



CONSULTANT DESIGN GUIDELINES

**DEPARTMENT OF DESIGN, CONSTRUCTION AND MANAGEMENT
FACILITIES PLANNING, CONSTRUCTION AND MANAGEMENT
THE CITY UNIVERSITY OF NEW YORK**

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CITY UNIVERSITY CONSTRUCTION FUND

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INTRODUCTION

THE CITY UNIVERSITY CONSTRUCTION FUND

The City University Construction Fund (CUCF) is a public benefit corporation established in 1966 by the New York State Legislature. The mission of the CUCF is to manage the resources necessary for the design and construction of space required to support the educational mandate of the City University of New York.

THE CITY UNIVERSITY OF NEW YORK

The City University of New York (CUNY) is the nation's leading urban public university. Founded in New York City in 1847 as The Free Academy, the University's 25 institutions include 11 senior colleges, seven community colleges and seven graduate, honors or professional schools. The University serves more than 274,000 degree-credit students and 275,000 continuing and professional education students. Located in all five boroughs of New York City, CUNY institutions occupy a total of approximately 27 million square feet of campus space and include nearly 300 buildings.

THE PURPOSE OF THE GUIDELINES

The purpose of the Consultant Design Guidelines is primarily to assist DDCM/CUCF's Consultants in the efficient and expeditious design of college facilities that conform to University design criteria and applicable codes, demonstrate best practices, and comply with the University's Master Plan. The guidelines outline the requirements for the design of new facilities and the renovation of existing facilities throughout the University. They also describe some qualitative expectations, as well as some generic requirements, applicable for most projects, that seek to create consistency in the quality of projects University-wide.

THE ROLE OF THE DEPARTMENT OF DESIGN, CONSTRUCTION AND MANAGEMENT

The City University of New York's Department of Design, Construction and Management (DDCM) in the office of Facilities Planning, Construction and Management (FPCM) compiled and edited these guidelines. DDCM updates the guidelines as requirements change.

Although there may be several offices and departments within the University, the colleges and the other agencies involved with the development of a project, DDCM is the primary contact for guidance on design criteria and requirements.

RESPONSIBILITY OF THE CONSULTANT

The Consultant is typically responsible for the design or renovation of a particular building or area of a campus based on the approved master plan for that campus and within the established budget for the project. The Consultant translates the program requirements in all their various aspects into a functional, aesthetically pleasing, economical and energy-efficient structure. The Consultant's design shall be responsive and sensitive to the context of the campus and relate the

new work to existing facilities and other planned facilities, including concurrent building projects under design by other professionals.

The Consultant is also responsible for initiating and sustaining an integrated design process with the entire design team. The Consultant will coordinate the work of all subconsultants and all other entities involved in the project during all phases of design. The Consultant will be proactive in identifying and recommending additional, different, innovative or technically-refined design criteria for application to a specific project, which DDCM welcomes for its consideration and approval. Early in the design process, the Consultant will determine the requirements of all regulatory agencies having jurisdiction and will develop an action plan for compliance.

The Consultant is totally responsible for all design and is required to deliver a design that is approved by DDCM/CUCF. Regardless of any periodic review that DDCM may perform, the Consultant is professionally and contractually responsible for the correctness and completeness of the contract documents and for conformance with the scope of work, budget, and applicable codes, zoning requirements and laws.

THE CONTENT OF THE GUIDELINES

The Guidelines begin with a general outline of DDCM's Design Approach and Design Criteria. Subsequently, there are chapters that delineate requirements for each of five possible design phases – Feasibility, Pre-Schematic (Conceptual), Schematic, Design Development and Construction Documents. Each of these chapters summarizes general requirements for the particular design phase and lists some specific requirements and items to consider for each of the major disciplines. In addition, there is an appendix on various special topics, some of which contain considerable detailed requirements.

The Guidelines primarily cover the design requirements and do not include specific information on procedures, other contract requirements, project management functions and responsibilities during construction. Project-specific requirements are as per Contract.

CHAPTER I

DESIGN APPROACH AND KEY DESIGN CRITERIA

A. DESIGN EXCELLENCE

1. **Design Intent:** The Consultant is responsible for the design of facilities of excellent quality within the budget and on schedule. Designs shall inspire the public, incorporate ecological and durable materials and systems, and reflect the cost-effective use of public funds.
2. **Promoting Learning Communities:** A primary goal is the creation of environments that are conducive to learning, teaching and the exchange of ideas and that enhance a sense of community.
3. **Campus Master Plan:** Each campus has a Physical Master Plan, approved by the CUNY Board of Trustees, which is updated periodically and provides the basis for the development of new facilities and renovation of existing facilities for that campus. In working on a specific building project, the Consultant will expand upon the site and building concepts in the current campus Physical Master Plan and further develop site and planning relationships in conjunction with programmatic needs.
4. **Site Planning/Orientation:** The Consultant shall site and orient a new facility to take advantage of natural light and exterior views in conjunction with consideration of other concerns such as noise, privacy, location of utilities, campus circulation, local transportation routes, security, and accessibility.
5. **Context:** The Consultant will take into account the massing, scale, and predominant materials of surrounding buildings and consider the effect of any new construction on adjacent buildings and spaces.
6. **Planning/Design Concepts:** The design of a facility shall adhere to the CUNY/CUCF-approved program of spaces and reflect required adjacencies and space relationships. It shall be efficient with a high ratio of net to gross square footage, minimizing the gross square footage while providing the specified spaces, space relationships, service areas, and clearly defined circulation. The design shall maximize flexibility to meet the needs of current and future users.
7. **Design Quality in Specifications and Details:** The design shall specify materials and systems that are durable, cost-effective, well-suited for their application and easily maintained. The design details shall be straightforward and aim to facilitate the ease of quality construction and installation.
8. **Commitment to Accessibility/Universal Design:** The University is committed to providing dignified equal access to all buildings for those with disabilities. All new construction and renovations must comply with the Americans with Disabilities Act (ADA) and all applicable codes and shall aim to promote universal design principles. Designs shall provide the same means of use, identical whenever possible, and equivalent when not, and avoid conditions that segregate persons with disabilities. The main entrance of each facility shall be accessible and reachable by an accessible path.
9. **Maintenance:** Designs shall ensure that maintenance can be routinely performed efficiently.
10. **Design Responsibility and Constructability:** The Consultant is fully responsible for providing a comprehensive, accurate, clearly detailed, and coordinated set of contract documents. The Consultant shall not delegate any design to others without the written

approval of DDCM. One goal is to maximize the contractors' understanding of the requirements during both bidding and construction and minimize disputes and delays.

- 11. Renovations:** In the renovation of existing buildings, the Consultant shall investigate all aspects of the systems and elements that are affected by the project and inform DDCM/CUCF of any conditions requiring improvement. Even in cases where budgetary or schedule constraints necessitate only a partial remediation, any building deficiencies that are discovered shall be examined and documented so that DDCM/CUCF may address these at a future time.
- 12. Art Work:** Some projects may include the creation and installation of art work, which will likely require the Consultant to coordinate the artist's work with various disciplines for an integrated installation.
- 13. Signage:** Signage shall be consistent with the University's Identity standards, available on the CUNY website. The Consultant shall aim to minimize the amount of orientation signage by designing clearly defined circulation for the movement of persons.
- 14. Building Information Modeling (BIM):** For major projects, as requested by DDCM/CUCF, the Consultant will use a building information modeling system (BIM) as a tool in the development of the design and the preparation of the contract documents.

B. SUSTAINABLE DESIGN AND CONSTRUCTION: The University is dedicated to minimizing its ecological impact and promoting a culture of sustainability throughout our community, as well as improving the quality of life of the users. The Consultant shall undertake a comprehensive analysis to lessen the use of energy and reduce the amount of non-renewable resources. To this end:

- 1. LEED:** New University buildings and major renovations shall be designed to obtain a minimum rating of LEED-certified silver.
- 2. Energy Conservation Program:** The current intent of the University's energy conservation program is to achieve a 40 per-cent reduction in greenhouse gases emissions by 2030 in compliance with NYC Executive Order 26 and NYS Executive Order 166 mandated reductions.
- 3. Lifecycle Costing:** The Consultant shall perform lifecycle cost assessment for all major energy consuming systems in order to minimize the overall energy consumption and maintenance and operational costs.
- 4. Commissioning:** Most projects shall require fundamental and enhanced commissioning. DDCM/CUCF will provide additional scope beyond typical commissioning, if required.
- 5. Tracking Building Performance:** Each project shall have monitoring, measuring and feedback systems to establish baseline energy usage and building performance.
- 6. Integrated Design:** The Consultant shall provide for an integrated design approach from project inception, including building engineering solutions and involving all stakeholders inclusive of campus building and grounds staff.
- 7. Energy Consumption:** The Consultant's design shall reduce the energy consumption of the building and site systems through the use of energy-saving mechanical, electrical, lighting, building envelope and construction technologies.

8. **Recycling and Reuse:** The Consultant shall reduce the use of non-renewable resources by specifying appropriate recycled and rapidly renewable materials and advocating the adaptive reuse of existing structures.
9. **Local Products:** The Consultant shall advance the use of locally manufactured or fabricated products and materials, thereby reducing transportation.
10. **Indoor Environmental Quality:** The design shall aim for a high level of indoor environmental quality which may exceed code requirements.
11. **Exterior Environmental Quality:** The Consultant shall design the landscape to create healthy, ecological and pleasant outdoor environments that reduce the exterior lighting demand, minimize stormwater runoff and decrease the need for irrigation systems.

C. REGULATORY AGENCY REQUIREMENTS

1. **General:** The Consultant will follow New York City regulations, including the New York City Construction Codes, Energy Conservation Code, Fire Code, Zoning Code, etc., and adhere to all New York State and Federal laws, rules and regulations that apply to the project.
2. **Regulatory Agencies and Other Entities:** Some of the NYC entities which may have jurisdiction include, and are not limited to: the Department of Buildings, the Department of City Planning, the Department of Transportation, the Metropolitan Transportation Authority, the Fire Department, the Department of Environmental Protection, the Department of Health, the Department of Sanitation, Utility Companies, the Design Commission and the Landmarks Preservation Commission. In addition, some regulations, procedures or guidance from State and Federal entities may apply to a particular project. Some of these include, and are not limited to: the NYS Department of Labor, Department of Environmental Conservation and the State Historic Preservation Office as well as the federal Occupational Safety and Health Administration, the Department of Justice, the Environmental Protection Agency and the Federal Emergency Management Agency.
3. **Responsibility:** The Consultant is responsible for determining and meeting all regulatory agency requirements and obtaining all approvals from regulatory agencies, commissions and utilities.
4. **Specifics:** The Consultant shall delineate the specifics of these requirements early in the design process and no later than Schematic Design. It is the Consultant's responsibility to determine which filings are required for each project and to verify the specific forms required by each regulatory agency.
5. **Schedule:** The Consultant shall be proactive in developing and maintaining a schedule for obtaining any required approvals in a timely way that allows for the completion of the project on schedule.
6. **Certificate of Occupancy:** The Consultant is typically responsible for obtaining or amending the Certificate of Occupancy (C of O) from the NYC Department of Buildings so that the college can occupy the facility as per the schedule. DDCM/CUCF will allow occupancy with a Temporary C of O; however, the Consultant shall work expeditiously and minimize the time to obtain the final C of O. In the partial renovation of an existing building that does not have a C of O, the Consultant will alert and consult with DDCM/CUCF at the earliest phase of design and determine a plan of action with DDCM/CUCF prior to Schematic Design.
7. **Public Assembly:** The Consultant is typically responsible for obtaining or amending the Public Assembly Certificate of Operation. The Consultant will perform a thorough analysis to

ensure full compliance with all NYC Department of Buildings requirements for all aspects of Public Assembly, as well as to ensure full compliance with stipulations of other regulatory agencies having jurisdiction. The Consultant is responsible for the comprehensive and accurate filing of all required documents, including seating plan options.

8. **Zoning:** The Consultant shall perform a complete zoning analysis at the outset of design and is responsible for reconfirming the zoning at each design phase. In most instances, the project shall be built as of right. If, however, there is a recommendation for any variance, the Consultant shall justify any change and delineate the schedule implications; if the change is accepted by DDCM/CUCF, the Consultant shall expeditiously work to obtain all approvals.
9. **Flood Zone Identification:** The Consultant shall identify the current flood zone. Designs in specific flood hazard areas shall comply with regulatory agency provisions that aim to promote the public health, safety and general welfare and minimize losses and disruptions due to flood conditions.
10. **Americans with Disabilities Act:** The University emphasizes the Consultant's responsibility to comply with the Americans with Disabilities Act (ADA) in every aspect of the design. If there is any discrepancy between the ADA and the NYC Construction Codes, the more stringent requirement will apply.
11. **Minority and Women's Business Enterprise (MWBE):** The Consultant shall be attentive to complying with governmental requirements and fulfilling contractual goals for MWBE participation.
12. **Air Emissions:** The Consultant is responsible for identifying and obtaining all NYC Department of Environmental Protection and all NYS Department of Environmental Conservation permits pertaining to air emissions if required.
13. **Certificate of Operations for Laboratory Units:** The Consultant is responsible for preparing and filing design and installation drawings for laboratory units as required by the NYC Fire Department (FDNY) and for obtaining the initial Certificate of Operations for laboratory units from the FDNY.

D. FUNCTIONAL AND PERFORMANCE REQUIREMENTS: Although the design of any facility has numerous requirements to meet the needs of the users, highlighted below are a few of those that are especially important to DDCM/CUCF:

1. **Health and Safety:** In addition to meeting all health, safety and fire codes, the Consultant will provide layouts, materials and systems that insure the health and safety of the occupants during normal use as well as facilitate their evacuation in an emergency. The Consultant's design shall aim to enhance the indoor air quality for the well-being and comfort of the occupants.
2. **Physical Safety/Security:** The Consultant shall design facilities that have physical design elements that allow natural surveillance, access control and territory control to enhance the security of the occupants. Attention to security matters in developing layouts and other physical components of the design often results in the reduction of the types of technological security solutions required, which can lead to lower initial and operational costs.
3. **Instructional Technology:** The Consultant will provide state-of-the-art design and technological solutions tailored for higher education learning environments.

4. **Daylighting Enhancement:** The Consultant shall maximize daylighting and visual connection to the exterior surroundings in regularly occupied spaces and minimize and control artificial lighting.
5. **Acoustical Performance:** The Consultant shall provide optimal acoustical performance for various learning environments and limit sound transmission between spaces, taking into account the academic requirements for different types of academic spaces and the sensitivity of scientific equipment.
6. **Vibration Control:** The Consultant shall evaluate vibration producing equipment for transmission of vibration to the building structure and provide necessary isolation as well as eliminate or minimize the transmission of vibration to sensitive scientific equipment.
7. **Maintenance and Operation:** The design, selection and placement of equipment shall aim to minimize the amount of required maintenance and provide for the ease of operation, ease of repair, and ease of replacement. The Consultant shall make provisions for these to occur without significant disruption to building operations, taking into account the need for easy access and ample clearances. The Consultant shall design facilities, equipment and systems that personnel can operate with a reasonable amount of training and minimize the need for specialized training or expertise.
8. **Integrated Controls:** For some projects, especially for new stand-alone buildings and major renovations, the Consultant shall plan for the integration of building management systems, security, fire alarms, and other applicable systems.

CHAPTER II

FEASIBILITY STUDY AND REPORT

A. FEASIBILITY STUDY - GENERAL

1. **Feasibility Study:** When DDCM/CUCF requires a feasibility study, DDCM/CUCF will define the project-specific parameters and the objectives in the Contract. There is a wide range of possible studies and these typically require research, analysis, conceptual planning and cost estimating. The intent of this chapter is to note some general tasks that will apply to many studies.
2. **Evaluation:** The Consultant shall review and study existing documentation and field conditions for the project site and building(s), evaluate existing systems and investigate code requirements.
3. **Recommendations:** Based on program and code requirements, as well as existing conditions, the Consultant shall provide options and make recommendations on project scope, cost, budget, construction and major building systems (structural, mechanical, electrical, plumbing, fire protection systems, etc.), as applicable.
4. **Report:** The Consultant shall provide a feasibility study report including all investigations, options and recommendations.

B. EXISTING DOCUMENTS SEARCH

1. Search CUCF, College, Utility, NYC Department of Buildings (DOB) and other relevant Regulatory Agency files for existing plans and documentation.
2. Search DOB records for any violations.
3. Review existing documentation for content, completeness and impact on the Project.
4. Obtain and review architectural backgrounds in AutoCAD format from DDCM/CUCF.

C. CODE REVIEW AND ZONING ANALYSIS

1. Define all applicable code, zoning and regulatory issues.
2. Review project with relevant code and regulatory officials and agencies.
3. Determine project code and regulatory requirements and report findings.

D. SURVEY OF EXISTING CONDITIONS

1. Verify existing conditions and existing documentation and field measure as applicable.
2. Verify conditions listed in existing DDCM/CUCF Condition Survey reports
3. Identify all locations where the proposed design will disturb or affect a component of an existing building and indicate coordination requirements with ongoing or planned projects, if any.
4. Survey existing heating, cooling, electrical, communication, distribution systems, and their functionality and conditions at each building or at the central plant if applicable.
5. Investigate all existing utilities (water, sewer, electric power, fire service, communication, heating and cooling, etc.) and determine their adequacy for the needs of the Project.

6. Prepare as-built dimensioned drawings of existing conditions including plans, sections, details and schematic diagrams of existing systems as required for the design concept by each discipline.
7. Arrange for a survey by a licensed Asbestos Investigator and if necessary arrange for the preparation of asbestos abatement plans and specifications for the bidding of the abatement work.
8. Arrange for lead testing, if applicable.

E. CONCEPTUAL DESIGN

1. Review the program with respect to net/gross planning efficiency.
2. Develop a design concept and define a proposed project scope with options. Incorporate conceptual recommendations for architectural, structural, mechanical, electrical, plumbing, fire protection, lighting, energy management, telecommunications, and security systems as applicable.
3. Perform vertical transportation analysis, where required, and make recommendations.
4. Include analysis of accessibility requirements.
5. Provide conceptual space planning drawings and diagrams.
6. Provide a description of proposed major materials, finishes and equipment.

F. CONCEPT COST ANALYSIS

1. Develop a realistic and current construction cost estimate based on conceptual drawings and specifications.
2. Use major categories from the latest Construction Specifications Institute (CSI) format and area and volume costs.

G. FEASIBILITY STUDY REPORT

1. Prepare a Feasibility Study Report including options considered and conclusions and recommendations on project scope, costs, budget, construction, project-specific systems such as mechanical, electrical, plumbing, fire protection, energy management, telecommunications, and security systems and any other project-specific items.
2. The Feasibility Study Report shall include, but not be limited to:
 - a. An executive summary
 - b. All studies, analyses and investigations (i.e., document search, code analysis, survey of existing conditions, etc.)
 - c. Digital photos (printed and electronic) of existing conditions and systems
 - d. Diagrams of existing systems and proposed new systems
 - e. Sufficient drawings, sketches and outline specifications to clearly show the design concept and project scope and to illustrate options investigated
 - f. Circulation diagrams showing program space and net/gross planning efficiency
 - g. Conceptual cost estimate, using major categories from the latest CSI format that takes into account the current construction market conditions
 - h. Incorporation of all DDCM/CUCF comments.

3. The report shall not be limited to the list above. The Consultant is responsible for providing a comprehensive feasibility report and shall include any additional project-specific matters, research, analyses, documents, etc. to fully define any issues and support the recommendations.

CHAPTER III

PRE-SCHEMATIC DESIGN PHASE

A. PRE-SCHEMATIC DESIGN – GENERAL

1. **Pre-Schematic Design and Report:** When required by the Contract with CUCF, the Consultant shall perform Pre-Schematic conceptual design work and provide a Pre-Schematic Report. The Consultant shall investigate a full range of architectural design options and site possibilities and include appropriate analysis and alternative designs for all project-specific requirements and systems (i.e., structural, mechanical, electrical, plumbing, fire protection, communications, swing space, etc.).
2. **Drawings:** The Consultant shall provide Pre-Schematic drawings at a scale appropriate to delineate the general nature of the designs envisioned for all applicable disciplines and suitable for preparation of a Pre-Schematic estimate.
3. **Other Submission Materials:** The Pre-Schematic submission shall include descriptive materials to complement the graphic information on the plans as well as outline specifications, schedules for all phases of design, an outline construction schedule and a conceptual estimate.
4. **Existing Conditions and Code Analysis:** If the Consultant was not required to perform a feasibility study for the project, he/she shall gather and review any existing documents and reports, survey existing conditions, and perform a code and zoning analysis during this phase of the project. (Refer to Chapter II for specifics.)
5. **Program:** Typically, DDCM/CUCF provides the space program. If any programming work is required, it will be project-specific as per Contract, require DDCM/CUCF approval, and comprehensively take into account CUCF space standards and the college's needs, projected needs and utilization of space.

B. PROPOSED PROJECT APPROACH AND ALTERNATIVE SOLUTIONS

1. **Proposed Project Approach:** Establish and recommend the best approach for program elements and critical relationships between program elements.
2. **Building and Site Development Solutions:** Unless otherwise directed by DDCM/CUCF, develop a minimum of three (3) options or alternate building and site development solutions for the full range of possibilities and generate appropriate illustrative drawings.
3. **Systems Solutions:** Develop a minimum of three (3) alternative HVAC, electrical and structural system configurations and considerations for the proposed solutions. Use twenty (20) year life cycle cost analysis for determining the feasibility of each alternative, including initial investment, thermal and electrical energy demand and operating personnel and plant maintenance costs.

C. ARCHITECTURAL CONCEPT

1. The development of an architectural concept shall be guided by the key design criteria described in Chapter I, taking into account design excellence, sustainability, regulatory agency requirements, and functional and performance requirements.

2. From inception, the Consultant will initiate and sustain an integrated design process with all the disciplines to produce a cohesive design concept that meets the program requirements and is within budget.
3. The Consultant shall investigate design alternatives and typically present a minimum of three solutions, with drawings and diagrams, and provide a justification for the recommended design.

D. STRUCTURAL SYSTEMS – The selection of structural systems, both superstructure and foundations, shall be guided by the following:

1. A comparison of various schemes to determine the least costly which meets College needs
2. Anticipation of possible construction problems, the availability of materials, as well as the ease of construction
3. Schemes that allow the College flexibility for future expansions and alterations
4. Taking into account existing soil conditions
5. Consideration of current code requirements.

