Requirements

- Specify compliance with AWS (Architectural Woodwork Standard) “Premium Grade” standards
- Specify “Premium Grade” per HPVA material fabrication standards per ANSI/HPVA HP-1-2004
- Edge banding to be hardwood, minimum of 3mm thick thermo-set solid hardwood
- Plywood construction for cabinet carcasses and shelving, typical (no particleboard); veneer core plywood is acceptable complying with American plywood Association PS-1 Standards
- Substrates allowed as follows:

Countertop Material	Allowable Substrate Materials			
	MDF	MR MDF	Plywood	Combination
Plastic Laminate	X	X		X
Wood Veneer				X
Stainless Steel	X	X		X
Solid Surface	No Substrate Required			
Millwork Finish Material (panel products)	Allowable Substrate Materials			
	MDF	MR MDF	Plywood	Combination
Plastic Laminate	X	X	X	X
Plastic Laminate / Melamine	X	X		X
Hardwood Veneer	X	X	X	X
Metal Panel	X	X		X
SCRC	No Substrate Required			
Millwork Finish Material (casework)	Allowable Substrate Materials			
	MDF	MR MDF	Plywood	Combination
Plastic Laminate			X	X
Plastic Laminate / Melamine				X
Hardwood Veneer			X	X
SCRC	No Substrate Required			

Notes for the tables above:

1. “Combination substrate material” refers to an MDF cross-banded softwood veneer cored panel
2. MR refers to Moisture resistant. Use as needed in wet areas.
3. Fire-resistant substrates may be used based on code requirements

D. Millwork Installation Requirements

- Specify compliance with AWI “Premium Grade” standards
- Blocking details and locations are to be indicated clearly on plans / elevations. At millwork installations, standard wood blocking or a manufactured steel stud backing system (i.e.: Dietrich “Danback” or equal) is acceptable.
- Countertops are to be scribed to fit to ensure no gaps remain. Countertops are to be caulked prior to the installation of back/ side splashes. Caulk required at top of back/ side splashes as well.
- Blocking Methods of Application:
 - Light Duty – 20 Gauge Steel Flat Stock per SSMA
 - Medium Duty – 20 Gauge Steel Stud / Track per SSMA
 - Heavy Duty – Wood Blocking
 - Extreme Duty (ie: grab bars / shower seating) – Solid Wood Blocking
- Blocking, anchoring and fastening methods are to be as tested in accordance with applicable ASTM weight rating standards, per applied loads
- All millwork applied to existing construction shall be anchored with methods appropriate for the wall construction as well as the anticipated maximum load requirement of the fixture.
- Toe kicks are to be a minimum of 4” high
- Supply specified fastening methods for Tech Team review

E. Wall Mounted Shelving Installation Requirements

- Specify compliance with AWI “Premium Grade” standards
- Blocking details and locations are to be indicated clearly on plans / elevations. At millwork installations, standard wood blocking or a manufactured steel stud backing system (i.e.: Dietrich “Danback” or equal) is acceptable. 20 gauge steel flat stock is only acceptable for light duty applications (i.e.: toilet accessories, not in support of applied loads)
- Blocking Methods of Application:
 - Light Duty – 20 Gauge Steel Flat Stock per SSMA
 - Medium Duty – 20 Gauge Steel Stud / Track per SSMA
 - Heavy Duty – Wood Blocking
 - Extreme Duty (ie: grab bars / shower seating) – Solid Wood Blocking
- Blocking, anchoring and fastening methods are to be as tested in accordance with applicable ASTM weight rating standards, per applied loads
- All shelving/fixtures and or wall standards applied to existing construction shall be anchored with methods appropriate for the wall construction as well as the anticipated maximum load requirement of the fixture.
- Supply specified fastening methods for Tech Team review

F. Gypsum Wallboard Applications

- Refer to ANSI A 137.1 for standard practices pertaining to onsite storage and handling
- Specify compliance with ASTM C-1396/C-1396M standards of applicable panel type per location criteria
- Specify compliance with ASTM C-1047 for wallboard system accessories standards and specify structural drywall interior trims with co-polymer cores and paper faces. Plastic trims are to be glued, not stapled.
- Refer to Appendix 4.13-2 for requirements for levels of gypsum wallboard finish
- Specify Level 5 decorative wall finishes in dormitory rooms and critical lighting areas including hallways, stairs and common areas where a uniform finish is required
- No lightweight joint compound for finish coats. Avoid level 3 finishes except in mechanical and electrical closets.
- Fire-rated partition – place wall rating stickers on partition above finished ceiling.

G. Ceramic Tile Applications and Shower Installations

- Installation to follow TCNA Tile Installation Handbook (current edition) standards of application
- Where possible, specify pre-formed corners and trim units. Where pre-formed pieces are not available, specify a silicone caulk (not grout) or a manufactured movement-free profile at all movement joints.
- Grout is typically sanded at floor applications (anything with $>1/8''$ joint) and unsanded at wall applications. Grout should be sealed per manufacturer's recommendations at showers and floors
- Where tile applications meet with a dissimilar material (i.e. doorways), provide a raised saddle ($1/4''$ above floor elevation)
- Substrates are to be mold / moisture / mildew resistant, refer to GA-238-03, guidelines for prevention of mold growth in gypsum board
- **See Section 4.11 for waterproofing requirements.**
- Specify inorganic adhesive to set tiles $\leq 8'' \times 8''$ in floor applications and $\leq 4'' \times 4''$ (nominal) in wall applications
- Consider use of floor drains where possible / feasible
- At all floor penetrations in wet areas use integral water barrier sleeve device.
- Refer to Appendix 4.13-3 for shower base details for positive drainage

H. Wood Window Requirements

- Specify compliance with AWI and WDMA "Premium Grade" quality standards for the fabrication, reproduction, repair and installation of wood windows.
- For wood repair, specify structural adhesive putty (no Bondo)

I. Wooden Door Requirements

- Entry doors – exterior stile and rail requirements - see appendix 4.13-4.
- Interior doors – SCL (structural composite lumber) cores are preferred to alleviate the need for special blocking to accommodate surface applied hardware. Specify compliance with AWI's AWS and WDMA "Premium Grade" quality standards for

the fabrication, reproduction, repair and installation of wooden doors.

- Provide solid hardwood stops at all glazed assemblies.

J. Attic Stock

- Specify attic stock requirements for ceramic, ceiling, and carpet tiles based on availability due to color and size. Note that extra tile should be provided for all but the most standard ceramic tiles as dye lots vary and will present difficulties with matching in the future.
- Specify that attic stock be separated out and stored off-site upon arrival at the project. The University's Grounds and Building Maintenance group may be able to assist in the short-term storage of attic stock if needed.

K. Firestopping

- Meet UL 1479 and ASTM 814 fire test standards based on the floor and wall assemblies planned. .

END OF DOCUMENT