E. MECHANICAL/HVAC SYSTEMS – Factors to be considered in selection of HVAC systems:

1. Compatibility with existing systems
2. Energy efficiency and cost including cost of fuel and utilities
3. Energy modeling analysis
4. Proposed “U” factors for walls, roofs and glass as they relate to building orientation and energy code
5. Useful life of proposed systems and equipment
6. Operating and maintenance costs
7. Future expansion requirements
8. Flexibility
9. Minimum, maximum and average loads
10. Usage factors
11. Location of equipment as it relates to efficient distribution.
12. Noise considerations including permissible noise level criteria and engaging an acoustical consultant if noise control is an important factor
13. Air pollution
14. Simplicity of design and ease of operation and maintenance
15. Pressure and temperature requirements of heating and chilled water distribution systems
16. Method of distribution, tunnel, direct buried or through existing buildings
17. Type of fuel or electricity
18. Central utility plants vs. individual plants

19. Low pressure steam vs. high pressure steam or hot water for heat distribution
20. Type of refrigeration equipment
 - a. Reciprocating chillers for smaller size
 - b. Electric VFD motor- driven centrifugal chillers
 - c. Steam turbine driven centrifugal chillers
 - d. Steam absorption chiller
 - e. Gas fired absorption chiller
 - f. Combination of two or more of above types
 - g. CFC Requirements.
21. Location, type and approximate size of cooling towers; preference is for forced draft cooling tower with water side economizer cycle
22. Type of air distribution system (i.e., constant volume, variable air volume, etc.).

F. ELECTRICAL SYSTEMS – Electrical factors to be considered in the selection of systems:

1. Location, type and capacity of existing power supply
2. For electrical supply, compare radial distribution (under 1000 KVA), primary selective, primary and secondary selective; for network compartments, compare costs for added transformers to provide first and second contingency for added reliability and growth
3. Maintenance Requirements
4. Existing and future load profile
5. Space requirements (power, lighting, etc.)
6. Emergency generation requirements
7. Energy efficiency.

G. PRE-SCHEMATIC COST ESTIMATE

1. Provide a current and realistic cost estimate in CSI format for each design option based upon measurement of physical characteristics: area, volume and complexity of massing. Include cost of mechanical and electrical systems.
2. Evaluate the Pre-Schematic Cost Estimate relative to the established Budget.

H. DDCM EVALUATION

1. Based on the Consultant's recommendation, DDCM will select the overall solution or combination of solutions which best address the needs of the campus and university.
2. DDCM will approve the conceptual architectural design and those systems it feels most appropriate to be considered for further detailed investigation in the Schematic phase. The final mechanical, electrical and structural systems selected shall typically be the most cost effective and energy efficient systems based upon a detailed life cycle cost analysis.

I. PRE-SCHEMATIC REPORT/SUBMISSION

1. Provide a comprehensive Pre-Schematic report outlining the project approach and including all analyses, alternative solutions and the Consultant's conclusions and recommendations. Include the following:

- a. Executive Summary.
 - b. Design sketches and diagrams of alternatives
 - c. Program
 - d. Narrative of proposed architectural approach/design, engineering systems, materials and finishes, etc.
 - e. Cost estimate in CSI format that takes into account current market conditions
 - f. Outline specifications
 - g. Schedules for all phases of design and an outline construction schedule
 - h. Background information, alternative solutions and conclusions from feasibility studies, reports, analyses, review of documents and evaluation of existing conditions
 - i. Code and zoning analysis.
2. The Pre-Schematic submission shall not be limited to the list above. The Consultant is responsible for providing a comprehensive submission and shall include any additional project-specific matters, research, analyses, documents, etc. to fully define any issues and support the recommendations.

CHAPTER IV

SCHEMATIC DESIGN PHASE

A. SCHEMATIC DESIGN – GENERAL

1. **Schematic Design:** The Consultant shall develop the Schematic Design based on DDCM/CUCF's direction which may include the approval of prior studies and recommendations.
 - a. The Schematic Design is critical to the success of the project. The Consultant shall make every effort to thoroughly analyze all aspects of the project and provide comprehensive documentation to DDCM for evaluation and determination of the design parameters.
 - b. During the Schematic phase, the Consultant shall develop study drawings and documents to illustrate design concepts, typically investigating at least three alternative schemes.
 - c. When a project's first phase is Schematics, there will likely be project-specific tasks or analyses typically performed in Pre-Schematics that the Consultant will handle in Schematics and for these, the Consultant shall reference all prior Chapters of these Guidelines.
 - d. The Consultant will discuss and review with DDCM the schematic planning relationships, site planning relationships, scale, systems, and zoning, code and jurisdictional requirements as well as the material and information to be included in the presentation of the Schematic Design.
2. **Schematic Documents Submission:** The Consultant shall provide Schematic Documents for all disciplines including, but not limited to:
 - a. **Drawings** for all disciplines at a scale appropriate to delineate the general nature of the designs (typically for 3 options) and suitable for preparation of a schematic estimate
 - b. **Descriptive materials** to complement the graphic information shown on the plans including, but not limited to:
 - **Narrative report** describing all pertinent aspects of the specific project: use, architectural concepts with options and recommendations, conformance to requirements, zoning, lot coverage, code analysis, total net and gross square footage, program details and conformance, materials and methods for construction, toilet and egress calculations, ADA/accessibility requirements and conformance, structural design criteria, heating and air conditioning systems, building envelope energy performance analysis, LEED approach, energy modeling, electrical system, plumbing systems, commissioning, communications, security, acoustics, lighting, landscaping, signage, regulatory agency approvals, swing space plans, and other project specific criteria, information, analyses, and recommendations, etc.
 - **Program:** A comparison of the actual areas for each space with the approved program space areas
 - **Schedule** for all phases of design and an outline construction schedule. The design schedule shall include: typical submission and review dates, major milestones for regulatory agency submissions and approvals, a LEED timeline if applicable, and commissioning agent target dates.

- c. **Outline Specifications** for Site Development, Site Utilities, Architectural, Structural, Mechanical, Plumbing, Fire Protection, Electrical, Lighting, Controls, Security, Telecommunications, Audio-Visual, Acoustical elements, Signage, and other applicable categories, etc.
 - d. **Cost estimate** in the latest CSI format, with a comparison to the budget and cost per square foot data. (See Appendix A.)
 - e. **Code and Regulatory Agency Requirements** including a comprehensive analysis of applicable codes and regulatory agency requirements for this project and a list of specific codes, other requirements and issues pertinent to this project.
3. **Schematic Review:** DDCM will review the documents and provide comments. If DDCM/CUCF hires a construction manager for this phase of the project, the CM will also provide comments. The Consultant is responsible for coordinating the input from all entities, responding to the comments in writing within two weeks of receiving them and informing DDCM of any conflicting comments, unresolved issues, or recommendations for deviations from DDCM's comments for DDCM's consideration and direction. DDCM will evaluate the consultant responses to the comments and provide direction on any open issues. The Consultant will fully incorporate DDCM's comments, revisions and determinations in the design prior to the next submission.
4. **Presentation:** Subsequent to incorporating revisions based on DDCM's review, the Consultant will present the final Schematic Design to the project team, including DDCM and college project managers and reviewers. The final Schematic Design shall illustrate that the recommended design meets the program, is responsive to the review comments, and justifies the solutions in terms of economic, functional and aesthetic factors. DDCM/CUCF's approval of the final Schematic Design shall conclude this phase.

B. SITE ANALYSIS

1. The master plan or comprehensive site plan for the campus or institution shall be the basis for design of the site work. Analysis shall consider all factors affecting the program and location of the buildings and shall include, but not be limited to the following:
- a. Surface conditions
 - b. Subsurface conditions
 - c. Climate
 - d. Site characteristics and services, such as:
 - Orientation to sun, wind and other buildings on site and adjacent to site
 - Site access
 - Roads and walks
 - Rights-of-way and easements
 - Drainage structures
 - Sewer, water, eclectic and gas lines and their capacities
 - Steam and HTHW/MTMW (Hot Temperature Hot Water/Medium Temperature Medium Water)
 - Fire protection services
 - e. Federal, state and local regulations, such as those pertaining to:
 - Anti-pollution requirements
 - Flood plain restrictions
 - Environmental impact
 - Blasting restrictions

- Transportation services
 - Community impact
 - Educational intent
 - Energy conservation requirements
 - Accessibility/ADA requirements.
2. Drawings – At a minimum, the following drawings shall be provided:
 - a. Location plan – Project location at a scale of 1" = 100'.
 - b. Site Plan – Location of Building (or Buildings) in relation to the immediate surrounding area, all existing and/or proposed necessary utility lines, grading and site improvement, lighting, walks, roads and parking and basic topography to the extent of existing information
 3. Specifications – Brief description of proposed materials and systems.

C. BASIC CONCEPT OF BUILDING AND ARCHITECTURAL

1. Provide a narrative description and graphic documentation of the basic concept of the building and the key design elements. (See Chapter I for Design Criteria.) Delineate:
 - a. Overview of scope and purpose/use with program details
 - b. Architectural concepts with options (typically a minimum of three) and recommendations,
 - c. Conformance to requirements
 - d. Total net and gross square footage
 - e. Compliance with DDCM/CUCF-approved program (with comparison chart of actual and approved square feet per space)
 - f. General building massing
 - g. Room/space relationships
 - h. Basic building plan
 - i. Circulation patterns
 - j. ADA/Accessibility Requirements and Compliance
 - k. Active design elements (i.e., stair placement to encourage use)
 - l. Selection of mechanical, electrical and structural systems (with analysis of options)
 - m. Other Systems and Disciplines (e.g., Security, Telecommunications, Audio-Visual, Fire Alarm, Building Management, Acoustics, Lighting, Landscape, Signage etc., as applicable)
 - n. Energy Efficiency Considerations including energy modeling
 - o. LEED approach
 - p. Plan efficiency considerations (i.e., vertically stacking toilet rooms on consecutive floors, etc.)
 - q. Code and Regulatory Agency Compliance
 - zoning, lot coverage
 - comprehensive code analysis (certificate of occupancy, public assembly, etc.)
 - calculations (egress, toilet, etc.)
 - building envelope energy performance analysis
 - regulatory agency approval requirements and timeline
 - r. Commissioning
 - s. Materials and methods of Construction
 - t. Swing Space and/or Phasing Considerations
 - u. Other project specific criteria, information, analyses, and recommendations, etc.

2. Architectural Drawings – At a minimum, provide the following architectural drawings:

- a. Location Plan
- b. Site Plan
- c. Zoning Diagrams indicating compliance with NYC zoning regulations
- d. Code compliance drawings
- e. Architectural Floor Plans:
 - 1/8" scale minimum
 - Basic building plans with overall dimensions, north arrow, all required spaces, doors, windows, stairs, square footage, planned occupancies, exits, major fixed equipment, and illustrating reasonable compatibility with routing of mechanical and electrical services
 - Program Space numbers, programmed area and actual area for each space
- f. Architectural Sections:
 - 1/8" scale minimum
 - Major building sections in two directions for all structures, indicating basic vertical dimensions and proposed structural and mechanical systems
- g. Architectural Elevations:
 - 1/8" scale minimum
 - All major facades, indicating basic dimensions and proposed surface materials
 - Interior elevations of key areas
- h. Circulation Flow Diagrams
 - Stair, corridor and exit count figures to meet compliance with current New York City Building Code
 - Circulation routes
- i. Reflected Ceiling Plans
- j. Finish Schedule Outline
- k. Net to Gross Analysis.

3. Specifications: Provide outline Specifications which define all architectural materials which will be used in the project.

4. Program:

- a. Provide a list of the program spaces with actual net assignable square feet, showing compliance with the DDCM/CUCF-approved program.
- b. If there is any deviation from the approved program, the consultant is responsible for highlighting this to DDCM; no changes in the program will be in effect without DDCM's full review and written approval of the changes.
- c. Provide color-coded program drawings to indicate space types/usage. Include occupancy numbers per space and square footage that corresponds to the program list.

D. SYSTEMS ANALYSIS

1. Detailed economic analysis, including life-cycle cost analysis, and engineering recommendations for systems shall be presented to DDCM before acceptance of the Schematic Design.
2. The design requirements shall conform to DDCM and ASHRAE conservation standards

3. System analysis shall include energy management, fire alarm, fire protection and vertical transportation analysis and recommendations. See Appendix H for fire alarm requirements.
4. Describe general commissioning requirements.

E. PROBES/TESTS FOR RENOVATIONS AND ALTERATIONS

1. Survey existing site conditions in conjunction with the review of existing documents, noting the potential of any hidden conditions.
2. Recommend probes/tests, within practical and funding limits, to minimize the potential for extra work and delays during construction because of field conditions.
3. Prepare and submit bid documents for probes/test work.

F. STRUCTURAL

1. Subsurface Investigation:
 - a. Review existing subsurface information, provided by DDCM/CUCF and other sources, from projects on or near the site.
 - b. Analyze data from all available sources and from site investigations and determine if subsurface investigations are recommended or necessary to meet the requirements of the NYC Construction Codes or those of other regulatory agencies with jurisdiction or to resolve uncertainties about subsurface conditions, rock excavation and ground water conditions.
 - c. Develop and submit a subsurface investigation plan for DDCM/CUCF approval.
 - d. Provide and submit bid documents, prepared by a soils engineer, who will provide continuous field inspection during the investigation.
 - e. Provide a soils report with recommendations.
2. Structural Schematic Documents shall include, but not be limited to the following:
 - a. Design Criteria
 - b. Loads with different combinations
 - c. Structural Framing Plans, developed sufficiently to show the selected comparative systems and associated costs.
 - d. Foundation plan showing basic foundation system based on available geotechnical information
 - e. Lateral load resisting system
 - f. Typical Structural Sections showing the structural design intent and materials of the various systems
 - g. Outline specifications delineating materials for various structural systems
 - h. Costs for each structural system.

G. MECHANICAL/HVAC

1. Provide a comprehensive narrative description of the mechanical systems that indicates, but is not limited to:
 - a. Design Intent/Basis of Design
 - b. Design Criteria and Calculations
 - Temperature and relative humidity criteria for inside and outside design conditions for summer and winter

- Block load, heating and cooling load calculations with required heating and cooling equipment capacity
 - Air change requirement criteria for specific applications such as laboratory, gymnasium, and auditorium spaces.
- c. Functional descriptions of the mechanical systems including a basic control sequence of operations
 - d. Identification and quantification of all central system and/or utility requirements, impact on central (or building) systems, and utility interconnection capacity
 - e. For existing facilities, an analysis of the feasibility, cost and construction phasing of major equipment installation.
2. Provide the following Mechanical Schematic drawings, diagrams and equipment schedules:
 - a. Basic mechanical and plumbing system flow diagrams indicating major equipment, utility and building system interconnection points and their capacities
 - b. Plans and sections on architectural backgrounds, in schematic form, of the alternative mechanical & plumbing system arrangements showing utility and central system interconnection points and the footprint of major equipment to ensure that the equipment fits in the structure
 - c. Equipment schedules for major equipment showing capacities, outputs and other requirements.
 3. Provide outline specifications for major equipment for all systems.

H. ELECTRICAL

1. Provide a brief description of the electrical system and major electrical equipment.
2. Provide Schematic Drawings, Diagrams and Calculations, including:
 - a. Block diagrams of the proposed major electrical equipment arrangement and locations and electrical utility interconnect requirements
 - b. Schematic riser diagrams for emergency power, fire alarm, low voltage master clock, signal & security systems and telecommunications (if applicable)
 - c. Basic one line diagrams indicating all services, voltage levels, spare capacity for future expansion and emergency power system and indicating existing utility and building system interconnection points.
3. Design Criteria include, and are not limited to:
 - a. Coordination with mechanical design in specification of adjustable speeddrives where possible, such as for fans and centrifugal pumps
 - b. Use of reduced voltage starters where required
 - c. Branch voltage design drop as per NYC Code, 2-1/2% to distribution point
 - d. Panel and switchboard copper design to a maximum of 1000 a/s.i. unless reduced by NEC Design Requirements
 - e. For above 3000 KVA service, specification of 480 volt Con Edison supply
 - f. Allowance of 25% project load growth factor
 - g. Avoidance of complex, elaborate maintenance requirements
 - h. For facilities with extreme nonlinear loading, use of double sized neutral and K-rated transformers and no undersizing of neutrals
 - i. Lighting illumination design criteria in foot candles per square feet for each area in compliance with IES (Illuminating Engineering Society) design criteria and the latest Ashrae 90.1. See Appendix M.

4. Provide outline specifications for major equipment for all systems.

I. PLUMBING AND FIRE PROTECTION

1. Provide a narrative description, including the design intent, of the proposed building systems.
2. Provide Schematic drawings, diagrams and calculations that include, but are not limited to:
 - a. Piping riser diagrams
 - b. Drawings indicating location of water, gas, sanitary sewer, storm sewer and sprinkler/standpipe services to the building
 - c. Drawings indicating the location, sizes and types of major equipment such as boilers, water heaters, heat exchangers, and flues/chases where required
 - d. Tentative fixture and equipment schedule
 - e. Fixture count calculations.
3. Provide outline specifications for major plumbing elements.

J. DATA, COMMUNICATIONS, BUILDING MANAGEMENT, SECURITY SYSTEMS, ETC.

1. There are several other disciplines for which Consultant experts may provide design documents to meet the requirements of a specific project. These include, but are not limited to disciplines such as: data, communications, audio-visual, building management and security systems.
2. The Consultant shall ensure that the Schematic documents for each discipline contain an appropriate level of description, follow best practices, are coordinated with other disciplines, and fully take into account existing conditions and infrastructure.
3. Many of these disciplines encompass rapidly evolving technologies, and DDCM/CUCF's intent is to include industry innovations in the design of its facilities. The Consultant shall outline and adhere to a schedule that both allows flexibility so that the changes in technology may be incorporated as the design progresses and also includes dates by which specific decisions shall be required or reconfirmed to allow for coordination of this work with the overall design within the overall project schedule.
4. The Consultant is responsible for determining the College's specific requirements for these systems; documenting, confirming, and reconfirming the requirements with the College stakeholders; and obtaining DDCM approvals.
5. For some projects, especially for new stand-alone buildings and major renovations, the Consultant shall plan for the integration of building management systems, security, fire alarms, etc. and delineate a single point of responsibility in the documents.

K. CONSTRUCTION COST ESTIMATE

1. Provide a preliminary comprehensive cost estimate in CSI format with economic justification and cost benefit analysis of systems selected, including cost per square foot.
2. Include projected construction completion date and proper estimate of escalation to midpoint of construction.
3. Include a comparison with the project budget.

CHAPTER V

DESIGN DEVELOPMENT PHASE

A. DESIGN DEVELOPMENT - GENERAL

1. **Basis:** Following DDCM's approval of the Schematic documents, DDCM/CUCF will direct the Consultant to proceed to the Design Development Phase and fully develop the design of the selected option and approved concepts from the Schematic phase.
2. **Quality Control/Submission:** The Design Development submission documents will include the drawings, specifications, calculations, estimate, program comparison and regulatory agency requirements. The submission shall clearly and completely define the selected option and approved concepts. The Consultant is responsible for the coordination of all disciplines in the submission and incorporating the input of DDCM/CUCF reviewers and that of various other team members, including those holding separate contracts with CUCF (i.e., construction manager, commissioning agent, etc.)
3. **Regulatory Agency Approvals:** In general, the Consultant will follow New York City regulations, including the New York City Construction Codes, Energy Conservation Code, Fire Code, Zoning Code, etc. The Consultant's responsibility includes providing a comprehensive list to DDCM/CUCF of all regulatory agencies having jurisdiction, identifying the necessary filings, and submitting a final schedule for submissions to these agencies that allows ample time for obtaining any approvals to comply with the project schedule.
4. **Design Development Calculations:** The calculations, submitted by the Consultant shall include, but are not limited to the following:
 - a. Architectural space net-to-gross calculation to show space planning efficiency
 - b. Applicable zoning and code calculations
 - c. Further developed architectural, structural, mechanical, electrical and plumbing calculations pertaining to the selected design option in sufficient detail to indicate method, assumptions, design intent, references and units for DDCM/CUCF review
 - d. Detailed heating and cooling block load calculations using ASHRAE standards
 - e. Ventilation requirements in accordance with the latest ASHRAE standard and the NYC Construction Code. When the Code requirements exceed the ASHRAE calculations, compliance with the Code is mandatory.
 - f. Energy analysis modeling including envelope calculations to meet NYC Energy Conservation Code
 - g. Electrical calculations indicating load requirements for the project and lighting illumination levels in all areas.

B. ARCHITECTURAL

1. **Space Requirements:** Resolve important space requirements at this stage of design, such as major equipment layouts and clearances, mechanical shaft sizes, and circulation, egress, stair and toilet requirements. Provide sufficient gross area for central mechanical facilities to assure adequate flexibility of design.
2. **Program:** Submit a comparison of actual space square footages in the Design Development documents with the approved Schematics program per space.

3. **Design:** Develop previously approved architectural concepts and delineate materials, systems, and other construction elements and ways of achieving project requirements. If there are any significant deviations from the approved Schematic design, provide a narrative explanation for the changes.
4. **Existing and New Work:** Clearly differentiate existing and new work for all elements of the design. Indicate proposed mechanical and electrical systems as well as existing systems to be retained or abandoned. In the selection of systems, allow for future expansion.
5. **Proposal for Final Drawings:** Provide a list of drawings proposed for final design for all disciplines.
6. **Design Development Drawings: Architectural** Drawings shall include, but not be limited to the following:
 - a. Cover sheet
 - b. Code compliance drawings
 - c. Floor plans at minimum 1/8" scale showing:
 - All spaces and areas required by program with room names, numbers and square footage per space
 - Ancillary facilities, such as exits, circulation, stairs, elevators, toilets, receiving areas
 - Mechanical equipment spaces, in scale, for boiler room, fan rooms, duct shafts, pipe shafts, transformer vaults, electrical distribution
 - d. Circulation diagrams including stair, corridor and exit count calculations
 - e. Block diagram with calculations for net and gross area and total cubage with indication of net areas of each programmed space
 - f. Exterior elevations at minimum 1/8" scale showing:
 - Heights, overall and floor to floor, and spot elevations at each floor relative to grade
 - Exterior materials and fenestration, including percentage of fenestration to total area
 - Parapets, reflecting care in the design of the parapets, coping, and flashing to prevent infiltration of moisture
 - g. Transverse and Longitudinal Sections typically at 1/4" scale, except for a major large building
 - h. Typical Exterior Wall Sections and Details
 - i. Interior Elevations
 - j. Typical Interior Details of, but not limited to, typical walls, partitions, floors and roofs, indicating materials, construction, fire-ratings, etc.
 - k. Enlarged Plans of areas requiring a higher level of detail such as laboratories, toilet rooms, etc.
 - l. Reflected Ceiling Plans
 - m. Typical furniture and equipment plans, for the following:
 - Classroom
 - Laboratory
 - Auditorium
 - Lecture Hall
 - Food Service and Seating Arrangement
 - Office
 - Locker Room
 - Library

- n. Submit drawings to New York City Buildings Department for compliance with zoning, exits, fire prevention, ADA, and to other regulatory agencies as required for the project.
 - o. Provide notification to Con Edison and/or National Grid for gas, electrical and steam supply approvals.
7. **Specifications** shall use the latest CSI format indicating the quality of materials, finishes, and workmanship. The Consultant is fully responsible for delineating the specifications and shall not delegate any design.

C. SITE DESIGN

1. Site Design Development Drawings shall include, but not be limited to:
 - a. Site plan including streetscape design:
 - Clearly delineate accessibility elements including ramps, handrails, lighting, bicycle storage, special parking provisions, accessible routes and such other features as are required by code or federal ADA standards.
 - Take into account fire department truck access requirements.
 - Indicate site lighting.
 - Provide grade elevations
 - b. Grading and drainage plan:
 - Combined utilities site plan at 1" = 40'
 - Indicate site drainage, sewer, water, gas, fire sprinkler mains, electrical distribution lines, steam and hot water heat distribution systems, chilled water distribution systems, fire hydrants and all other existing and proposed utility systems connecting to the project building and in the area of the project, noting appropriate elevations.
 - Provide Cathodic protection systems for direct buried doublewall metallic steam and hot water distribution lines, subject to DDCM approval.
 - c. Soil erosion and sediment control plan.
2. Provide specifications in latest CSI format for all site materials and surfaces, including surfaces cut/and or damaged by project construction.

D. STRUCTURAL: In the Design Development phase, clearly indicate the selection of all structural systems, both superstructure and foundations.

1. The selection of structural systems shall be guided by the following parameters:
 - a. Soil conditions and associated impact and selection of foundation design as it pertains to spread footings versus pile footings, mat foundations, drilled piers, soil liquefaction, etc.
 - b. Site conditions and the impact on adjoining structures on selection of foundation
 - c. Lateral load resisting system
 - d. Intended use of the building
 - e. Impact of structural system on the project schedule
 - f. Evaluation of possible construction problems
 - g. Availability of materials
 - h. A scheme which allows the College flexibility to make alterations and additions in the future
 - i. Resistance to moisture penetration and corrosion
 - j. System that requires less maintenance.

2. **Structural** Design Development Drawings and Specifications

- a. Floor, and Roof Framing Plans (1/8" scale min.) to include the following:
 - Size and location of all major openings, stairs, and any unusual features
 - Design load tables indicating live loads of each area
 - Typical notes, sections, and details with sufficient information to indicate design of structural systems selected and materials to be used
 - Sufficient information to show the type and size of beams and girders to allow for estimating.
- b. Foundations Plans (1/8" scale min.)
 - Foundations of structure based on borings analysis and recommendations of a soils Consultant (if any)
 - Indication of waterproofing requirements
 - Typical design of footings, piles caps, grade beams, foundation walls, etc.
 - Excavation support details
 - Estimated foundation loads
 - Exterior grade elevations indicated at foundations walls
 - Boring plans and logs on drawings.
- c. Lateral Load Resisting System
- d. Outline specifications using the latest CSI format indicating the quality of materials, finishes, and workmanship.

3. Additional Requirements for **Alterations to Existing Structures**:

- a. Clearly differentiate new and existing construction.
- b. Clearly differentiate the structure to be removed.
- c. Indicate loading capacity of existing structure.
- d. Indicate a section through existing structural slabs and other existing members where structural work will be required. Sections shall indicate existing materials, thicknesses, sizes, etc., and any other items which clarify the work to be performed.
- e. On plan, indicate all locations which will require structural reinforcing, framing, etc. and method of reinforcement.
- f. Where loads are transferred from one system of structural elements to another during construction operations, include precise requirements from the NYC Construction Codes and provide Notes for suggested procedures and sequences for shoring, bracing, cutting, underpinning, etc.
- g. The Consultant shall visit the site and take field measurements of the existing structure in all areas affected by alteration work and show measurements on the design drawings.

E. **MECHANICAL/HVAC**: Items for consideration in the Design Development Phase include, but are not limited to the following:

1. Individual Building System Considerations:

- a. Single duct, normal velocity, constant volume with reheat
- b. Single duct, normal velocity, with multi-zone assembly
- c. Single duct, normal velocity, variable air volume systems with associated controls
- d. Unit ventilators
- e. Fan coil units
- f. Induction units
- g. Packaged equipment

- h. Fume hood exhaust systems
 - i. Exhaust systems
 - j. Economizer cycles, air and waterside, both for free cooling during intermediate season.
2. Glycol Cooling Systems
 - a. Glycol solution design for:
 - Condenser water systems used with computer room cooling units utilizing outdoor-mounted “dry cooler”
 - Chilled water systems subject to freezing
 - Hot water pre-heat systems subject to freezing
 - Other water systems which might ordinarily freeze.
 - b. Glycol: industrial type ethylene glycol only; No use of automotive type ethylene glycol
 3. Mechanical Design Criteria for Science Laboratories: The proper design of laboratories is comprehensively delineated in Appendix G.
 4. Commissioning Requirements
 5. Mechanical/HVAC Design Development Drawings and Specifications
 - a. General - Design Development documents developed to such a degree to clearly define the heating, ventilating and air conditioning equipment and systems installation for the building
 - b. Floor and roof plans – superimposed on architectural plans (minimum 1/8” scale) to generally show HVAC work
 - c. Enlarged equipment room layouts (minimum 1/4” = 1’0”) showing location and size of major equipment to scale, chimney, means of access for larger size equipment and its replacement, approximate sizes and locations of air intake and discharge openings, special details
 - d. Single line drawings showing location of main piping runs, major ductwork, shafts, etc., with double line indication of larger pipe and duct sizes
 - e. A schedule of all major equipment, including boilers, chillers, cooling towers, blowers, pumps, tanks, air conditioning and ventilating units, indicating the main features of each location, area served, capacity and size
 - f. Flow and control diagrams of the main air, water steam, etc. systems
 - g. Indication of areas requiring smoke purge fans in case of fire
 - h. Energy management system with number of points for mechanical system
 - i. Heating and cooling block Load calculations
 - j. Design Development specifications, using the latest CSI format, with brief description in outline form of all major equipment and piping, ductwork and other materials used.

F. ELECTRICAL

1. Provide a list of codes applicable to this project, including but not limited to New York City Electrical Code, New York City Construction Codes, New York City Fire Code, New York State Energy Conservation Code, NFPA 72 and 72d, and all applicable Local Laws. Where the National Electrical Code is more stringent than the New York City codes, it shall be complied with, as approved by DDCM.
2. Provide a list of required regulatory agency approvals of the final plans and specifications.
3. **Electrical** Design Development Drawings shall include, but not be limited to:

- a. General – Design Development drawings and specifications that clearly define the electrical installation for the project
- b. Floor and Roof Plans superimposed on architectural drawings indicating service runs and major equipment
- c. Floor Plans indicating electrical and data outlet locations
- d. Equipment Layouts
 - Layout of electrical services showing all major equipment such as service runs, main switchboard, transformer vaults, manholes, etc.
 - Layout of all other major electrical equipment such as motor control centers, major conduit runs, dimmer board, generators, etc.
- e. Riser diagrams for various systems such as fire alarms, clock, telecommunications (telephone and data), and program annunciation systems, etc.
- f. Schedules for major equipment and lighting showing capacities, output and requirements
- g. Lighting Plans with layouts of typical areas and catalog cuts of proposed main lighting fixtures
- h. Elementary one-line service layout.

4. Electrical Calculations shall include, but not be limited to:

- a. An estimated load calculation for lighting, power and equipment with a load summary table on plans indicating new and existing loads, final net connected load and proposed demand factor and identification of the watts per square foot allowance for facility
- b. Illumination level calculations for all areas
- c. Preliminary load profile to the utility company to establish an understanding of the adequacy of the utility's power source to handle the expected load.

5. Electrical Design Development Specifications, in the latest CSI format, shall include, but not be limited to descriptions of the following:

- a. Electrical service
- b. Service and distribution equipment and metering
- c. Panel boards, light and power
- d. Motor control centers and starters
- e. Light and power distribution
- f. Extent of electrical work and controls in connection with equipment supplied under other contracts, such as motors, boilers, starters, etc.
- g. Wiring and raceways
- h. Wiring devices
- i. Lighting systems including listing the types of fixtures to be used in various areas, foot candle intensities and methods of control for each. See Appendix M.
- j. Various systems to be furnished and installed under the electrical contract such as telephone, fire alarm, clock and program annunciation system, etc.
- k. Emergency light and power provisions
- l. Temporary light and power system
- m. Special systems and equipment in accordance with College program requirements
- n. Security systems
- o. Electrical generation.

G. PLUMBING AND FIRE PROTECTION

- 1. Design toilet rooms so that the plumbing fixtures can be installed back-to-back to minimize mains and runouts and vertically stack toilet rooms on consecutive floors.

2. Minimize use of ejector systems and install only when required by site limitations.
3. Where individual chilled water drinking fountains are specified, they shall be wall hung, located in corridors and vertically stacked to permit one (1) chiller unit to serve several drinking fountains on consecutive floors.
4. Provide type and location of standpipe and sprinkler systems.
5. **Plumbing and Fire Protection Design Development Drawings and Specifications:**
 - a. Design Development plumbing plans (superimposed on Design Development architectural background) at 1/8" scale, shall clearly indicate the following:
 - Floor and roof plans that show the extent of plumbing work
 - Domestic hot and cold water systems, including type of system, equipment and loads
 - Single line drawing of water supply mains for domestic and fire protection indicating size and connections to city services
 - Location of pumping equipment, pneumatic tanks and roof tanks
 - Location of back-flow devices including RPZ devices, when required
 - Routing of main storm sewers, leaders, roof and area drains indicating sizes of mains
 - Location of sewer ejectors, if required
 - Routing of special drainage systems, such as acid systems, industrial wastes, radioactive materials, etc.
 - Main routing of gas distribution piping and connections to utility service mains
 - Sprinkler systems and other fire protection systems.
 - b. Design Development Specification, in the latest CSI format, will include a brief description of all major equipment, piping, materials and fixtures that are project-specific.

H. DATA, COMMUNICATIONS, BUILDING MANAGEMENT AND SECURITY SYSTEMS

1. When documents are required by Contract for these or any other disciplines, the Design Development drawings and specifications shall delineate the full extent of the work.
2. The documents shall be fully coordinated with other disciplines and any existing infrastructure.
3. The Consultant shall confirm specific requirements with the College and DDCM.

I. COST ESTIMATE

1. Submit a comprehensive Design Development cost estimate by trade, using the latest CSI format. (See Appendix A.)
2. This estimate shall be based on the systems and equipment indicated on the drawings and specifications.
3. Describe methods used for estimating various components— quantity take-off, contractor's estimate, vendor's estimate, previous similar project, Means, Dodge, etc.
4. Indicate assumed bid date, construction start date, and duration of construction on the estimate and escalate costs to the midpoint of construction, taking into account market conditions
5. Include comparisons to previous estimates and to the project budget.

CHAPTER VI

CONSTRUCTION DOCUMENTS PHASE

A. CONSTRUCTION DOCUMENTS – GENERAL

1. **Basis:** The Consultant shall prepare the Construction Documents based on DDCM/CUCF's review of the Design Development documents and DDCM/CUCF's direction to proceed.
2. **Consultant Responsibility and Quality Control:** The Consultant is fully responsible for the technical correctness and completeness of the Construction Documents and for conformance to applicable codes, laws and zoning requirements. The Consultant shall coordinate the work of all its subconsultants to provide integrated documents of excellent quality that provide sufficient detail to ensure competitive bidding. The Consultant will thoroughly incorporate input from DDCM/CUCF and other team members (such as the Construction Manager and the Commissioning Agent), if directed by DDCM/CUCF. The Consultant is responsible for a comprehensive set of documents and shall not delegate any design to others (contractors, manufacturers, etc.) without the written approval of DDCM.
3. **Design:** Throughout preparation of the Construction Documents, the Consultant shall maintain the previously approved design and budget parameters and advise DDCM of any deviations from Design Development specifications and cost, for advice and consent, and for proper adjustment of the specifications and cost estimate to match the available budget.
4. **Submissions:** Construction Documents submissions and reviews shall follow the Contract requirements and the DDCM/CUCF-approved schedule. Submission milestones may include: 60%, final and bid documents. DDCM will review and provide comments for incorporation into the documents.
5. **Cost Estimates:** Each submission shall include a detailed cost estimate, organized using the latest Construction Specifications Institute (CSI) categories and reflecting current construction market conditions. (See Appendix A.)
6. **Regulatory Agency Approvals:** Concurrent with the preparation of the construction documents, the Consultant shall obtain final approvals from all regulatory departments and agencies having jurisdiction.
7. **Contract Documents:** The Consultant will prepare complete Contract Documents for bidding including the drawings and project manual. The project manual will include CUCF boilerplate information on bidding and contract requirements, a listing of the drawings, general conditions, supplementary conditions, and technical specifications.
8. **Contract Packaging:** The contract packaging responsibilities are project specific and may involve coordination with a construction manager (CM). The contract packaging is dependent on the method of bidding (e.g., phased design and construction, design/build, construction management, multiple or single contract, Wicks Law compliance, etc.). Some projects may be bid as one prime contract covering all trades and others will require the preparation of multiple bid packages. When there is more than one package, each bid package shall be complete and stand on its own, not relying on other bid packages.

- B. 60% CONSTRUCTION DOCUMENTS:** Typical requirements at this phase shall include, but not be limited to the following:

1. **Submission:** The Consultant shall submit drawings, specifications and a detailed cost estimate, all representing a minimum of 60% completion of the Final Construction Documents. The Consultant shall also submit a schedule of the status of all regulatory agency filings/approvals and a program comparison of the actual program to the approved program.
2. **Extent of Work:** The 60% Construction Documents shall completely define the entire project from a construction viewpoint even though all the construction details are not fully developed.
3. **Drawings:** The drawings shall include all of the drawings developed for Design Development upgraded for this submittal and any additional drawings that will be in the Final set of the Construction Documents. The Consultant is responsible for determining the required drawings that will fully describe the work and shall take into account the lists of possible drawings in the Final Construction Documents sections found later in this chapter.
4. **Specifications:** The Specifications shall follow the latest CSI format and fully define the entire project. In developing the Specifications, the Consultant shall consider the various Specifications checklist items for the major disciplines, as described in the Final Construction Documents sections later in this chapter, as well as the following parameters:
 - a. Proprietary items shall not be specified without prior written approval by DDCM.
 - b. The use of manufacturers' or suppliers' names and products in prescriptive specifications is permitted provided that at least three products of equal quality are listed for each item of equipment, assembly or material specified, as well as the phrase "or approved equal". Such listings shall indicate particular characteristics, standards of quality, or performance and shall not indicate preferences or otherwise limit competition.
 - c. The inclusion of the phrase "or approved equal" permits suppliers to furnish equipment, materials, or services which, in the judgment of the Consultant, are equal in all respects to those specified; these require written approval by the Consultant.
 - d. Substitutions of equipment, materials, or services of lesser value than specified shall not be used except upon written approval by DDCM, and, if approved, will result in a deduct change order, adjusting the contract price downward.
 - e. The Consultant has full responsibility for the design of the project and the specifications shall not delegate the design of any system or element to others without the written approval of DDCM.
5. **Regulatory Agency Submissions:** The Consultant shall provide a status report of its submissions to various agencies having jurisdiction and shall include target dates for approvals. The Consultant shall confirm compliance with NYC Energy Conservation Code (NYCECC) filing requirements and verify and/or update energy modeling calculations.
6. **Color and Material Sample Charts:** The Consultant shall submit the final Color and Material Sample Charts, if not previously submitted. The Consultant will prepare three (3) charts: one for DDCM/CUCF, one for the College, and one for the Consultant. The charts shall include all the approved exterior and interior finishes and paint colors.
7. **Alternates:** Most projects will include alternates, and the Consultant shall submit a prioritized list of proposed alternates for review and approval by DDCM. In making recommendations, the Consultant shall consider that alternates will be accepted only in the order in which they are listed in the bid documents.
8. **Quality Control:** Prior to submission, the Consultant shall review the drawings and specifications for the following requirements:

- a. To assure general conformity with DDCM's evaluation of the Design Development drawings and outline specifications and directed modifications to the Design
 - b. To check for compliance with any special decisions and determinations, as well as DDCM technical comments, made in the Design Development Phase
 - c. To assure that the facilities being designed meet DDCM/CUCF general requirements; are not detailed in such a way as to produce delays in construction or to produce maintenance and operational problems; and are designed economically and are energy efficient, recognizing that operating costs may in certain instances be substantially reduced by some additional initial investment.
9. **Review of 60% Construction Documents:** DDCM, and other team members, will review this submission and supply comments for Consultant compliance. DDCM/CUCF will provide boilerplate documents, including the General Conditions, for customization by the Consultant in the preparation of final contract documents.

C. FINAL CONSTRUCTION DOCUMENTS SUBMISSION - GENERAL

1. **Final Construction Documents** shall be 100% complete construction documents, ready for bidding except for DDCM's final review and comments. Documents shall contain all the information necessary to estimate, bid and construct the Work.
2. The **Submission**, which shall incorporate all prior review comments from DDCM/CUCF, shall include the drawings, a complete project manual (specifications, various bid documents, etc.), the cost estimate, calculations and regulatory agency approvals. To obtain DDCM/CUCF approval, the Submission shall be comprehensive and contain all these elements.
3. The **Drawings**, prepared and coordinated in accordance with industry best practices, shall show the complete project. The drawings for all disciplines shall be fully coordinated, dimensioned and detailed. The graphics shall be clear and consistent, including only project-specific legends, keys, notes, etc., and omitting extraneous information. They shall follow current NYC Department of Buildings drawing guidelines (i.e., for numbering, etc.). There are some additional specific guidelines for drawings for each major discipline noted in later sections in this chapter.
4. The **Project Manual** will include CUCF's boilerplate bid documents, customized to be project-specific, and the final Specifications.
5. **Specifications** shall follow the latest CSI format. Reference the additional specifications guidelines for each major discipline noted in later sections in this chapter.
6. **Cost Estimate:** The Consultant will provide the final realistic Construction Cost Estimate in the required format, using CSI categories, and will include the established budget amounts and prior estimate for comparison purposes.
7. **Quality Control:** Prior to submission, the Consultant shall review the drawings and final specifications for the following requirements:
 - a. To check that DDCM's technical review comments and direction are fully incorporated in the documents
 - b. To check that all the documents are fully coordinated and complete.
8. **Regulatory Agency Approvals:** The Consultant shall submit the approvals from all government agencies having jurisdiction with the submission of the final Contract Documents.
9. **Review of Submission:** DDCM/CUCF will review this submission and provide the Consultant with comments for inclusion in the bid set. In that the goal is for the Consultant to

provide a comprehensive final submission, DDCM/CUCF's intent is to have minimal comments at this stage. If there is a lack of clarity, omissions, or errors (except for very minor items), DDCM/CUCF will reject the submission.

- 10. DDCM/CUCF Acceptance:** Construction Documents accepted by CUCF indicate DDCM's acceptance of materials and workmanship specified therein. No substitutions altering the quality or quantity of same will be permitted without prior approval of DDCM/CUCF.

D. FINAL ARCHITECTURAL DRAWINGS AND SPECIFICATIONS

1. The **final architectural and site drawings** shall be fully dimensioned and coordinated and shall include, but not be limited to the following:
 - a. **Cover Sheet** - name of project, location, list of drawings, names of Consultant and sub-consultants, etc.
 - b. **NYC Department of Buildings (DOB) Drawings**-including all information and calculations required by the NYC DOB -- total occupancy meeting code, occupancy and area per space, exit capacity of stairs and doors, travel distances, fire separations, fixture counts, etc.
 - c. **Site Drawings** – site, location and landscape plans and details including property survey, contract limit lines, site features, landscaping, existing and new utilities, site paving and drainage, lighting, planting, walks, driveways, existing and new contours, elevations, etc.
 - d. **Demolition Plans** – clear delineation of extent and type of demolition and removals and of items to be salvaged and/or stored or reused.
 - e. **Floor Plans @ 1/8" = 1'-0"** minimum
 - Fully dimensioned, including size of rooms and other areas and finish floor elevations
 - Fire rating of walls, partitions, door openings and door swings
 - Room and space numbers and designated use
 - Column lines and other structural elements
 - f. **Roof Plans**—with all penetrations, roof supported equipment, walkways, etc.
 - g. **Circulation/Egress Plans**
 - h. **Enlarged Floor Plans of Key Areas @ 1/4" = 1'-0"**
 - i. **Exterior Elevations:** with floor to floor heights, floor elevations, exterior materials and fenestration.
 - j. **Sections:** including all major sections through the building
 - k. **Wall Sections and Details:** Exterior and Interior
 - l. **Other Enlarged Sections and Details:** as necessary to completely define the construction of the project-with thickness and height dimensions, materials, etc.
 - m. **Interior Elevations**
 - n. **Partition Types**, noting fire ratings
 - o. **Reflected Ceiling Plans:** with construction, penetrations, location of light fixtures, sprinklers, diffusers, etc.
 - p. **Furniture and Equipment Plans**
 - q. **Roof Details:** with all roofing, flashing, penetration, closure, walkway, equipment support etc. details.
 - r. **Elevator and Escalator Plans, Sections and Details:** with elevator shafts, pits, and equipment layouts.
 - s. **Stair Plans, Sections and Details**
 - t. **Schedules:** Doors, windows, finish, hardware, specialties, equipment etc.
 - u. **Window and Curtain Wall Details**
 - v. **Composite Sections and Details**

2. **Checking for completeness:** The Consultant is responsible for checking his/her work for completeness. To aid the Consultant, noted below are some of the key items for a general check of the architectural drawings and specifications, organized by key categories from the Construction Specifications Institute (CSI). The Consultant will also identify other items that are project specific for checking, inclusion and coordination.

3. **Division 1 - General requirements**

- a. Schedules
- b. Temporary facilities, temporary power, temporary lighting
- c. Project closeout
- d. Allowances
- e. Add alternates
- f. Provision for access and protection of site during construction
- g. Project sign - Consultant shall design and indicate the number and locations of construction signs after checking with DDCM/CUCF for the latest names, titles, and general sign dimensions.

4. **Division 3 - Concrete**

- a. Control joints in parapet walls and architectural concrete walls
- b. Expansion joints in new structure and where new construction meets existing
- c. Coordination of penetrations and installation sequence with other trades
- d. Concrete testing and allowances (estimate of quantities)
- e. Coordination with other trades for requirements for concrete pads and anchors
- f. Sufficient sections, details and schedules to clearly show dimensions and elevations of all concrete members and required reinforcing
- g. Special Inspection requirements
- h. Seismic requirements
- i. Coordination with structural documents.

5. **Division 4 - Masonry**

- a. Masonry anchoring and reinforcement for stonework, including copings
- b. Wall ties, vertical and horizontal reinforcement
- c. Flashing details and weep holes for cavity wall construction
- d. All openings and knock-out panels
- e. Fire rated penetrations
- f. Horizontal and vertical expansion and control joints
- g. Seismic bracing and details for shear walls when required
- h. Proper detailing of exterior wall envelope to create a moisture-proof environment.

6. **Division 5 - Metals**

- a. Structural steel arrangement and detailing with sufficient sections and details to clearly indicate all framing and connections
- b. Sufficient information and details required for connections, including typical & non-typical connection details
- c. Miscellaneous iron requirements
- d. Adequate lintel provision and anchorages
- e. Guards where stairs pass windows
- f. All protection guard rails in conformance with OSHA, ADA and Department of Buildings requirements. Hand rail details and connection details and connection to support structure

- g. Guards for depressions in grade levels, moving machinery area ways, etc.
- h. Protection of walls, equipment and columns in automobile and truck areas
- i. Ladders and associated details to access platforms, elevator pits and machine rooms.
Check requirements for cages and protection at openings
- j. Protection and cleaning of aluminum at plaster and water surfaces, at points of contact
- k. Protection for dissimilar metals in contact with each other which may cause an electrolytic reaction
- l. Provisions for rigging hooks for major mechanical items
- m. Protective coatings for structural steel appropriate for specific conditions
- n. Equipment support and access platforms and catwalks
- o. Fireproofing for steel columns, beams, and metal decks
- p. Lateral bracing system
- q. Coordination with structural design.

7. Division 6 - Carpentry

- a. Wall hung display cases and cabinets – with adequate support and provisions for light fixtures as required
- b. Fire retardant wood where code requires same and pressure treated wood for areas exposed to moisture and weather
- c. Requirements for setting door bucks, hanging doors and installation of hardware.

8. Division 7 – Thermal and Moisture Protection

- a. Caulking and flashing requirements of windows and openings
- b. Caulking details for exterior metal work
- c. Caulking at all masonry to metal joints
- d. At exterior masonry pavement, adequate expansion joints
- e. Flashing details where required including at:
 - Roof elements and penetrations such as curbs, hatches, vents, ducts and other features extending through roof surfaces
 - Chimneys
 - Stone or masonry sills made of more than one piece
 - Spandrels
 - For slate or shingles, flash under these with polymer modified bituminous sheet “ice shield” extended a minimum of 3’ up from the eaves, or use standing seam copper or aluminum for the same distance to prevent damage by water backing up from ice dams at the eaves.
- f. Roof scuppers and flashing and drains
- g. Lip of all gravel stops shall be 1-1/2” minimum
- h. Insulation at exterior walls in accordance with the New York City Energy Conservation Construction Code
- i. Roof slopes to drain at a minimum 1/4” per foot unless otherwise directed by DDCM
- j. Waterproofing where required including:
 - At planters and basement walls
 - Waterproofing and drainage at balconies and terraces.
- k. Adequate drips at exterior soffits
- l. Weatherstripping at all exterior doors
- m. Expansion joints at roofs, parapet walls, chimneys, and metal fascias, as required
- n. Roofing Specifications requirements: (1) before the roofing installation is begun, Contractor and roofing subcontractor shall submit a statement, signed by both, certifying

that they have examined the surfaces over which the roofing is to be applied and find it satisfactory; (2) before beginning their application, the Contractor and roofing subcontractor shall meet with the Consultant and DDCM to agree on the procedures that must be followed

- o.** DDCM roofing recommendation – SBS modified bitumen roofing systems for flat roof unless otherwise directed
- p.** Roofing Warranty – Minimum 20 Year Roofing Warranty unless otherwise directed by DDCM
- q.** Firestopping systems to retain integrity of fire resistance rated construction at penetrations through floor, roof, and wall assemblies, at joints, perimeter gaps, etc.

10. Division 8 - Openings

a. Glass and windows:

- Clearances for insulating glass at all edges for expansion within the frame
- At partitions with glass panels, consideration of ease of glass removal and replacement
- Windows' conformance with Fire Department requirements
- Protection of glass partitions against vibration and door slamming
- Windows shall conform to applicable regulations for window cleaning

b. Doors

- Direction of swing on entrance doors for consistency, code requirements, traffic flow, etc.
- Door labeling as "Push or Pull" for safety reasons
- Visible markings on glass doors for safety
- Doors with strike jamb toward a column located a minimum of 24" from the column
- For gasketing on soundproof doors, make allowances at head and jamb
- Doors requiring fire label
- Placement of door bumpers, hinges, checks, etc., especially for doors coming in contact with plywood and glass partitions
- Doors for undercuts and louvers required by HVAC, or carpeting.

c. Ventilation of ceiling and wall space

d. Hardware

- Heavy duty hardware for exterior doors; medium hardware acceptable for interior doors except in heavy traffic areas or on special purpose doors; lightweight hardware not acceptable for any use
- Type, size, and number of hinges per door specified to suit the door size and function and door guarantee requirements; minimum of 1-1/2 pair of hinges for all doors
- If mortised hardware, doors must be adequately reinforced, and if necessary, the hardware through-bolted
- Compliance with ADA requirements.

11. Division 9 - Finishes

- a.** Verification that materials of floors, walls, partitions, ceilings conform to legal or code (i.e., load, fire-resistance ratings, etc.) requirements and to outline specifications previously approved

- b. No resilient flooring in fire resistive stairways and passages leading to such stairs
- c. Non-slip durable floor materials in vestibules
- d. Coordination of height of hung ceilings to mechanical drawing (e.g. ducts) including practicability of locating hangers in regard to ductwork and ceiling systems suspended from structural elements only
- e. Wall finishes selection for ease of maintenance including use of cement board 12" high in all spaces which are below grade (basements/cellars) on all partitions where site is prone to floods
- f. All plaster on the exterior of buildings to be "cement plaster"
- g. Expansion joints in cement plaster soffits every 12 feet maximum as well as against building face and fascia; Runner channels parallel to the building and lapped and wired, not bolted; Lath to remain free and not be carried over the gap
- h. Conditions for installation of various interior finish materials – i.e., only after space is enclosed, weatherproof, and dry; and air temperature and humidity requirements for installation of specific interior materials, etc.

12. Division 10 - Specialties

- a. Chalk boards, tack boards, bulletin boards, directories, graphics, etc.
- b. Lockers, adequate size and construction
- c. Shelving in all closets
- d. Bookcases or cabinets
 - Located so as not to impair the proper functioning of radiators or convectors
 - Designed so that sections are the same length, and interchangeable
 - If delivered assembled, verify doorways permit access.
- e. Skylights for adequacy of detail and ease of maintenance
- f. Signs and directories, consistent with the University's signage/identity standards, described on the CUNY website
- g. Toilet accessories required; paper holders, soap dispensers, grab bars, etc.
- h. Occupancy and exit signs required by NYC Building and Fire Departments
- i. Provisions for installation of artwork, including lighting structural support.

13. Division 11 – Equipment - Conformance of equipment with approved layouts and detailed facilities program.

14. Division 12 – Furnishings - Conformance of furniture with approved layouts and detailed facilities program.

15. Division 13 – Special Construction

- a. Check if the following is required: terrazzo floors, special soundproof room, animal quarters, radiation shielded rooms, chemical storage rooms, sound isolation, etc.
- b. Lightning Protection.

16. Division 14 – Conveying Systems

- a. Intermediate elevator rail supports if floor to floor unsupported distance is over 17'-0" or as required by code
- b. Elevator machinery support beams shown in structural drawings
- c. Cab, thresholds, etc.
- d. Elevator shaft ventilation and conformance with NYC Code requirements
- e. Certifications by appropriate authorities.

17. Division 25 – Integrated Automation - For stand-alone new buildings and major renovations – integration of building management systems, security, fire alarms, etc.

18. Division 31 - Earthwork

- a. Foundations and footings shown under steps, walls, area ways, unless the condition of the soil and the job specifically allows their omission
- b. Underground drain tile
- c. Pitch of concrete terraces at 1" in 10' - 0"
- d. Rough textures, non-slip and ADA-compliant surfaces on terraces and sidewalks at entrances
- e. The extent and limits of work including but not limited to the following:
 - All new structures
 - All existing structures, including those to be demolished
 - Property lines, including rights-of-way and easements
 - Contract limit lines
 - Construction access roads
 - Site protection including fences and barricades
 - Planting, including existing vegetation to be preserved
 - Contractor's material storage and parking areas
 - Trailers
 - Dumping and stockpile areas
 - Subsurface information including all utilities, existing and proposed
 - Baseline, coordinates, benchmarks, monuments, etc.
 - Drainage and grading
 - Excavation supports.
- f. All work that is to be removed shall be clearly shown and disposal indicated.

E. FINAL STRUCTURAL DRAWINGS AND SPECIFICATIONS

1. General

- a. The structural engineer of record shall be responsible for the design of the entire structure.
- b. The final structural drawings and specifications shall incorporate all decisions from prior Design phases. Any deviations from prior decisions shall be clearly defined.
- c. The structural engineer of record shall sign and stamp all structural drawings.
- d. A licensed structural engineer, registered in the State of New York, shall sign all structural shop drawings for steel and concrete.
- e. The structural drawings shall contain all the information necessary without referring to other drawings, except for miscellaneous items such as location of railpost inserts, mechanical equipment supports, etc., and only if the item is clearly cross-referenced by drawing number.

2. The final structural drawings shall include, but not be limited to the following:

- a. Plans and elevations at 1/8" = 1'-0" scale or larger, fully dimensioned, etc.
 - Foundation Plans indicating location of footings, piles, walls, pits, columns, beams, ties, anchor bolts, cut outs, etc.
 - Floor Framing Plans with beam, girder, column sizes and details, elevations, etc.

- Roof Framing plans with all openings, depressions, slopes, elevations, thicknesses, etc.
 - Elevation of all braced bays shoring lateral load resisting system
 - Elevation of moment frame resisting lateral loads
- b. Sections and details at $3/8" = 1' - 0"$ scale or larger, with sufficient detailing to indicate complete structural systems and systems for resisting lateral loads.
- Foundation Sections and details including footings, piles, pile caps, foundation walls, waterproofing
 - Special details for unique or complicated construction
 - Reinforcement details for all concrete members including precast members, with clear dimensioning including size, spacing, and length of reinforcement as well as concrete and reinforcing strength
 - Precast concrete connection details
 - Typical steel structure details
 - Typical concrete structure details
- c. Schedules:
- Column and foundation schedules, with location, size and height of each column, cumulative loads and lateral loads per floor.
 - Beam, pier, slab, footing, lintel and design-load schedules.
- d. Where the existing structure or part of the structure may be temporarily unstable during any phase of construction, and the condition is unusual or not obvious, the contract documents shall clearly indicate the existence of this condition to the Contractor.
3. The Consultant shall **check** the structural drawings for or provide the following:
- a. Coordination between specifications and drawings.
 - b. Coordination of all structural drawings with architectural, mechanical, and all other trade drawings.
 - c. Cross reference notes on each drawing to locate typical detail sheet, general notes, column schedules, etc.
 - d. Shaded key plan or area covered by a particular drawing
 - e. Type and frequency of necessary special inspections noted in specifications
 - f. Floor loading schedule, Itemizing all loads
 - g. Where lifting hooks and beams are shown such as for elevators, etc., indication of load capacities of hooks.
4. **Foundations**
- a. Foundation design consistent with boring data information and recommendations of soils consultants (soil bearing capacity; footing elevations, etc.)
 - b. Review adjacent structures for underpinning, sheeting, etc. Show method of protecting existing structures.
 - c. Where ground water conditions exist either permanently (above the lowest cellar or pit level) or only temporarily during construction, specify drainage and pumping systems and provide waterproofing for permanent water conditions and:
 - Design slab for uplift and walls for hydraulic pressures.
 - Study effects of pumping on adjacent existing structures.
 - Describe the type of waterproofing and clearly indicate where it occurs on all sections.

- d. Structural supports for utilities between the buildings - placed on properly prepared subgrade to carry applied load.
- e. Check for superimposed loading on underground utility lines (especially steam lines) and for special protection for these lines. Provide anchor supports and guides required to support thermal forces.
- f. Existing foundations, cellars, underground utilities and other buried obstacles --noted on the foundation drawings if they are expected to affect the construction.
- g. Footings - checked for interferences with underground utilities. Adjacent footings on soils shall not have a difference of elevation such that the slope between is greater than one on two. Wall footing shall not step more than 2'-0" for each increment, and shall maintain an overall slope along the wall of one to two.
- h. Existing foundations - checked and reinforced for additional loads from alterations and extension of superstructures
- i. Piles - Type and capacity of piles selected from boring information, with care given to avoid field problems. Consider liquification of soil for seismic loads.
- j. Openings in walls for utilities - indicated on drawings with details indicating structural framing
- k. Where applicable, knock-out panels for major equipment removed - shown and detailed
- l. Indication of use of temporary bracing for any new or existing construction. Specify type, location, and duration of any such bracing
- m. Indication of all bottom and top elevations of walls
- n. Indication of beam pockets, pipe chases and dowels
- o. General foundation notes and details provided separately from superstructure notes and details
- p. Specification of fill requirements as well as compaction requirements
- q. Finalize and submit any remaining documentation to utility/agencies and obtain any outstanding approvals. Clearly show by notes, details, etc., any modification to the work as a result of the requirements of Con Edison, National Grid, Transit Authority, Department of Environmental Protection, Department of Transportation, etc.

5. Superstructure

- a. Floor plans indicating all openings, depressions, slopes, differences in elevation and thickness, and special reinforcing or bracing
- b. Sufficient sections and details to clearly show the work
- c. Elevations of slab and top of steel, as well as slab thickness, indicated on each plan
- d. Existing concrete or steel members of superstructure -checked and reinforced for additional loads from alterations and extension of superstructures
- e. Special stiffeners, plates, and connections for structural steel beams and columns and special reinforcement not covered in schedules of concrete beams and columns - indicated on details and sections
- f. Design of all structural steel framing and associated connections by a licensed structural engineer registered in the State of New York, including all splices, special connections which carry moments and have unusual geometry
- g. Standard shear connections may be detailed by the steel fabricator; The Structural Engineer of Record shall clearly identify, in the Construction Documents, the maximum load required to be carried by each connection. The steel fabricator shall be required to define the basis for the connection by standard connection tables or to provide structural calculations if the fabricator should choose to use custom designed connections. The Structural Engineer of Record shall review and approve all connections provided on the shop drawings by the fabricator and shall be responsible for their structural correctness.

- 6. Design Calculations** – It is required that all structural members as well as the stability of the overall structure be clearly presented in design calculations. Submit calculations for all structural systems including structural steel, cast-in-place concrete, pre-cast concrete, and foundations.

7. Division 3 Concrete Specification

- a. Cast-in Place Concrete** – The Concrete specifications shall include, but not necessarily be limited to:
- Concrete, form work, and reinforcing materials
 - Types and strengths of Concrete
 - Quality Control and testing requirements
 - Shop drawing requirements
 - Concrete placement and curing requirements
 - Surface finish and repair requirements.
- b. Precast Concrete** - In addition to the items in (a) above, precast concrete shall include but not necessarily limited to:
- Providing additional rebars for erection stresses
 - Sample Panels
 - Standard for acceptance and replacement of panels
 - Design loading, prestressing, and post-stressing requirements
 - Connection details and requirements.
- c. Concrete Planks** - In addition to the items in and b above, concrete planks shall include but not necessarily limited to:
- Design loading and prestressing requirements
 - Manufacturers' and National Standards
 - At a minimum list 3 acceptable manufacturers.

8. Division 5 - Metals Specifications

- a. Structural Steel** - This shall include, but not necessarily limited to:
- Description of Structural Steel materials, certifications, strength, work included
 - Description and strength requirements of connections - welding, bolting, etc.
 - Description of painting and touch-up
 - Description of erection procedures, fabrication, tolerances
 - Survey and alignment requirements
 - Special Inspection requirements
- b. Steel Joists & Metal Decking** - This shall include, but not necessarily limited to:
- Description of materials, certification, work to be included. Indicate type of deck (form deck, composite deck etc.) and type of steel joist
 - Design requirements, attachment, openings, bracing, hanging devices with minimum thickness and section of modulus steel deck
 - Erection procedures, closures, temporary shoring. Description
 - Painting, touch up description
 - End support details
 - Welding requirements for support of deck and diaphragm requirements for deck
 - At a minimum, indicate 3 acceptable manufacturers for each product.

- c. Protective Coatings, as specified below, are minimums. The Consultant shall determine whether additional coatings are required, and the types of coatings necessary to suit the conditions of a particular project.
- Structural steel not encased in concrete, but in water-tight buildings not subject to condensation or high humidity conditions - one shop coat and one field touch-up coat on abraded surfaces after erection
 - Structural steel not encased in concrete, but subject to condensation or high humidity - one shop coat, one field touch-up coat on abraded surfaces after erection, and one final complete field coat
 - Structural steel exposed to weather, marine atmospheres, or other high humidity conditions - one shop coat, one field touch-up coat on abraded surfaces after erection, and one final complete field coat. The type of coating for continuous high humidity conditions or other special conditions shall be evaluated by the Consultant.
 - Structural steel below ground water level, subject to corrosive agents or atmospheres, and members not encased in concrete which are closer than 8" to the outside face of masonry walls - protective coatings as specified by the Consultant. (Consider hot-dipped galvanized and special high build corrosion resistant paint)
 - Steel decking, ladders, grating, hand rail and posts - galvanized.

9. Division 35 Earthwork Specification

- a. Earthwork - This shall include, but not necessarily be limited to:
- Excavation
 - Soil/Rock Bearing Capacity.
 - Description of Acceptable Fill Material
 - Compaction Standards
 - Description of Shoring, Sheet piling, Underpinning
 - Dewater requirements
 - Description of procedure for encountered subsurface utilities
 - Inspection and testing requirements.
- b. Piles - Specification reviewed by a soils consultant. Piling shall include but not necessarily limited to:
- Description of Boring Stratum and Pile Embedment
 - Description of Pile(s)
 - Description of Pile Driving criteria with estimated Pile-Tip elevations and Pile lengths
 - Instructions for obstructions to Pile Driving
 - Description of Pile load test, Test Piles, Special Inspection
 - Pile redesign requirements, costs.
- c. Site Improvements - including, but not necessarily limited to:
- Pavement, concrete curbs and roadwork construction in compliance with NYS Department of Transportation (DOT) applicable standards.

F. FINAL MECHANICAL/HVAC DRAWINGS & SPECIFICATIONS

1. **General:** The final HVAC drawings and specifications shall incorporate all the design decisions made during the Design Development stage. Any deviation from prior decisions shall be clearly defined.

2. The **Final submission** of the **HVAC construction documents** shall include, but not be limited to:

- a. Floor layouts in $1/8" = 1' - 0"$ scale or larger
- b. Equipment Room Layouts in $1/4" = 1' - 0"$ scale or larger
- c. Flow diagrams
- d. Control diagrams
- e. Riser diagrams
- f. Details
- g. Equipment schedules with ratings
- h. Engineering calculations, including ventilation index with design and actual cfm
- i. Specifications
- j. Estimate of cost.

3. **Drawings – General**

- a. Floor layouts indicating all equipment piping, ductwork and accessories
- b. Ductwork in double line, except for small size ducts, which may be indicated by single lines where space conditions are not critical
- c. Ductwork designed in accordance with the recommendations of the latest edition of the A.S.H.R.A.E. Guide and Data Book
- d. Sections demonstrating that space problems are solved, headroom is maintained, and sufficient access for maintenance provided
- e. In critical locations, composite drawings indicating equipment of all trades involved
- f. Coordination of openings on exterior walls, interior partitions, doors, and roofs for fans, louvers, ducts, grilles, registers, etc.

4. **Ductwork – Ductwork shall include at a minimum:**

- a. All volume dampers for balancing purposes
- b. Fire dampers and smoke dampers as required by code
- c. Automatic dampers, maximum and minimum dampers, return air dampers sized and with indication of flow quantities
- d. Damper sizing to insure proportionate control of airflow
- e. All ceiling diffusers, registers, grilles, etc. properly selected and sized, indicating cfm quantities
- f. All VAV boxes and location of thermostats controlling them
- g. A coordinated reflected ceiling plan for all spaces showing all ceiling diffusers, registers, access panels, lighting fixtures, etc.
- h. Shaft layouts in plan and elevation
- i. Access doors and cleanouts for breechings, ducts, shafts, housings of centrifugal fans, access doors at each heating and cooling coil, fire dampers, automatic dampers, etc.
- j. Approved type openings for taking Pitot tube readings, preferably located at discharge side of dampers
- k. Detail of sheetmetal plenums including weatherstripping of doors
- l. Special ductwork material for corrosive conditions, thermal and noise insulation.

5. **Piping:**

- a. Layout shall include at a minimum:
 - All pipe runs indicating size, direction of flow and pitch,
 - Trenches, pits, etc.

- All anchors, guides, supports
 - Expansion joints and loops
 - Accessories
 - Openings in foundation walls, and floors properly sized and located.
- b. All areas shall have the same orientations and shall be properly identified. This shall include:
- North arrow
 - Room titles and room numbers
 - Coordinates (column line designations)
 - Cross references
- 6. Equipment Rooms** – Equipment room layouts shall include, but not be limited to:
- a. All equipment with sufficient detail and indicating:
 - All clearances for maintenance work, such as pulling or cleaning of tubes
 - Clearances for transportation and replacement of equipment
 - Pit or drop in boiler room floor if required for the boiler.
 - b. Foundations and supports for equipment such as boilers, stacks, pumps, tanks, chillers, cooling towers etc.
 - c. Ductwork
 - d. Piping - Pipes 3" to 8" in diameter and larger in congested areas and MERs and all pipes above 8" in diameter in all areas shown by double lines. Pipe fittings and valves. shown to scale and in the correct position
 - e. Ventilation of refrigeration machine rooms, boiler room, and mechanical equipment rooms. Ventilation plenum space above boiler room to prevent overheating of space above. Supply air for boiler combustion
 - f. Flue breaching layout
 - g. Access platforms for service and maintenance of major equipment.
- 7. Flow Diagram** – Flow diagrams shall show all substantial components of the system, such as dampers, coils, valves, strainers, drain and vent valves, expansion tanks, thermometers, gauges, etc. They shall show also flow quantities, temperatures, pressures to be maintained. Flow diagram shall include, but not be limited to the following systems:
- a. High, low and medium pressure steam
 - b. Condensate return
 - c. Chilled water systems (Primary and secondary)
 - d. Condenser water system
 - e. Hot water heating (Low, medium and high temperature, supply and return)
 - f. Refrigerant
 - g. All air conditioning, ventilation and exhaust air systems
 - h. Fuel oil distribution and storage systems
 - i. Gasoline storage and dispensing systems
 - j. Flue gas systems.
- 8. Control Diagram**, with all components of the systems including piping and wiring, shall be shown for all systems requiring automatic controls, including, but not limited to:
- a. Boilers and burners
 - b. Refrigeration machines and systems.
 - c. All water heating and cooling systems and condenser water pumps

- d. All steam heating systems
 - e. All air conditioning, ventilation and exhaust systems
 - f. Electric motor controls and interlocks
 - g. Smoke detectors systems.
9. **Riser Diagrams**, with all sizes, valves, drains, vents, dampers, etc. shall include, but not be limited to:
- a. Heating and cooling risers to radiators, induction units, unit ventilators, fan coil units, etc.
 - b. Condenser water supply and return
 - c. Condensation drain risers
 - d. Duct risers
 - e. Risers shall show all valves, drains, vents, dampers, etc.
10. **Details** shall include, but not be limited to the following:
- a. Connections to cooling and heating coils
 - b. Connection to boiler and burners
 - c. Connection to refrigeration machines
 - d. Connection to heat exchangers and water heaters
 - e. Connection to pressure reducing valves
 - f. Connection to safety valves
 - g. Connection to traps (high and low pressure)
 - h. Connection to pumps
 - i. Connection to unit heaters, unit ventilators, fan coil units, induction units, radiators and convectors
 - j. Connections to fuel oil tanks
 - k. Connection to expansion and makeup water tanks
 - l. Connection to condensate and boiler feed pumps
 - m. Pipe anchors, guides, hangers and supports. Seismic anchors and supports shall be provided where applicable. For high pressure/temperature service, Consultant shall perform a stress analysis on final layout indicating loads on equipment nozzles, hangers and anchors and supports.
 - n. Pipe sleeves and penetrations through walls and chases
 - o. Pipe conduits
 - p. Air venting detail
 - q. Thermostat locations and number of zones
 - r. Flush tanks and flash legs
 - s. Humidifiers
 - t. Perimeter radiation unit detail including insulation behind units
 - u. Fire damper
 - v. Roof fan detail including curb, electric conduit through roof
 - w. Method of flashing of equipment and piping
 - x. Roof air discharge elbow
 - y. Roof supported equipment, including penetrations, support structure, flashing and waterproofing
 - z. Ducts, including dampers, transition sections, outlets, VAV boxes PIM's, thermostats, flexible connections and hangers
 - aa. Equipment Schedules – with list of all equipment specified and all performance data for starters, push button stations, pilot lights, disconnect switches, break glass switches, interlocks etc.
 - bb. Details indicating means of eliminating vibration and noise

- cc. Details shall indicate all accessories, such as valves, strainers, controls, flanged or union connections, thermometers, gauges, vents and all other items required for the application.

11. Equipment Schedules – Equipment schedules shall be prepared for all equipment specified, regardless whether one or more pieces of the particular item are needed. All data determining the performance of the equipment shall be indicated on the schedules. For motor driven equipment the data shall include starters, push button stations, pilot lights, disconnect switches, break glass switches, interlocks, etc.

12. Engineering Calculations -- Engineering calculations shall include, but shall not be limited to the following:

a. Design criteria for all systems.

- Updated load calculations if any changes from prior submissions
- Specific calculations for special situations, such as animal quarters, art facility, kitchen, laundry, business machines, computers, laboratories, constant temperature rooms, unusual hours of operation, temporary heat, and special sound level requirements, clearly indicating design criteria.

b. Method used for establishing sizes of:

- Steam lines of different pressures
- Condensate return lines
- Hot and chilled water lines
- Condenser water lines
- Other pipelines
- Ductwork.

c. Thermal stress calculations for heat and chilled water distribution systems. Calculate anchor, guide and support forces. Show how they are resisted. Provide loads to structural engineer for incorporation into building structure where applicable. These calculations shall be performed by the Consultant or his mechanical engineering subconsultant.

13. Final Mechanical/HVAC Specifications – Division 23

a. The final submission of Specifications shall be comprehensive, fully describing the work, and organized using the latest format from the Construction Specifications Institute (CSI)

b. The Consultant shall verify that the Specifications include the following:

- List of codes (local, state and federal) for Contractor compliance
- List of certificates of inspection and approvals required by the authorities having jurisdiction
- Temporary heating provisions if required
- For any list of acceptable manufacturers, a minimum of three is required.

c. The Specifications will be written in a manner to avoid jurisdictional disputes. Note the following:

- Electric motor starters, disconnect switches -- specified to be supplied by the heating and air conditioning subcontractor and installed by the electric subcontractor
- Wiring to the starters and motors, interlocks, wiring to local and remote push buttons and pilot lights, to hand-off-automatic switches -- specified in Division 23

- If exceptions are made and control wiring is specified under Division 26 (i.e., for unit heaters, etc.), the particular control wiring diagram shall be indicated on the electrical drawings.

G. FINAL ELECTRICAL DRAWINGS AND SPECIFICATIONS

1. General

- a. Final design drawings shall be developed so that the work is well defined and that all components are sufficiently detailed. The electrical work shall be coordinated with the work of all other trades. The final drawings and specifications shall incorporate all the design decisions made during the previous design phases.
- b. Construction Documents shall be checked for technical errors and coordination with other trades.
 - The Consultant shall verify all field conditions to confirm that no interference with other trades or physical impediments will require redesign and contractor's change orders. The Consultant is liable for field change orders resulting from verifiable pre-existing conditions that were not properly investigated.
 - Verify that there is no overhead piping above electrical equipment such as switchgear and transformers.
 - Verify continuity between floor plans and riser diagrams.
 - Electrical switchboard rooms and mechanical equipment rooms shall be adequately sized to permit required maintenance in addition to code required clearances and fire rating.
 - Spaces adjacent to service transformers shall not be regularly occupied or used for sensitive equipment if EMF measures above 150 milligauss.
- c. Review project for hazardous locations and provide proper design.
- d. Emergency lighting circuits shall be independent of other wiring. Local Law 16 egress lighting shall be provided.
- e. Check for discrepancies between the specifications and the drawings.
- f. Check for compliance with the College program requirements for the project.

2. Final Electrical Drawings shall include, but not necessarily be limited to the following:

a. Plans, Elevations and Details:

- **Demolition** Plans and Details
- **Site** Drawings including Plans, Elevations and Details of utilities such as primary service, secondary service, telephone, exterior fire alarm, etc., including underground ductwork and showing all elements such as transformer vaults, manholes, pull boxes, poles, vaults, etc.
- **Grounding and lightning protection** plans and details
- **Power Distribution** Floor Plans with service runs and major equipment
- **Lighting layout drawings indicating types of lighting fixture with all necessary circuiting** required and switching, dimming, time switch control, etc.
- **Cable and conduit** routing drawings
- **Communications, fire alarm, security, clock, CCTV, public address, and other special** systems drawings, details, wiring and other diagrams
- **Telecommunications** plans, details, equipment cable trays, etc.
- **Electrical equipment** locations and connections, including switchboards, panels, motor control centers, motors, receptacles, fixtures, clocks, fire alarm stations, gongs,

bells speakers, horns, strobes, demarcation boxes for remote monitoring of meter pulses for all new utility meters, and all other electrical equipment required for the project. Final connections to all electrical equipment may be shown on the drawings by riser diagrams, by individual circuiting, by schedules or any combination thereof.

- **Control wiring**, required under the electrical contract, one-line diagram or schematic wiring diagrams and all control elements clearly indicated and located on the electrical drawings so as to fully show the extent of the work to be done by the electrical contractor.

b. Schedules:

- **Electrical distribution** equipment schedule showing sizes, bus capacity, fuses, trip settings, ratings, phases, voltages, etc.
- **Lighting fixture** schedule indicating types, number of lamps, supports and manufacturers catalog number complete with a description of the fixture and any special mounting details required. Drawings of fixtures of special nature for which no applicable catalog numbers are available shall be included. Specify electronic ballasts with total harmonic distortion 10% or less. Minimize number of different lamp types.
- **Motor control centers** and substations with applicable equipment schedules
- **Electrical symbol** list per IEEE /ANSI standard. Show all electrical equipment and work provided, including all electrical equipment which power and/or control connections are required by mechanical and architectural equipment. Symbol list shall be customized to this project.
- **Cable and conduit routing schedules** for all feeders indicating size of conductors, number of conductors, capacity of feeder, raceway size, connected load of feeder and voltage drop
- **Calculations** showing the coordination between all major electrical equipment and the short circuit calculation at each major point in the distribution system.

c. Riser diagrams, indicating all cable and conduit interconnections, including size and type of raceways; size, type and number of conductors; and all major elements for the following systems:

- Light and power riser diagrams from the utility source to all equipment showing service switches, metering, switchboards, power and lighting panels, motor control centers, etc.
- Electric power distribution. (riser and one-line diagrams)
- Telecommunications – telephone and data
- Interior fire alarm including interconnections required by NFPA code
- Exterior fire alarm with connections required by NFPA code
- Clock and program
- Public Address/Sound
- Security/ Closed circuit TV
- Exit, stair and emergency light and power.
- Temporary light and power including site security lighting required and for sidewalk bridges
- All special systems required under College program, LAN Network, etc.

3. Final Electrical Specifications, Division 26, shall include, but not necessarily be limited to the following:

- a.** Full description of the work, using the most recent CSI format

- b. A list of applicable codes (local, state and federal) and a list of certificates of inspection and approval required by the authorities having jurisdiction
 - c. A list of all items of work and equipment to be furnished by other contractors or the College which require the Contractor to provide permanent power connections and/or control wiring
 - d. Temporary Electrical requirements
 - e. Any list of acceptable manufacturers indicated shall include a minimum of three manufacturers for each item listed
 - f. Equipment spare parts requirement of 10 per cent
 - g. Performance and documentation of final acceptance test (if required)
 - h. Submission requirement of digital copy of programming with passcode for fire alarm systems, security systems, etc.
- 4. Special Considerations for Preparation of Final Electrical Construction Documents**
Additional Checklist includes and is not limited to:
- a. Provisions for future requirements
 - b. Anticipated hours of operation: areas requiring unusual hours of operation.
 - c. Other special areas requiring mechanical services such as kitchens, laundry, computer areas, etc., as indicated in college program.
 - d. Power
 - To be provided direct from utility company or be sub-fed from a building?
 - Service requirements of utility company primary or secondary service furnished? Overhead or underground? Current characteristics: voltage, CPS, delta or star system, grounded or ungrounded available KVA capacity?
 - Underfloor ducts, spacing
 - Transformer vault, size
 - Spare conduit for underground ductbank
 - e. Lighting
 - Lighting intensity for various spaces in compliance with IES (Illuminating Engineering Society) design criteria and ASHRAE 90.1
 - Type of acceptable lighting may vary for different locations/functions
 - Emergency light or power desired other than required by code
 - Special requirements for kitchen, laboratories, laundry, business machines, others
 - Provisions for future equipment
 - Site lighting and floodlighting
 - Refer to Appendices M and N.
 - f. Communications
 - Special telephone requirements
 - Emergency telephone system
 - Television and/or radio; closed circuit television and multimedia centers
 - Other special communications systems.
 - g. Electrical Service
 - Service entrance: transformer vault, meter room switchboard location, service entry support
 - Panels: location
 - h. Switches: confirm space and location requirements and check for revised door swings and space at door jambs.

- i. Outlets: location; schedule of heights on drawings; dimensions of ceiling outlets. Check wall outlets against baseboard heating locations.
 - j. Various miscellaneous systems required
 - k. Exit lighting adequacy and conformance with NYC Buildings Department requirements; Check architectural drawings.
 - l. Power circuits
 - m. Special lighting such as stage lighting meets program yet not overly sophisticated
 - n. Flashing and waterproofing for electrical penetrations through roof and exterior walls
 - o. Fire rated walls and firestopping
 - p. Wall thickness for panel boxes (coordinate with architectural drawings)
 - q. Electrical equipment interferences with structural and mechanical
 - r. Location of fire gongs/horns/speakers for adequacy of sound coverage.
5. Design Criteria: Refer to the Electrical Design Criteria in Appendix F

H. FINAL PLUMBING AND FIRE PROTECTION DRAWINGS & SPECIFICATIONS

1. **General:** The final design drawings and specifications for plumbing and fire protection shall incorporate all the design decisions made during prior design phases. It is the Consultant's responsibility to clearly identify and inform DDCM/CUCF of any deviations from prior decisions. The drawings and specifications shall include but not be limited to the items that follow.
2. **Site Plan**, based on the topographical map, and including the following:
 - a. All city-service lines available for the particular building
 - b. Cold water connections to city services for domestic and fire protection purposes, lawn sprinkler system, etc.; check for adequate pressure; determine location of backflow prevention devices in compliance with NYC Building Code
 - c. Sanitary sewer connections to city services
 - d. Storm sewer and site drain connections
 - e. Gas connections to utility lines and pressure reducing station and support details for pressure reducing station
 - f. All pipe sizes, invert and top elevations, catch and road basins, manholes, all pertinent valving, dry well, if any, etc.
3. **Floor plans** at 1/8" = 1'-0" or larger including:
 - a. Location of equipment, fixtures, piping systems layouts, with all valves, valve tags and other accessories.
 - b. Same orientation and north arrow
 - c. Room titles and room numbers
 - d. Coordinates (Column lines).
4. **Equipment room layouts** at 1/4" = 1'-0" or larger indicating heaters, pumps, tanks, water treatment, piping, apparatus, etc.
 - a. Show all equipment with sufficient detail and Indicate all clearances for maintenance work, such as pulling of tubes and access to valves, and all clearances for the transportation and replacement of large size equipment.
 - b. Coordinate with architectural and structural drawings for sleeve locations concrete support pads, supports for equipment, heavy piping, water tanks, etc.; flashing for piping through roofs.

- c. Show the following with double lines: all piping connections, pipes 3" to 8" in diameter in congested areas and MERs, and all pipes above 8" in diameter in all areas. Show pipe fittings and valves to scale and in the correct positions where piping is indicated by double lines. Valve arrangements shall be adequate for operation and maintenance.
- 5. Enlarged Plans and Details** of kitchens, laundries, toilet rooms, shower rooms laboratories, janitors' closets, shall indicate complete piping layouts, accessories, all necessary access doors to valves and shock absorbers, and necessary clearances for accessibility and maintenance.
- 6. Riser diagrams** shall include but shall not be limited to:
- a. Domestic cold water and hot water systems
 - b. Fire standpipe system and sprinkler system and other special fire protection systems (dry pipe sprinkler systems and clean agent fire suppression systems for computer rooms, data facilities, etc.)
 - c. Sanitary and Storm drainage system. Indicate fixture units and square foot areas drained
 - d. Natural gas system
 - e. Acid water system
 - f. Drinking water system, if required
 - g. Air and vacuum systems, etc.
 - h. Piping sizes, valves, major equipment, and fixture unit notations
 - i. Room designations
 - j. Floor levels.
- 7. Piping Drawings:** with piping and equipment details, connections, pipe sizes, valves, strainers, thermometers, gauges, and for all other accessories, including, but not be limited to:
- a. Water meter assembly
 - b. Gas meter assembly and regulator assembly if needed; check gas pressure requirements
 - c. Domestic hot water generator and connections
 - d. Domestic water and fire protection house tanks and connections
 - e. Pneumatic tank and connections
 - f. Kitchen and laundry equipment connections
 - g. Display fountain detail and connections
 - h. Laboratory equipment details and connections
 - i. Pump details and connections
 - j. Backflow prevention valve assemblies
 - k. Catch basin, road basin and manholes
 - l. Diagrams and details shall show equipment with all connections, pipe sizes, accessories, valves, strainers, thermometers, gauges, etc.
 - m. Fire protection sprinkler and standpipe systems - fire extinguishers
 - n. Central drinking water system - individual coolers or drinking fountains
 - o. Swimming pool systems - supply, drainage, filtration
 - p. Other Details as required, including support and penetration details
- 8. Final Plumbing and Fire Protection Specifications:**
- a. All work described in specifications in prior design phases shall be fully described in the final submission.
 - b. Specifications shall include a list of codes (local, state, and federal), to which the plumbing Contractor shall comply when executing the project.

- c. Coordinate with electrical specifications for the following:
 - Starters for electric motors, disconnect switches, etc., shall be specified to be supplied under Division 15 and installed under Division 16.
 - Wiring to starters and motors, interlocks, wiring to the remote push button stations and pilot lights shall be specified in Division 16.
 - Control wiring for the equipment specified under plumbing including: wiring to alarms, level controllers, etc., shall be specified in the plumbing specification.
- d. Toilets shall be provided on each floor, suitable for the use of persons with disabilities.
- e. List a minimum of three approved manufacturers for every item. Indicate that contractor shall be permitted to supply the product of any of the manufacturers listed, and that other products must be specifically approved by DDCM.
- f. Provide metering of services to allocate costs to concessionaires and to allow proper records to be kept for the operation of the facility.

I. DATA, COMMUNICATIONS, BUILDING MANAGEMENT AND SECURITY SYSTEMS DOCUMENTS

1. Some projects will require the preparation of contract documents for other disciplines, including, but not limited to: data, communications, building management and security systems.
2. The Consultant shall ensure that the documents for each discipline are complete, follow best practices, are fully coordinated and allow for comprehensive bidding by contractors.

J. BID DOCUMENTS

1. Upon CUCF's written approval of the final Contract Documents, either the Consultant or the Construction Manager will assemble bid packages, in accordance with the Contracts, CUCF's Procurement requirements and DDCM's direction.
2. The Bid Documents typically comprise the drawings and the project manual that contains the CUCF "boiler plate" items and the specifications.
3. Every final drawing shall include the identification, professional seal and signature of the Consultant and all sub-consultants responsible for work thereon and shall be in conformance with the New York City Administrative Code.
4. Project Manual Typical Components: may include, but are not limited to:
 - a. Advertisement for Bid.
 - b. Bid Form & Sheets
 - c. Information for Bidders
 - d. Form of Bid Bond
 - e. Form of Performance and Payment Bonds.
 - f. Contract Agreement
 - g. Schedule - Contractor's Monthly Requisition Form
 - h. General Conditions.
 - i. Additional Supplemental General Conditions (where federal funds will be used.)
 - j. Specifications
 - k. Equal Employment Opportunity, Minority and Women-Owned Business Enterprises, and Service Service-Disabled Veteran-Owned Businesses clauses.
 - l. NYC/NYS Prevailing Wage Rates

m. Alternates.

- 5.** DDCM/CUCF will not accept the Bid Documents submission if the Consultant has not provided all required documentation indicating approval from the Department of Buildings and all other regulatory agencies having jurisdiction, which is a requirement for the prior Final Documents submission.
- 6.** In addition to the submission of the original signed documents, the Consultant shall also provide an electronic submission, in a format approved by DDCM/CUCF, of all the Bid Documents.

APPENDIX A

COST ESTIMATING

A. GENERAL

1. The Consultant will prepare Cost Estimates for each phase of design as specified in the Contract and include an estimate with each set of documents (drawings, specifications, reports, etc.) submitted to DDCM/CUCF for review and comment.
2. Accurate estimates are essential to the success of a project, and, during design, they are a key resource in making decisions to help keep a project within budget.
3. After bids are received, the Consultant will compare his/her estimate to the low bidders' trade payment breakdown for evaluation of the bids.

B. COST ESTIMATE FORMAT/ORGANIZATION

1. Follow the latest CSI (Construction Specifications Institute) categories.
 - a. For Feasibility and Pre-Schematic Design, use major CSI categories and include estimates based on measurement of physical characteristics: area, volume and complexity of massing. Include costs of various systems (mechanical, electrical, etc.)
 - b. For subsequent design phases, itemize elements using the current CSI format and delineate material and labor quantities, unit costs and total costs for each item.
2. Refer to the sample cost estimate spreadsheet. If there are recommended project-specific adjustments, submit a modified spreadsheet for DDCM/CUCF approval prior to performing estimate.
3. When there is more than one bid package, organize the estimate to reflect this and provide the itemized and total costs per bid package.

C. COMPONENTS OF THE COST ESTIMATE

1. Itemized elements by CSI category
2. Design contingency
3. Bid contingency
4. Contractor's overhead and profit
5. Inspection and testing costs
6. Escalation to the midpoint of construction
7. Construction contingency
8. General Conditions.

D. ADDITIONAL INFORMATION INCLUDED WITH THE COST ESTIMATE

1. A comparison to the previous estimate and the project budget
2. The assumed bid date
3. The assumed duration of construction
4. Cost per square foot.



COST ESTIMATE SAMPLE FORM

PROJECT TITLE: _____ CAMPUS: _____ PROJECT NO: _____ DATE OF ESTIMATE: _____

CONSULTANT: _____ ESTIMATOR: _____ CONSTRUCTION START/END DATES: _____

DESIGN PHASE: Pre-schematic ___ Schematic ___ Design Development ___ 60% Construction Documents ___ Final Construction Documents ___

CSI Number	Description	Quantity	Unit	Unit Cost of Material	Total Cost of Material	Unit Cost of Labor	Total Cost of Labor	Total Cost: Materials and Labor
	SUBTOTAL							
	General Conditions							
	Overhead /Profit							
	Design Contingency*							
	Bid Contingency							
	Construction Contingency							
	Escalation – midpoint of Construction							
	TOTAL							
	*Not used in final estimate							

APPENDIX B

SUBMISSION STANDARDS

A. GENERAL

1. Appendix B outlines some general standards applicable for all phases of design. Included are some requirements for drawings, specifications, presentations, electronic submissions and schedules and a list of industry sources for various trade standards.
2. For specific requirements for a particular design phase, reference the phase-specific chapters in the main text of these Guidelines.
3. For project-specific requirements, reference the Contract.
4. For estimating requirements, reference Appendix A in these Guidelines.

B. DRAWINGS FORMAT

1. **Drawings Organization:** Follow industry best practices in the organization of the drawings, ensure consistency of orientation, full dimensioning, and clear cross referencing, and fully delineate the work including providing all necessary details.
2. **Recommended Drawing Size:** 24" high x 36" wide (min size unless otherwise approved by DDCM and meets NYC DOB requirements).
3. **Cover sheet shall contain:**
 - a. Title of project, college and location; Project No.
 - b. The City University Construction Fund (with CUCF logo)
 - c. Index of all drawings
 - d. Abbreviations List
 - e. Small scale site plan indicating locations of the work with North arrow
 - f. One inch borders except at left side, provide 2 ½" border for screw/post binding only.
4. **Drawing Numbers:** Use drawing numbering system that is consistent with New York City Department of Buildings requirements.
5. **Title Box – In the same location on each drawing,** provide a suitable title box acceptable to DDCM/CUCF and complying with NYC DOB requirements showing:
 - a. Project title, college and location that is official address of the building(s)
 - b. Drawing Number
 - c. Drawing Title
 - d. Consultant's and Sub-Consultants' names & addresses
 - e. Space for seal
 - f. Project number
 - g. Scale
 - h. Date
 - i. Space for revisions, date and remarks
 - j. The City University Construction Fund (with CUCF Logo)
 - k. Designated space for NYC DOB employee stamps and signature, minimum 3"x3"
 - l. Designated space for NYC DOB Bscan sticker (application #), minimum 3" X 1"

6. Building Area and Volumes: Provide tabulations for each floor as follows:

Location	Area (Sq. Ft.)	Height (Feet)	Cube (Cu. Ft.)
Cellar			
1 st Floor			
2 nd Floor			
3 rd Floor			
Etc.			
TOTALS			

C. SPECIFICATION FORMAT

1. Provide Specifications in accordance with the latest format developed by the Construction Specifications Institute (CSI).
2. The Specification Submissions shall become increasingly detailed with each submission.
3. For each item specified, list at least three products/manufacturers “and or approved equal” unless the item is sole-source (requiring justification) or is on state-contract.

D. REVIEW OF DOCUMENT SUBMISSIONS

1. DDCM will review Consultant submissions of design documents and provide comments.
2. Other team members such as the Construction Manager, the Commissioning Authority and the College may also provide comments.
3. It is the Consultant’s responsibility to respond to all comments in writing within two weeks of receiving them. The Consultant will alert DDCM in writing of any conflicts in the comments, any deviations from previously accepted scope, and any cost implications.
4. DDCM will evaluate the Consultant responses to comments to determine if they are acceptable, resolve any conflicts or issues and provide direction prior to accepting any subsequent Consultant submission.
5. The Consultant is responsible for incorporating comments, as per DDCM’s direction, in the next submission and will make that submission only after any issues raised in prior comments have been satisfactorily resolved.

E. ELECTRONIC SUBMISSIONS

1. At each review phase, provide an electronic version of the full submission. At a minimum, this will include the drawings, specifications, estimate, and any design narrative.
2. Provide electronic submissions of the full bid documents including all addenda and the final as-built documents.
3. There may be additional electronic submissions (i.e., presentations) that are project-specific.
4. For major projects that will include Building Information Modeling (BIM), the requirements will be as per Contract.
5. Consult with DDCM for the latest DDCM/CUCF format requirements for electronic submissions.

F. SCHEDULES

1. The Consultant will develop a design schedule for all phases of design for DDCM/CUCF approval. It will include, but not be limited to, major milestones for submissions to and approvals from DDCM/CUCF and regulatory agencies.
2. It is the Consultant's responsibility to adhere to the design schedule. If circumstances arise that might cause a delay, the Consultant will alert DDCM/CUCF immediately and be proactive in resolving any issues with the goal of maintaining the overall schedule for the project.
3. The Consultant will also provide an outline Construction schedule that will be refined and expanded as the Design progresses.

G. PRESENTATION RENDERINGS AND MODELS

1. DDCM/CUCF may require that the Consultant provide renderings or models of a project. The requirements may be project specific.
2. Typical requirements for renderings are that they shall be matted, titled and framed in glass.
3. Typical requirements for models are that they shall be complete in scope, detail and color and be built at a scale approved by DDCM/CUCF. Each model shall be mounted on a base that allows for display and shall have a clear plastic shell cover that is suitable for visibility. The title of the model shall be within the shell.
4. If requested by DDCM/CUCF, the Consultant will provide glossy photographs of any renderings and models, suitable for reproduction, as well as an electronic submission of these.

H. INDUSTRY STANDARDS – The Consultant shall reference Industry Standards including, but not necessarily limited to those from the following entities:

- | | |
|-------------------------------------------------------------------------------|----------|
| 1. American Association of State Highway & Transportation Officials | (AASHTO) |
| 2. American Concrete Institute | (ACI) |
| 3. Americans with Disabilities Act | (ADA) |
| 4. American Institute of Steel Construction | (AISC) |
| 5. American Iron and Steel Institute | (AISI) |
| 6. Air Moving and Conditioning Association | (AMCA) |
| 7. American Society of Civil Engineers | (ASCE) |
| 8. American National Standards Institute | (ANSI) |
| 9. Air conditioning and Refrigeration Institute | (ARI) |
| 10. American Society of Heating, Refrigeration and Air Conditioning Engineers | (ASHRAE) |
| 11. American Society of Mechanical Engineers | (ASME) |
| 12. American Society of Testing Materials | (ASTM) |
| 13. American Wood Preservers Institute | (AWPI) |
| 14. American Welding Society | (AWS) |
| 15. American Water Works Association | (AWWA) |

16.	Architectural Woodwork Institute	(AWI)
17.	Concrete Reinforcement Steel Institute	(CRSI)
18.	Concrete Reinforcing Steel Institute	(CRSI)
19.	Construction Specifications Institute	(CSI)
20.	Heat Exchange Institute	(HEI)
21.	Hydraulic Institute	(HI)
22.	Institute of Electrical and Electronic Engineers	(IEEE)
23.	Illuminating Engineering Society of North America	(IES)
24.	Laboratory Products Association	(LPA)
25.	Metal Building Manufacturers' Association	(MBMA)
26.	National Electrical Code	(NEC)
27.	National Electrical Manufacturers Association	(NEMA)
28.	National Electrical Safety Code	(NESC)
29.	National Fire Protection Association	(NFPA)
30.	New York State Department of Transportation	(NYS-DOT)
31.	Occupational Safety and Health Act, 1970 and as Amended	(OSHA)
32.	Portland Cement Association	(PCA)
33.	Precast Concrete Institute	(PCI)
34.	Steel Deck Institute	(SDI)
35.	Steel Joist Institute	(SJI)
36.	Sheet Metal and Air Conditioning Contractors' National Association	(SMACNA)
37.	Steel Structures Painting Manual	(SSPC)
38.	Tubular Exchanger Manufacturers Association, Inc.	(TEMA)
39.	Thermal Insulation Manufacturers Association	(TIMA)
40.	Underwriters Laboratory Inc.	(UL)

APPENDIX C

INTERDISCIPLINARY COORDINATION REVIEWS

A. GENERAL

DDCM/CUCF requires that, in addition to all other checking and quality controls established, the Consultant performs interdisciplinary reviews on all projects. This is not intended to be a technical review. Single disciplinary reviews are also essential for assuring technical accuracy. Approximately 50% of all construction change orders are due to interdisciplinary errors that could have been avoided. A major source of design errors and omissions is the point of interface between disciplines.

B. TYPICAL EXAMPLES OF INTERDISCIPLINARY COORDINATION ERRORS

1. Civil drawings with site plans that have underground utilities such as water, sewer, or storm lines interfering with locations of electrical substations, power poles, underground conduit, duct banks, storage tanks, or new structures.
2. Landscape drawings with new trees in the same locations as sewer manholes and sewer lines, or in the middle of drainage swales shown on civil drawings.
3. Structural drawings with column locations and grid lines that vary from architectural locations.
4. Architectural floor plans that do not match other discipline floor plans.
5. Plumbing drawings with riser diagrams that do not match plumbing fixtures on architectural floor plans.
6. Mechanical drawings that read “see structural or architectural drawings for additional equipment supports on the roof” while the referenced drawings do not indicate such supports.
7. Electrical drawings that indicate items of equipment having different horsepower ratings, voltages, and phases than indicated on mechanical drawings and/or specifications.
8. Specification sections that refer to other sections that do not exist or that say to install something “as indicated” when there is no indication of the item on the contract drawings.

C. ERRORS ARE COMPLICATED BY SEQUENCE OF CONSTRUCTION

1. A typical construction contractor will typically work from civil drawings first, structural drawings second, plumbing drawings third, electrical and mechanical drawings fourth and architectural drawings last.
2. If the architectural drawings indicate a men’s room with water closets in certain locations while the plumbing drawings indicate the water closets on other locations, chances are the plumbing service and drain lines will be located as per the plumbing drawings.

D. ADVANTAGES OF STARTING COORDINATION PROCESS EARLY

1. Interdisciplinary change orders greatly affect the on-time completion of construction projects.

2. Interdisciplinary checking should start early in the project. Coordination meetings dates should be established at the start of the project and take place throughout the project. Major coordination meetings should take place at 30% and 50% Construction Document stages with a full interdisciplinary review at substantial completion (95%).
3. An interdisciplinary checklist should be prepared prior to the start of coordination meetings. Each design team member should go over the portion of the checklist that pertains to his/her discipline. All disciplines should be present at the coordination meetings.
4. There is a great advantage to starting the coordination process early. When a coordination meeting is held at the completion of the 30% Construction Document stage, team members are about 85% willing to accept ideas/revisions of others and will readily change their work. If a coordination meeting is held later, such as the 50% completion stage, the willingness to change reduces to about 25% as every discipline has too much time invested in their documents to make changes. If the drafter finds an error, it can be corrected in one time unit. If the PM or QA coordinator finds the error, it can be corrected in ten time units. If the contractor finds the error, then one hundred time units will be expended to correct the error. And finally, if lawyers get involved it will take one thousand time units. The earlier in the design process that coordination discrepancies are located, the easier and less costly they are to solve.
5. All checklist items should be coordinated no later than the 50% Construction Document Stage. When coordination discrepancies are found, all disciplines that the solution may affect, must be notified. Working in this manner, each discipline should make the appropriate changes prior to the 95% Construction Document Phase.
6. During a final coordination review, the number of reviewers should be kept to a minimum. For most projects less than 10 million-dollar construction cost, the use of only one reviewer is ideal. The review should be performed by a person who has not worked on the contract documents.

INTERDISCIPLINARY CHECK LIST

A. CIVIL DRAWINGS

1. Verify that new underground utilities (power, telephone, water, sewer, gas, storm drainage, fuel lines, greasetraps and fuel tanks) have no interferences. Common discrepancies include power and telephone poles directly above storm sewer lines, electrical substations not coordinated with other disciplines, and landscape drawings indicating plants and trees directly above underground utilities such as electrical conduits, ductbanks, water and sewer lines.
2. Verify that existing power/telephone poles, pole guys, street signs, drainage inlets, valve boxes, manhole covers, etc., do not interfere with new driveways, sidewalks or other site improvements. In addition, check that existing utility lines, fences, and other obstruction to new construction are clearly identified so there is no confusion to what is existing and what is new construction. Check that existing utility lines to be preserved, maintained, abandoned in place, or removed following a particular construction phase are clearly indicated.
3. Verify that limits on construction, clearing, grading, sodding, grass and mulch are shown and are consistent in other disciplines. These limits should be consistent on all discipline site plans. Common discrepancies include site plans not taking into consideration underground utility connections to existing services that will increase the limits of construction.

4. Verify that fire hydrants and street light poles do not conflict with the above items. Common discrepancies are to have landscape drawings indicate plants and trees that interfere with the light poles or hydrants, and landscaping indicated to be planted in swales or drainage ditches.
5. Verify that profile sheets show other existing and new underground utilities to avoid conflicts. Identify utilities that cross each other on the civil plans, then check the profile sheets to ensure that utility crossings do not interfere with each other. Check that underground utilities are shown with respective elevations on the profile sheets so that conflicts can be identified. A common discrepancy is to have storm lines at the same elevation as another underground utility such as water, power, communication, or gas lines. Verify that existing utility locations are specifically noted as approximate, subject to field verification.
6. Verify that horizontal distances between drainage structures and manholes match scaled dimensions and stated dimensions on both plan and profile sheets.
7. Verify that building footprint and finished floor elevations match other disciplines. Verify finished floor elevations match other discipline floor plans. Check that the building footprint and other site improvements match other discipline site plans. Check that the finished grade slopes away from the building.

B. STRUCTURAL DRAWINGS

1. Verify that column grid lines on structural, architectural and other disciplines match. Check that the structural foundation plan matches the ground floor architectural plan and structural floor framing plans.
2. Verify that footings are within property lines.
3. Verify that structural and corresponding architectural floor plans show consistent edge of slab dimensions. Look for recesses and protrusions that don't match. Verify that depressed or raised slabs are indicated and match architectural. Locate depressed or raised slabs by checking the architectural finish schedule for floor materials such as quarry tile, ceramic tile, and raised computer access floors. Check structural floor plans against the drawings for all disciplines to see that the areas for floor depressions, raised slabs and all slab elevations match.
4. Verify that foundation piers are identified and sized on a schedule or plan. Locate foundation piers on structural plans and check that each pier is on a schedule. Piers are usually identified by a letter/number symbol such as "F-1". Look for symbol omissions and obvious typos. Check location of piers with those shown on the architectural drawings.
5. Verify that foundation beams are identified and sized on a schedule or plan. Locate beams on foundation plans and check that each beam is on a schedule. Foundation beams are usually identified by a letter/number symbol such as "B-1". Look for symbol omissions and obvious typos. Check location of beams with architectural drawings.
6. Check mechanical and electrical drawings for pipe and conduit penetrations. Verify that there are no penetrations through piers, footings or beams.
7. Verify that locations of roof framing plan column lines and columns match foundation plan column lines and columns.
8. Verify that structural perimeter roof line matches architectural roof plan. Make sure the structural framing plan is adjusted for unusual architectural features such as concealed gutters or skylights. Check if roof slopes on structural match architectural roof plan slopes.

9. Verify that columns, floor beams, and roof beams are listed in column and beam schedules. Locate each column and beam on plans and check for each on a schedule. Look for omissions and typos. Often a column or beam shown on a plan is inadvertently not listed on a schedule. Verify that all column and beam sizes are provided.
10. Verify that length and columns in column schedule matches the length shown in sections and elevations shown on plans. Check that schedule lengths match architectural and structural floor plans and sections.
11. Verify that sections are properly labeled. Check that section labels are complete, turned in the proper direction and refer to the proper sheet and section or detail number.
12. Verify that expansion joint locations match other disciplines. Overlay all discipline floor plans to check locations of expansion joints. Check that expansion joints are uninterrupted throughout the entire building including floor, interior and exterior walls, ceiling, and roof materials on other discipline drawings. Verify that architectural building elevations and mechanical and electrical drawings indicate and match locations of expansion joints.
13. Verify that dimensions match architectural and all other discipline drawings. Verify dimensions such as overall building dimensions and dimensions where concrete is indicated for structures such as elevator shafts. Concrete is so expensive to remove when in the wrong location that extra care should be taken to ensure that dimensions are coordinated with the architectural floor plans.
14. Verify that drawing notes do not conflict with specifications. Very often a structural engineer will list a large number of general notes at the beginning of the structural drawings. These notes indicate items such as the strength of concrete, the class of steel, and compaction requirements.
15. Verify that openings or penetrations for stairs, elevators, ducts, conduits, pits and chases match other disciplines. Check structural shear wall elevations for vertical openings against architectural and mechanical HVAC plans.
16. Verify that all structures, and pads required for support of mechanical and electrical equipment are shown on the structural drawings and coordinated with architectural drawings.

C. ARCHITECTURAL DRAWINGS

1. Verify that property line dimensions on survey and civil site plans match architectural. Match the survey and site plans with the architectural site plans to ensure that overall dimensions are the same.
2. Verify that the building is located behind setback lines. Location of setback lines on survey should be outside of the building as positioned on the civil or architectural site plans. Ensure that building location is clearly defined and coordinated with civil site plans.
3. Verify that overall building dimensions and locations of columns and bearing walls match structural. Verify that architectural overall building dimensions and elevator and stair core dimensions match structural. Make sure all columns, bearing wall and shear wall locations are identical on architectural and structural plans.
4. Verify that existing and new work is clearly identified on site plans. Existing and new work should be identified in legends and linework.
5. Verify that building elevations match floor plans. In particular, check roof lines, window and door openings, louver openings, exterior light fixtures, and expansion joints. Also match

architectural elevations with mechanical plans to verify location and size of wall louvers, and with electrical lighting plans to verify location and mounting height of exterior fixtures.

6. Verify that building sections match architectural elevations and plans of various other disciplines. Check roof lines, windows and door locations.
7. Verify that wall sections match architectural and structural building sections. Pay particular attention to top of slab elevations, width and depths of beams, and concrete slab thicknesses.
8. Verify size of openings for windows and doors. Verify that window glass types match specifications. Size of openings on the window and door schedule should match the architectural and structural floor plans. Make sure there is a shim space to allow for irregularities so the windows and doors will fit. Verify that structural bracing does not conflict with window or door openings. Check mechanical and electrical drawings for pipe and conduit crossing windows and doors.
9. Verify that expansion joints are continuous throughout the building. Check that expansion joints on architectural plans, sections, details, and elevations are uninterrupted throughout the entire building including floor, interior and exterior walls, ceiling and roof materials.
10. Verify that large scale partial floor plans match small scale floor plans.
11. Verify that reflected ceiling plans match architectural floor plans to ensure no variance with wall locations. Verify that location of electrical fixtures, sprinklers and mechanical registers/diffusers on electrical and mechanical plans doesn't contradict the location on reflected ceiling plans.
12. Verify that room finish schedule information matches plan and elevation information; including room numbers, names of rooms, finishes, and ceiling heights. Look for omissions and inconsistencies. First look at the schedule for obvious omissions by checking that all boxes are filled in. Second, look at the schedule for inconsistencies. For example, if all toilets have ceramic tile walls and floors and a gypsum board ceiling, and suddenly a toilet is in the schedule with carpeting and an acoustical tile ceiling, chances are that it is wrong. It is much easier to check similar rooms as a group than to check each individual room in sequence as on the schedule. For example, check all toilets at once, then all office spaces, all corridors, all mechanical rooms, etc. Third, compare the room finish schedule with the plan and elevation sheets to match room numbers, names of rooms, finishes, and ceiling heights, and to ensure that all rooms are on the schedule.
13. Verify that door schedule information matches plan, and elevation information; including sizes, types, labels, etc. Look for omissions and inconsistencies. Similar to the room finish example above, first look at the schedule for obvious omissions by checking that all boxes are filled in. Second, look for inconsistencies. For example, if all except one door along a certain corridor are fire rated there is probably an error. It is easier to check similar doors as a group than to check each individual door in the sequence on the schedule. For example, check aluminum storefront doors at once, then steel doors, then hollow core wood doors, then solid core doors, and then fire rated doors. Check mechanical HVAC floor plans to locate doors that need to be indicated on the door schedule as requiring louvers, or to be undercut. Third, compare the door schedule with plan and elevation sheets to make sure all doors are on the schedule. Fourth, verify hardware sets on schedule match specifications.
14. Verify that the location of fire rated walls matches the location of fire and/or smoke dampers on mechanical plans. The fire rated walls will usually appear on the architectural floor plans and/or reflected ceiling plans. Verify that the wall ratings have no gaps. Overlay the

architectural floor plans with the mechanical HVAC ductwork drawings. Verify that the mechanical drawings indicate fire and/or smoke dampers at the rated walls.

15. Verify that cabinets will fit in available space and that electrical outlets on cabinet walls are at the right height. Check cabinetry plan measurements against small scale architectural floor plans. Can the cabinets be brought into the rooms once the walls are in place? Due to slight variances in construction it is advisable for the plans and/or specifications to require the contractor to make field measurements before beginning cabinet fabrication. Check that electrical power drawings indicate outlets above cabinet counter tops.
16. Verify that the locations of flag poles, dumpster pads, generator pads, transformers, cooling towers, vaults, and landscaping have been coordinated with other discipline site plans. Look for conflicts between flag poles and underground utilities, and for landscaping conflicts such as trees that will interfere with above ground features such as parking lot lights or below ground utilities such as sewer lines.

D. MECHANICAL/PLUMBING DRAWINGS

1. Verify that plumbing floor plans match architectural floor plans. Look for wall location equipment and floor drain inconsistencies.
2. Verify that new gas, water, sewer, etc. lines connect to existing or new utilities on civil drawings. Compare civil site plans and plumbing floor plans to look for utilities line size discrepancies and inconsistent alignment connection point location. Plumbing plans typically connect with civil utilities five feet beyond the building perimeter. Verify invert elevations between plumbing and civil drawings.
3. Verify that plumbing fixtures match plumbing schedules and architectural locations. Most plumbing drawings have a fixture schedule that identifies each fixture such as a water closet, ADA accessible water closet, drinking fountain, etc. Verify fixture designations match fixture schedule and specifications.
4. Verify that roof drain locations and roof slopes match architectural roof plans to check that roof drain locations and roof slopes are identical. Check structural plans to see that roof drains are not directly on top of roof beams.
5. Verify that pipes are sized sensibly and that drains are connected and do not interfere with foundations. Pipe sizes should increase as additional lines join. Be concerned when a 6" pipe increases to 10" pipe and then decreases to an 8" pipe. When checking for foundation interference check the structural drawings for elevations of footings and compare with inverts indicated on plumbing drawings. Pay particular attention to roof drains next to columns and adjacent to a parapet and to plumbing lines crossing footings.
6. Verify that wall chases are provided on architectural drawings to conceal vertical piping. Whenever there are waste and vent lines there will probably be the need for a chase. Check that structural drawings do not indicate columns that will be inside chase walls where they will obstruct the installation of horizontal piping and vents. Check fire rating requirements of chase wall.
7. Verify that plumbing fixtures and vertical riser pipe sizes match riser diagrams. Check that fixtures are connected by comparing the plumbing floor plans with the plumbing riser diagrams.
8. Verify that HVAC floor plans match architectural. Verify that walls and door openings occur at the same locations.

9. Verify that sprinkler heads do not interfere with other ceiling items. In those areas to be protected by sprinklers, ensure that the sprinklers do not interfere with light fixtures, ceiling resisters, soffits and beams.
10. Verify the ducts and pipes do not conflict with architectural features or structural members. Look for unusual conditions on architectural sections that may reduce available space. For example, if there is a large folding partition supported by a steel beam, make sure there is adequate space above the partition support for HVAC ductwork to pass beneath the main structure of the building.
11. Verify that adequate ceiling height exists at worst case duct intersections or largest beam. Look for the depth of the two biggest ducts that cross or for the largest duct that passes under a beam. Check the architectural finish schedule to determine the finish ceiling height in the space. Check the architectural finish schedule to determine the finish ceiling height in the space. Check the structural drawings to determine the clear space between the bottom of the structure and the finish ceiling height. Don't forget to add the depth of fire proofing and thickness of duct insulation. Check the specifications for thickness of insulation for HVAC ductwork. Check the electrical drawings for depth of recessed light fixtures. Check the architectural ceiling details to determine the thickness of the ceiling. Check the electrical drawings for depth of recessed light fixtures. Check the architectural ceiling details to determine the thickness of the ceiling. Check the plumbing drawings for plumbing lines that may be in the area. Consider the effect of seismic bracing. Add up all the actual depth dimensions plus minimum installation clearance space, and determine if the finish ceiling height is possible.
12. Verify that structural supports required for mechanical equipment are indicated on structural drawings. Pay particular attention to roof mounted equipment. Check mechanical and structural plans to determine that roof supports have been provided for the mechanical equipment. Check for reference to architectural drawings for flashing of duct and piping penetrations and equipment supports. Check architectural drawings for roof and wall flashing details. Beneath heavy mechanical equipment, look for increased beam sizes and/or closer spacing of beams on structural drawings. Check that structural floor and wall supports indicated on mechanical drawings exist on structural drawings. Check structural drawings for lintels over duct/louver wall openings.
13. Verify that smoke and fire dampers are indicated at smoke and firewalls. Check architectural plans that identify the smoke and firewalls with the mechanical HVAC ductwork plans to ensure that dampers are located at smoke and fire rated walls.
14. Verify that diffuser locations match architectural reflected ceiling plans. Check HVAC drawings and architectural reflected ceiling plans to look for conflicts with lights, sprinkler heads, dropped soffits, and skylights.
15. Verify that openings for roof penetrations (ducts, fans, etc.) are indicated on structural roof plans. Check structural roof framing plans with the mechanical HVAC ductwork plans to assure that roof openings and additional framing supports around the openings have been provided. Check that opening sizes are larger than the size of the ductwork.
16. Verify that ductwork is sized logically. Check that ductwork has a size and that the size appears to make sense. For example, if an 18" x 30" supply duct leaves an air handling unit and then suddenly becomes 26" x 30" there is probably a mistake. Main line duct sizes should increase as they near an air handling unit.
17. Verify notes. If a note indicates to see sheet M-15 for additional details, check that the details are on sheet M-15. Avoid duplicating the same notes in drawings and specifications.

18. Verify that air conditioning units, heaters, and exhaust fans match architectural roof plan locations. Match mechanical/plumbing plans with architectural roof plans to check locations of equipment. Check that roof planks are provided for maintenance personnel.
19. Verify that mechanical equipment will fit in spaces allocated and that there is room for access and maintenance such as removing filters and tubes.
20. Verify that horsepower ratings, phases, and voltages of major items of equipment on mechanical and electrical drawings and specifications match. Check mechanical schedules, electrical riser diagrams and/or panel schedules and specifications against each other.
21. Verify that thermostat locations have been coordinated with architectural drawings. Check architectural drawings. Check architectural floor plans to avoid thermostats behind doors, chalkboards, bulletin boards, artwork, etc.
22. Check architectural drawings to make sure that there is no water piping running through the elevator shafts.

E. ELECTRICAL DRAWINGS

1. Verify that electrical floor plans match architectural and mechanical. Check that the location of floor mounted equipment is consistent between disciplines. Check the architectural floor plans with the electrical power and HVAC floor plans to make sure that wall locations and door swings are the same. If the door swings don't match there may be light switches located on the wrong side of the door, behind door swings. Check the architectural, mechanical, and electrical plans for matching location of pumps, compressors, air handling units, and other equipment.
2. Verify that the location of light fixtures matches architectural reflected ceiling plan and that light fixtures do not conflict with the structure or mechanical HVAC system. Match electrical light plans and architectural reflected ceiling plans and check for conflicts with columns, ceiling diffusers, ceiling grids, skylights, expansion joints, drapery, folding partition tracks, sprinklers, and soffits. Make sure that recessed or surface mounted light fixtures are suitable for the ceiling. A common problem is to indicate a surface mounted fixture for an acoustical tile ceiling where a recessed fixture was desired. Match electrical light plans with structural and mechanical plans to locate possible areas of conflict with recessed lights, structure, and ducts. Check that sizes and types of light fixtures are the same in the specifications and drawing schedules.
3. Verify that major equipment has electrical power connections and that horsepower ratings, phases, and voltages are consistent with other disciplines schedules. Check mechanical, plumbing, and kitchen schedules for major pieces of equipment that require electrical service and verify that these pieces of equipment are included in electrical line diagrams, power plans, and/or panel schedules. Check horsepower ratings, voltages, and phases for inconsistencies on mechanical schedule sheets, electrical power plans and riser diagrams, and specifications.
4. Verify that locations of panel boards are consistent with architectural, mechanical, and plumbing floor plans and that the panel boards are indicated on the electrical riser diagram. Match the electrical power plans with architectural floor plans to find conflicts in the location of the panel boards. Check for the same number and designation of electrical panels on the electrical plans and riser diagram.
5. Check notes. If a note indicates to see sheet E-11 for additional details, check that the details are on sheet E.11. Avoid duplicating the same notes in the drawings and specifications.

6. Verify that locations of electrical conduit runs, floor trenches, and openings are coordinated with structural and architectural plans. Check that major conduit runs, floor trenches, and openings are shown the same on structural and architectural drawings.
7. Verify that electrical and fire alarm panels are not recessed in fire rated walls. Check electrical power plans with architectural plans to determine the locations of fire rated walls. Usually recessing anything in a fire rated wall will destroy the fire rating of the wall. If panels need to be recessed in a fire rated wall, check that there is a double wall provided with the rated wall behind the panel.
8. Verify that electrical and fire alarm equipment locations are coordinated with site paving, grading, and landscaping. Check that locations for substations, transformers, generators, underground conduit and duct banks do not conflict with civil, architectural, and landscape site plans. Check that structural drawings indicate structures required for substations, switchgear and light poles. Check that electrical service is provided for motorized sprinkler valves, pools, and fountains.
9. Check mechanical and plumbing drawings to assure that there is no water piping in electrical rooms or above electrical equipment.
10. Verify that structural supports are provided for roof top electrical equipment plans. Check electrical plans with the structural plans to locate the electrical equipment and corresponding increased beam sizes and/or closer spacing of beams on structural drawings.

F. KITCHEN/DIETARY DRAWINGS

1. Verify that the equipment layout matches other discipline floor plans and that there are no conflicts with columns. Compare kitchen/dietary plans with architectural, plumbing, mechanical, and electrical plans to make sure the equipment layout is the same. Check that the location of columns on structural plans does not interfere with the equipment
2. Verify that equipment is connected to utility systems. Check that water service lines, steam lines, drain lines, gas lines, electrical services, and exhaust and make-up hoods, connect to utility systems on electrical, plumbing, mechanical and civil plans.
3. Verify that kitchen equipment as shown on the drawings matches kitchen floor plans and specifications. Check kitchen equipment item numbers, quantities, manufacturer names and model numbers between the drawings and specifications.
4. Verify that floor depressions and floor troughs are coordinated with other disciplines. Check architectural and structural plans to verify locations and depths of depressions at coolers/freezers and locations and sizes of floor troughs. Check drawings and specifications for freezer insulation requirements and the impact on the structure.

G. SPECIFICATIONS

1. Although more interdisciplinary problems are associated with drawings than with specifications, there are some coordination issues that the consultant shall check in order to minimize change orders.
2. Guide specifications indicate a large variety of materials and systems, which could be used on any project. These guide specifications should be edited to remove all items that are not specifically required for the particular project. This is also true for using specifications from a previous project.

3. Check specifications against drawings to assure that all materials and system indicated on the drawing are covered in the specifications. Compare architectural finish schedule to specification index. Ensure all finish materials are specified. This is a simple cross check that often yields dividends. By checking all of the floor, wall, and ceiling materials on the finish schedule against the specification index you will often discover a material that is on the schedule but not specified.
4. Check major items of equipment and verify that they are coordinated with contract drawings. Pay particular attention to horsepower ratings and voltage requirements. If quantities of equipment, horsepower ratings, voltages, and phases are indicated on schedules in the drawings, they should not be repeated in the specifications. If they are repeated, make sure they are the same.
5. Verify that the index and sections contained in the body of the specifications match. Check that all specifications in the body of the specification are indexed. Also glance through all specification pages and look for references to other specification sections. Verify that these references are in the specification index. Often references are to sections that do not exist.
6. Verify thickness of materials delineated in specifications. These items are often best shown on the drawings and should not be repeated in the specification. For example, it is a good idea to avoid indicating the thickness of drywall or gypsum wallboard in the specifications if it is already indicated on architectural sections and details. Another example concerns kitchen equipment. Very often the kitchen equipment specifications will list the number of deep fat fryers and other equipment, and at the same time the dietary or kitchen drawings will have a schedule that the same information. It is best not to repeat information that will increase the opportunity for contradictions.
7. Verify that those items specified "as indicated" or "where indicated" in the specifications are in fact indicated on contract drawings. The courts have ruled many times that items specified "as indicated" and not shown on the drawings make it impossible for the contractor to bid since he doesn't know the installation location. Under these circumstances the contractor is relieved of the requirement. Avoid this pitfall by ensuring that items noted on the drawings and in the specifications as "where indicated" or "as indicated" are clearly shown.
8. Check that alternates or bid items explicitly state what is intended and are coordinated with the drawings. If there are insufficient funds to award the contract on the base bid plus all bid items, then problems occur. For example, consider a situation such as a project with an additive alternate bid item number 4 identified as "landscaping". The landscaping drawings for this project contain an underground irrigation system. When the bids come in there are insufficient funds to pick up alternate number 4. The intent of the Consultant is that the underground irrigation system is part of the base bid and not part of alternate number 4. However, the contractor interprets the underground irrigation system as part of the landscaping since it was shown on the landscape drawings. A dispute such as this will usually be resolved in favor of any reasonable interpretation and the contractor will likely win the claim, regardless of what the specification writer may have intended. This could have been avoided if alternate number 4 indicated "all work indicated on the landscape drawings except the underground irrigation system which is part of the base bid".
9. Check specification for phasing of construction. Are the phases clear? Anything that impacts on the contractor's freedom to schedule the work should be clear. For example, if the Contractor has a project to provide an asphalt overlay to an existing parking lot that serves several large buildings, it may not be possible to close the entire parking lot at one time for the work to be performed. If this is the case the specification should be very specific about

phasing of the work. Mobilization and de-mobilization by a Contractor is costly if not precisely specified.

H. GENERAL CONCEPTS TO IMPROVE THE QUALITY OF CONTRACT DOCUMENTS

1. Perform interdisciplinary check as early as possible and throughout the project.
2. Draw all major plan drawings at the same scale and at the same orientation, preferable north to the top or to the right.
3. Show the correct information the least number of times, preferably only once.
4. Use consistent terminology between drawings and specifications and amongst drawings.
5. Avoid vague notes such as “see architectural” or “see mechanical”. Refer to the specific detail on the specific drawing.
6. If possible, avoid match lines. When necessary to use, match lines should be clear and have the same orientation.
7. Clarify by legend and/or linework the difference between new construction and existing structure and systems.

APPENDIX D

CLASSIFICATION OF BUILDING AREAS

The following definitions of building areas shall be used by the Consultant to establish their cost estimates and to identify the physical space and function of each area.

DEFINITIONS OF BUILDING AREAS

A. GROSS AREA (Gross Square Feet – GSF)

1. **Definition:** The sum of all areas on all floors of a building included within the outside faces of its exterior walls, including floor penetration areas, however insignificant, for circulation and shaft areas that connect one floor to another.
2. **Basis for Measurement:** Gross area is computed by physically measuring or scaling measurements from the outside faces of exterior walls, disregarding cornices, pilasters, buttresses, etc., which extend beyond the wall faces. Exclude areas having less than a six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.

Measured in terms of gross square feet (GSF)

Gross Area = Net Usable Area + Structural Space

3. **Description:** In addition to all the internal floored spaces obviously covered above, gross area should include the following: excavated basement areas; mezzanines, penthouses, and attics; garages; enclosed porches, inner or outer balconies whether walled or not, if they are utilized for operational functions; and corridors whether walled or not, provided they are within the outside face lines of the building, to the extent of the roof drip line. The footprints of stairways, elevator shafts, and ducts (examples of building infrastructure) are to be counted as gross area on each floor through which they pass.
4. **Limitations:** Exclude open areas such as parking lots, playing fields, courts, and light wells, or portions of upper floors eliminated by rooms or lobbies that rise above single-floor ceiling height.

B. ASSIGNABLE AREA (Net Assignable Square Feet -NASF)

1. **Definition:** The sum of all areas on all floors of a building assigned to, or available for assignment to an occupant or specific use.
2. **Basis for Measurement:** Assignable area is computed by physically measuring or scaling measurements from the inside faces of surfaces that form the boundaries of the designated areas. Exclude areas having less than a six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.
3. Measured in terms of assignable square feet (ASF),
4. **Assignable Area** = Sum of Area Designated by the Ten Assignable Major Room Use Categories
5. **Description:** Included should be space subdivisions of the ten major room use categories for assignable space - classrooms, labs, offices, study facilities, special use, support, health care, residential and unclassified - that are used to accomplish the institution's mission.

6. **Limitations:** Deductions should not be made for necessary building columns and projections unless each is larger than 2' x 2' in area. Areas defined as building service, circulation, mechanical, and structural should not be included.

C. NONASSIGNABLE AREA

1. **Definition:** The sum of all areas on all floors of a building not available for assignment to an occupant or for specific use, but necessary for the general operation of a building.
2. **Basis for Measurement:** Nonassignable Area is computed by physically measuring or scaling measurements from the inside faces of surfaces that form the boundaries of the designated areas. Exclude areas having less than six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.

Measured in terms of area,

Nonassignable Area = Sum of the Area Designated by Three Nonassignable Room Use Categories.

3. **Description:** Included should be space subdivisions of the three nonassignable room use categories - building service, circulation and mechanical - that are used to support the building's general operation.
4. **Limitations:** Deductions should not be made for necessary building columns and projections, unless they are larger than 2' & 2' in area.

D. BUILDING SERVICE AREA

1. **Definition:** The sum of all areas on all floors of a building used for custodial supplies, sink rooms, janitorial closets, and for public rest rooms. (NOTE: Building service area includes all areas previously classified as custodial area. Building service area also includes public rest rooms that were previously classified as mechanical area. Building Service Area does not include assignable areas.
2. **Basis for Measurement:** Nonassignable Area is computed by physically measuring or scaling measurements from the inside faces of surfaces that form the boundaries of the designated areas. Exclude areas having less than six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.

Measured in terms of area

Nonassignable Area = Sum of the Area Designated by Three Nonassignable Room Use Categories.

3. **Description:** Included should be space subdivisions of the three nonassignable room use categories—building service, circulation and mechanical—that are used to support the building's general operation. Included should be janitor closets or similar small cleanup spaces, maintenance material storage areas, trash rooms exclusively devoted to the storage of nonhazardous waste created by the building occupants as a whole, and public toilets.
4. **Limitations:** Deductions should not be made for necessary building columns and projections unless they are larger than 2' x 2' in area. Areas defined as assignable should not be included. Areas defined as central physical plant shop areas, or special purpose storage or maintenance rooms, such as linen closets and housekeeping rooms in residence halls, should not be included. Private rest rooms are not included.

E. CIRCULATION AREA

1. **Definition:** The sum of all areas on all floors of a building required for physical access to some subdivision of space, whether physically bounded by partitions or not.
2. **Basis for Measurement:** Circulation area is computed by physically measuring or scaling measurements from the inside faces of surfaces that form the boundaries of the designated areas. Exclude areas having less than a six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.
3. **Description:** Included should be, but is not limited to, public corridors, fire towers, elevator lobbies, tunnels, bridges, and each floor's footprint of elevator shafts, escalators and stairways. Receiving areas, such as loading docks, should be treated as circulation space. Any part of a loading dock that is not covered is to be excluded from both circulation area and the gross building area. A loading dock which is also used for central storage should be regarded as assignable area and coded as central storage. Also included are corridors, whether walled or not, provided they are within the outside facelines of the buildings to the extent of the roof drop line.
4. **Limitations:** Deductions should not be made for necessary building columns and minor projections unless they are larger than 2' x 2' in area. When determining corridor areas, only spaces required for public access should be included. Restricted access private circulation aisles used only for circulation within an organizational unit's suite of rooms, auditoria, or other working areas should not be included.

F. MECHANICAL AREA

1. **Definition:** The sum of all areas on all floors of a building designed to house mechanical equipment, utility services, and shaft areas.
2. **Basis for Measurement:** Mechanical area is computed by physically measuring or scaling measurements from the inside faces of surfaces that form the boundaries of the designated areas. Exclude areas having less than six-foot, six-inch clear ceiling height unless the criteria of a separate structure are met.
3. **Description:** Included should be mechanical areas such as central utility plants, boiler rooms, mechanical and electrical equipment rooms, fuel rooms, meter and communications closets, and each floor's footprint of air ducts, pipe shafts, mechanical service shafts, service chutes, and stacks.
4. **Limitations:** Deductions should not be made for necessary building columns and projections unless they are larger than 2' x 2' in area. Areas designated as private toilets are not included.

G. NET USABLE AREA

1. **Definition:** The sum of all areas on all floors of a building either assigned to, or available for assignment to, an occupant or specific use, or necessary for the general operation of a building.
2. **Basis for Measurement:** Net usable area is computed by summing the assignable area and the nonassignable area.

Measured in terms of net usable square feet (NUSF)

Net Usable Area = Assignable Area + Nonassignable Area.

3. **Description:** Included should be space subdivisions of the ten assignable major room use categories and the three nonassignable space categories.
4. **Limitations:** Deductions should not be made for necessary building columns and projections unless they are larger than 2' x 2' in area. Areas defined as structural should not be included.

H. STRUCTURAL AREA

1. **Definition:** The sum of all areas on all floors of a building that cannot be occupied or put to use because of structural building features.
2. **Basis for Measurement:** Precise computation by direct measurement is not possible under these definitions. It is determined by calculating the difference between the measured gross area and the measured net usable area.

Measured in terms of area.

Structural Area = Gross Area - Net Usable Area

3. **Description:** Examples of building features normally classified as structural areas include exterior walls, fire walls, permanent partitions, unusable areas in attics or basements, or comparable portions of a building with ceiling height restrictions, as well as unexcavated basement

APPENDIX E

HISTORIC PRESERVATION

A. GENERAL

1. Historic Preservation work can apply to an entire project, large or small, including all trades and engineering disciplines, or to any part of a project that includes preservation and conservation components.
2. Historic Preservation is required at those sites, structures, interiors and works of art that are officially designated landmarks by the New York City Landmarks Commission and those that are listed in the National Register or State Register of Historic Places. In addition, DDCM/CUCF generally applies similar historic preservation criteria to other sites, structures, interiors and works of art that are of landmark quality, may be eligible for governmental designation, or have historic, cultural, artistic and/or architectural features of merit and significance; this may protect their future eligibility for historic status. All these projects, those officially designated and those of landmark quality, shall hereafter be referred to as Preservation Projects.
3. It is the Consultant's Responsibility to determine the applicable regulatory agency requirements for a specific Preservation Project and to comply with the requirements, including preparing documentation and filing for and obtaining applicable approvals.
4. The United States Secretary of the Interior provides key resources—standards, guidelines, and technical information—for developing Preservation Projects. The New York State Historic Preservation Office and the New York City Landmarks Commission also offer important resources.
5. The goals of a project (protection, stabilization, rehabilitation, restoration or reconstruction) will determine the most pertinent design criteria, standards and guidelines. The Consultant is responsible for delineating those that apply to a specific project.

B. CONSULTANT SERVICES

1. A Preservation Project requires that the Consultant provide a full range of preservation and conservation services by qualified experts for every phase of the project. The Consultant is therefore required to have on his/her team all the specialists necessary to carry out the scope of the work, such as, historian, archaeologist, architectural conservator, art conservator, materials specialist, historic systems engineers etc.
2. The services will be project-specific and are generally required for the entire duration of the project, including all phases of design and construction. Some services which are normally expected during a Preservation Project include:
 - a. Documentary, historic and field research sufficient to inform the scope and intent of the project, and to verify conditions which are exposed during construction.
 - b. An assessment report of features that are significant with respect to preservation, including an inventory and description of special elements, spaces, materials, systems, details, furnishings, equipment etc.
 - c. An evaluation of existing conditions based on probes and tests that are necessary to achieve accurate construction documents and a detailed cost estimate. The Consultant is expected to identify and plan the probes and tests. Upon approval, tests and or probes that require specialized equipment, scaffolding, laboratory conditions etc. may be

- performed under an allowance for additional work. The Consultant remains responsible for planning, supervision and coordination of the work and for the submittal of an illustrated report documenting the procedures, the results and the interpretation.
- d. In the absence of existing measured drawings, the Consultant shall produce a set of base measured drawings for the areas of work included in the scope, and shall provide photographic documentation of existing conditions, the work in progress and as built conditions. The Consultant shall also keep a record of changes to the specifications which are approved during construction and document them in descriptive memoranda. The above documentation shall be turned over to DDCM/CUCF.
 - e. All of the preservation services which are rendered as part of the project shall be documented in a way suitable for inclusion in a historic structures report, noting all sources of information, written and graphic. The Specific Requirements of a project may require the Consultant to produce a complete historic structures report as part of the project scope.
 - f. The Consultant may be required to prepare an application for eligibility for the National or State Registrar, when DDCM/CUCF decides to seek this status as part of the project. And for example, in the case of ADA compliance, "eligibility" status may modify the application of the law and mitigate the effect on the historic fabric.
 - g. During the Bid & Award phase and during construction, the Consultant shall review, verify and evaluate the Special Experience Requirements and Qualifications submitted by the Contractor and his proposed Subcontractors. The Consultant shall visit sites of sample work, to verify quality and applicability to the project, and to recommend appropriate action based on project requirements.
 - h. The services described above are considered usual for all Preservation Projects. Their extent may vary according to the overall scope of work. In special cases, other services may be required.
 - i. If additional or unforeseen services of specialists are required during construction, it is the responsibility of the Consultant to bring this to the attention of DDCM/CUCF and to provide for these services as part of the construction requirements.
3. Development of Alternative Plans:
- a. The Consultant will develop alternative plans for preservation treatment which shall include at least one proposal which addresses complete conformance with the Secretary of the Interior's standards.
 - b. Each proposal must fully explain the approach and the consequences for preservation issues and must be accompanied by a cost estimate so that a full range of options are explored in an effort to arrive at a sensitive and appropriate solution.

APPENDIX F

ENVIRONMENTAL ENGINEERING

A. ENVIRONMENTAL DESIGN QUALITY

CUCF is dedicated to excellent environmental design which often includes assessing potential environmental issues in the early stages of a project and proactively considering the data gained in making planning decisions. Each project's design will address project-specific environmental concerns and incorporate measures to mitigate any adverse environmental conditions.

1. Environmental Engineering Scope of Work:

- a. Depending on the requirements of a particular project, an environmental consultants' assignment may include a wide range of types of work -- from assessment of the impact of a planned major project on a neighborhood and community to investigations and remediation of the presence of specific hazardous materials in an existing facility.
- b. The assignments include, but are not limited to: guiding the SEQR or CEQR process; preparing an Environmental Impact Statement (EIS); preparing Phase I and Phase II environmental reports; surveying, identifying and confirming the presence of specific hazardous materials (such as asbestos containing materials [ACM], lead-based paint, lead dust, mold and other biological substances, polychlorinated biphenyls [PCBs] and oil-contaminated soil), preparing contract documentation for the remediation of these hazardous materials, and obtaining approvals from regulatory agencies

2. Regulatory Agencies' Rules and Regulations:

- a. **Regulatory Agencies:** The Environmental Consultant is responsible for adhering to applicable rules and regulations established by various city, state and federal agencies. These agencies include, but are not limited to: the New York City Department of Environmental Protection (DEP), the New York State Department of Environmental Conservation (DEC), the New York State Departments of Health and Labor, the United States Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).
- b. **Schedule and Consultant Responsibility:** The consultant will determine the applicable regulations and regulatory agency reviews for a particular project and create a timetable for the required work that is coordinated with the overall project schedule with the goal of progressing the work without delay. The schedule will highlight milestone dates for various activities (including investigations and testing), for submissions and reviews, and for obtaining environmental approvals from regulatory agencies with jurisdiction.

B. ENVIRONMENTAL ENGINEERING ASSIGNMENTS

1. Major Assignments:

- a. **Compliance with State Environmental Quality Review Act (SEQRA) and City Environmental Quality Review (CEQR)**

A CUCF capital project may require initiating some environmental engineering assessments at a very early stage. Some major projects require compliance with SEQRA or CEQR including assessing, disclosing and mitigating any environmental impacts to the greatest extent that is practicable. The consultant will be responsible for all aspects of the SEQR or CEQR process to meet project-specific requirements.

b. Environmental Impact Statement (EIS) and Phase I or Phase II Environmental Reports etc.

The Consultant's work may include the preparation of an Environmental Impact Statement (EIS), Phase I or Phase II environmental reports and other documentation as necessary, as well as making submissions to regulatory agencies and providing cost estimates. The consultant will adhere to applicable regulations and rules and provide assessments in accordance with applicable standards from the American Society for Testing Materials (ASTM).

2. Specific Hazardous Materials Investigations and Remediation Assignments:

a. Asbestos Containing Materials (ACM)

- **Investigator Survey:** For each construction/renovation project, a Certified New York City Investigator will perform a survey of the facilities to identify the presence of any ACM that could be disturbed during the construction/renovation (e.g.; spray-on fireproofing, pipe insulation, vinyl asbestos tiles, etc.) and prepare a report. The investigator shall determine and include any hidden areas or areas beyond the immediate construction that require assessment.
- **Abatement Contract Documents:** The contract documents shall include abatement of all ACM that can reasonably be expected to be disturbed by construction/renovation activities. The documents shall delineate any phasing requirements in coordination with the overall construction schedule.
- **Regulatory Agency Filing:** The Consultant must file either an ACP-5 or ACP-7 form according to the latest regulations with the Department of Environmental Protection and all other appropriate agencies having jurisdiction.

b. Lead-containing materials:

- **Survey:** The consultant shall identify lead-containing materials before or during the Design Development phase.
- **Remediation:** Referencing compliance with federal, state and local regulatory agency rules and requirements, including Occupational Safety and Health Administration (OSHA) requirements, the consultants' specifications shall outline the contractor requirements for protection of workers and adjacent occupants during renovation and for the proper disposal of hazardous lead waste.

c. Mold and other biological substances (pigeon droppings, etc.)

- **Survey:** The consultant shall identify all biological substances.
- **Remediation:** The consultant shall specify remediation methods and estimate the costs.

d. Polychlorinated biphenyl (PCB)-Containing Materials:

- **Survey:** The consultant shall identify the presence of PCBs before or during the Design Development Phase including, but not limited to, its presence in electrical equipment such as transformers, bushings, capacitors, etc., cooling and insulating fluids, and caulking.
- **Remediation and Disposal:** The consultant will provide guidance for the appropriate handling and disposal of these materials in compliance with regulations from all agencies having jurisdiction, including EPA and state regulations.

e. Contaminated soil – oil, volatile compounds (vocs), toxic metals, etc.:

- **Review existing reports:** As early as possible and before or during the Schematic

phase, the consultant will review existing environmental reports and other historical records to ascertain whether contaminants might be present in the soil and determine testing requirements for verification of the presence of contaminants. Early confirmation is essential especially when there are possibilities for alternative siting.

- **Remediation:** Based on historical research and test results, the consultant shall determine and specify procedures for handling, removal and disposal of the contaminated materials and estimate the costs.

f. Other Hazardous Materials Issues:

- **Waste Management:** The Consultant shall ensure that all applicable hazardous waste rules and regulations are fully delineated in the specifications and contract documents. These include, but are not limited to, provisions involving hazardous waste streams, use-approved waste transporters and use-approved waste disposal facilities.
- **Underground Storage Tanks:** The Consultant shall identify the presence of all underground storage tanks that may be affected by the construction work and include appropriate specifications in the contract documents for their protection during construction or removal, all in compliance with State and Federal regulations.
- **Other Environmental Issues:** During the design phase, the Consultant is responsible for identifying any other additional environmental issues that may be created by the proposed construction.

C. DESIGN PROCESS OUTLINE REQUIREMENTS

- 1. Pre-Preliminary/Schematic Phase:** The environmental consultant shall participate in meetings for the discussion and review of required and recommended environmental design elements and initiate environmental assessments necessary to maintain the project-specific schedule.
- 2. Schematic Design:** The Consultant will perform a survey to identify hazardous materials, summarize the findings in a report and provide a cost estimate for remediation.
- 3. Design Development:** The Consultant shall provide an environmental survey and detailed report that includes, but is not limited to, the following:
 - a. The limits of all accessible environmental hazards that might be disturbed, altered, demolished or affected by the proposed work
 - b. Any inaccessible or hidden suspect hazards and recommendations for exploratory probes, physical penetrations, sample collection and analytical tests to determine whether suspect hazards are present within the boundaries of the scope of work
 - c. Sketches and plans showing the approximate locations where samples were collected;
 - d. A summary of all samples, analyses, chain of custody and laboratory certifications
 - e. An assessment of the cost of remediation of all hazards including an estimate of quantities and conditions of the hazards identified
 - f. Diagrams, photographs, sketches, drawings, etc. as necessary to document the conditions.
- 4. Construction Document Phase:**
 - a. Hazardous Materials Construction Documents**

The Consultant shall prepare comprehensive contract documents delineating all required work for the safe remediation and abatement of hazardous materials. These documents

shall be suitable for bidding and include plans and specifications, procedures and protocols, protection requirements and phasing plans.

b. Standard Operating Procedures

The Consultant shall specify procedures and protocols in compliance with the latest NYC Department of Environmental Protection and NYS Department of Labor standards, as necessary for the scope of the environmental work, including, but not limited to:

- Special experience requirements for environmental abatement/remediation
- Emergency precautions and notifications
- Quality assurance standards
- Air monitoring and/or bulk sampling requirements
- Removal/remediation procedures
- Decontamination procedures
- Critical barriers and engineering controls
- Waste handling and disposal
- Reinstallation or replacement with non-hazardous materials
- Identification of products – identification of any and all products necessary for completion of the hazardous materials abatement, with performance specifications for those products, including, but not limited to material handling devices, replacement materials, specialized tools and equipment, cleaning materials, worker protection (respiratory protection and protective clothing), waste disposal materials, decontamination facilities, barriers and air moving equipment.

c. Cost Estimate:

The Consultant shall submit a detailed cost estimate with quantities.

d. Filings with Regulatory Agencies:

The Consultant shall submit the appropriate regulatory filings and obtain necessary approvals that are coordinated with the overall project schedule. These filings may include NYC DEP ACP 5, or ACP 7 form (filed with the NYC Department of Environmental Protection) and applicable variances, NYS DOL variances, NYS DEC notifications and work plans and any federal EPA / OSHA / DOT filings or notifications that may be required due to the nature of the hazards within the scope of work.

APPENDIX G

LAB DESIGN CRITERIA

A. DESIGN PARAMETERS

1. The following design parameters must be established for a laboratory space:
 - a. Temperature and humidity, both indoor and outdoor
 - b. Air quality from both process and safety perspectives, including the need for air filtration and special treatment (e.g., charcoal, HEPA, or other filtration of supply or exhaust)
 - c. Equipment and process heat gains, both sensible and latent
 - d. Minimum ventilation rates
 - e. Equipment and process exhaust quantities
 - f. Exhaust and air intake locations
 - g. Style of the exhaust device, capture velocities, and usage factors
 - h. Need for standby equipment and emergency power
 - i. Alarm requirements.
 - j. Potential changes in the size and number of fume hoods
 - k. Anticipated increases in internal loads
 - l. Room pressurization requirements.
2. It is important to:
 - a. Review design parameters with the College safety officers and scientific staff
 - b. Determine limits that should not be exceeded
 - c. Establish the desirable operating conditions. For areas requiring variable temperature or humidity, these parameters must be carefully reviewed with the users to establish a clear understanding of expected operating conditions and system performance.
 - d. Determine and comply with all specific regulatory agency (DOB, FDNY, etc.) requirements, such as fire rating of perimeter lab walls and doors
 - e. Submit diagrams indicating extent of boundary of rated walls and doors to DDCM/CUCF/College for posting in the labs

B. LABORATORY VENTILATION

1. The total airflow rate for a laboratory is dictated by one of the following:
 - a. Total amount of exhaust from containment and exhaust devices
 - b. Cooling required to offset internal heat gains
 - c. Minimum ventilation rate requirements.
2. Fume hood exhaust requirements (including evaluation of alternate sash configurations shall be determined in consultation with the safety officers. The HVAC engineer must determine the expected heat gains from the research equipment after consulting with the research staff (see the section on Internal Thermal Considerations). Minimum airflow rates are generally in the range of 6 air changes per hour when the space is occupied; however, some spaces (e.g., animal holding areas) may have minimum airflow rates established by specific standards or by internal facility policies. For example, the National Institutes of Health (NIH 1999a, 1999b) recommend a minimum of 6 air changes per hour for occupied laboratories but a minimum of 15 air changes per hour for animal housing treatment areas. The maximum airflow rate for the laboratory should be reviewed to ensure that appropriate supply air delivery methods are chosen such that supply airflows do not impede the performance of the exhaust devices. Laboratory ventilation systems be arranged for either constant-volume or variable-volume airflow. The specific type should be selected with the research staff, be

given to unique areas such as glass washing areas, hot and cold environmental rooms and labs, fermentation rooms, and cage washing rooms. Emergency power systems to operate the laboratory ventilation equipment should be considered based on hazard assessment or other specific requirements. Care should be taken to ensure that an adequate amount of makeup air is available whenever exhaust fans are operated on emergency power. Additional selection criteria are described in the sections on Hazard Assessment and Operation and Maintenance.

3. Usage Factor

- a. In many laboratories, all hoods and safety cabinets are seldom needed at the same time. A system usage factor represents the maximum number of exhaust devices with sashes open or in use simultaneously. The system usage factor depends on the:
 - Type and size of facility
 - Total number of fume hoods
 - Number of fume hoods per researcher
 - Airflow diversity
 - Type of fume hood controls
 - Fume hood sash configuration and minimum airflow required
 - Type of laboratory ventilation systems
 - Number of devices that must operate continuously due to chemical storage requirements or contamination prevention
 - Number of current and projected research programs
- b. Usage factors should be applied carefully when sizing equipment. For example, teaching laboratories may have a usage factor of 100% when occupied by students. If too low a usage factor is selected, design airflow and containment performance cannot be maintained. It is usually expensive and disruptive to add capacity to an operating laboratory's supply or exhaust system. Detailed discussions with research staff are required to ascertain maximum usage factors as well as likely future requirements.

4. Noise

- a. Noise level in the laboratory should be considered at the beginning of the design so that noise criterion (NC) levels suitable for scientific work can be achieved. For example, at the NIH, sound levels of NC 40 to 45 (including fume hoods) are required in regularly occupied laboratories. (Levels for animal experiments can be considerably less.) The requirement is relaxed to NC 55 for instrument rooms. If noise criteria are not addressed as part of the design, NC levels can be 65 or greater, which is unacceptable to most occupants. Sound generated by the building HVAC equipment should be evaluated to ensure that excessive levels do not escape to the outdoors. Remedial correction of excessive sound levels can be difficult and expensive. Supply air systems for laboratories provide the following:
 - Thermal comfort for occupants
 - Minimum and maximum airflow rates
 - Replacement for air exhausted through fume hoods, biological safety cabinets, or other exhaust devices
 - Space pressurization control
 - Environmental control to meet process or experimental criteria
- b. The design parameters must be well defined for selection, sizing, and layout of the supply air system. Installation and setup should be verified as part of the commissioning process.

Design parameters are covered in the section on Design Parameters, and commissioning is covered in the section on Commissioning. Laboratories in which chemicals and compressed gases are used generally require non-recirculating or 100% outside air supply systems. The selection of 100% outside air supply systems versus return air systems should be made as part of the hazard assessment process, which is discussed in the section on Hazard Assessment. A 100% outside air system must have a very wide range of heating and cooling capacity, which requires special design and control. Energy recovery systems should be considered.

- c. Supply air systems for laboratories include constant-volume, high-low volume, and variable- volume systems that incorporate either single-duct reheat or dual-duct configurations, with distribution through low-, medium-, or high-pressure ductwork.

5. Filtration

Filtration for the air supply depends on the requirements of the laboratory. Conventional chemistry and physics laboratories commonly use 85% dust spot efficient filters (ASHRAE *Standard* 52.1). Biological and biomedical laboratories usually require 85 to 95% dust spot efficient filtration. HEPA filters should be provided for spaces where research materials or animals are particularly susceptible to contamination from external sources. HEPA filtration of the supply air is necessary for such applications as environmental studies, studies involving specific pathogen-free research animals or nude mice, dust-sensitive work, and electronic assemblies. In many instances, biological safety cabinets or laminar flow clean benches (which are HEPA filtered) may be used rather than HEPA filtration for the entire laboratory.

6. Air Distribution

Air supplied to a laboratory must be distributed to keep temperature gradients and air currents to minimum. Air outlets (preferably nonaspirating diffusers) must not discharge into the face of a fume hood, a biological safety cabinet, or an exhaust device. Acceptable room air velocities are covered in the sections on Fume Hoods and Biological Safety Cabinets. Special techniques and diffusers are often needed to introduce the large air quantities required for a laboratory without creating disturbances at exhaust devices.

C. EXHAUST SYSTEMS

1. Laboratory exhaust systems remove air from containment devices and from the laboratory itself. The exhaust system must be controlled and coordinated with the supply air system to maintain correct pressurization. Additional information on the control of exhaust systems is included in the section on Control. Design parameters must be well defined for selection, sizing, and layout of the exhaust air system. Installation and setup should be verified as part of the commissioning process. See the sections on Design Parameters and Commissioning. Laboratory exhaust systems should be designed for high reliability and ease of maintenance.

This can be achieved by providing multiple exhaust fans that are not necessarily redundant or by sectionalizing equipment so that maintenance work may be performed on an individual exhaust fan while the system is operating. Another option is to use predictive maintenance procedures to detect problems prior to failure and to allow for scheduled shutdowns for maintenance. To the extent possible, components of exhaust systems should allow maintenance without exposing maintenance personnel to the exhaust airstream. Access to filters and the need for bag-in, bag-out filter housings should be considered during the design process. Depending on the effluent of the processes being conducted, the exhaust airstream may require filtration, scrubbing, or other emission control to remove environmentally

hazardous materials. Any need for emission control devices must be determined early in the design so that adequate space can be provided and cost implications can be recognized.

2. Ductwork Leakage:

Ductwork should have low leakage rates and should be tested to confirm that the specified leakage rates have been attained. Leaks from positive pressure exhaust ductwork can contaminate the building, so they must be kept to a minimum. Designs that minimize the amount of positive-pressure ductwork are desirable. All positive pressure ductwork should be of the highest possible integrity. The fan discharge should connect directly to the vertical discharge stack. Careful selection and proper installation of airtight flexible connectors at the exhaust fans are essential. Some feel that flexible connectors should be used on the exhaust fan inlet only. If flexible connectors are used on the discharge side of the exhaust fan, they must be of high quality and included on a preventative maintenance schedule because a connector failure could result in the leakage of hazardous fumes into the equipment room. Another viewpoint contends that the discharge side of the exhaust fan should be hard connected to the ductwork without the use of flexible connectors. The engineer should evaluate these details carefully. The potential for vibration and noise transmission must also be considered. Machine rooms that house exhaust fans should be ventilated to minimize exposure to exhaust effluent (e.g., leakage from the shaft openings of exhaust fans).

3. Containment Device Leakage

Leakage of the containment devices themselves must also be considered. For example, in vertical sash fume hoods, the clearance to allow sash movement creates an opening from the top of the fume hood into the ceiling space or area above. The air introduced through this leakage path also contributes to the exhaust airstream. The amount that such leakage sources contribute to the exhaust airflow depends on the fume hood design. Edge seals can be placed around sash tracks to minimize leaks. Although the volumetric flow of air exhausted through a fume hood is based on the actual face opening, appropriate allowances for air introduced through paths other than the face opening must be included.

D. ANIMAL FACILITIES

- 1. Temperature and Humidity:** Due to the nature of research programs, air-conditioning design temperature and humidity control points may be required. Research animal facilities require more precise environmental control than farm animal or production facilities because variations affect the experimental results. A totally flexible system permits control of the temperature of individual rooms to within $\pm 2^{\circ}\text{F}$ for any set point in a range of 64 to 85°F. This flexibility requires significant capital expenditure, which can be mitigated by designing the facility for selected species and their specific requirements. Table 1 lists dry-bulb temperatures recommended for several common species. In the case of animals in confined spaces, the range of daily temperature fluctuations should be kept to a minimum. Relative humidity should also be controlled. ASHRAE *Standard* 62 recommends that the relative humidity in habitable spaces be maintained between 30 and 60% to minimize growth of pathogenic organisms.
- 2. Ventilation:** A guideline of 10 to 15 outside air changes per hour (ach) has been used for secondary enclosures for many years. Although it is effective in many settings, the guideline does not consider the range of possible heat loads; the species, size, and number of animals involved; the type of bedding or frequency of cage changing; the room dimensions; or the efficiency of air distribution from the secondary to the primary enclosure. In some situations, such a flow rate might over-ventilate a secondary enclosure that contains few animals and

waste energy or under-ventilate a secondary enclosure that contains many animals and allow heat and odor to accumulate.

3. The air-conditioning load and flow rate for an animal room should be determined by the following factors:

- Desired animal microenvironment
- Species of animal(s)
- Animal population
- Recommended ambient temperature (Table 1)
- Heat produced by motors on special animal housing units (e.g., laminar flow racks or HEPA-filtered air supply units for ventilated racks)
- Heat generated by the animals (Table 2) Additional design factors include method of animal cage ventilation; operational use of a fume hood or a biological safety cabinet during procedures such as animal cage cleaning and animal examination; airborne contaminants (generated by animals, bedding, cage cleaning, and room cleaning); and institutional animal care standards. It should be noted that the ambient conditions of the animal room might not reflect the actual conditions within a specific animal cage.

4. **Animal Heat Production:** Air-conditioning systems must remove the sensible and latent heat produced by laboratory animals. The literature concerning the metabolic heat production appears to be divergent, but new data are consistent. Current recommended values are given in Table 2. These values are based on experimental results and the following equation:

$$ATHG = 2.5M$$

where

ATHG = average total heat gain, Btu/h per animal

M = metabolic rate of animal, Btu/h per animal = $6.6W^{0.75}$

W = weight of animal, lb.

Conditions in animal rooms must be maintained constant. This may require year-round availability of refrigeration and, in some cases, dual/standby chillers and emergency electrical power for motors and control instrumentation. Storage of critical spare parts is one alternative to installing a standby refrigeration system.

Table 1: Recommended Dry-Bulb Temperatures for Common Laboratory Animals

Animal	Temperature, °F
Mouse, rat, hamster, gerbil, guinea pig	64 to 79
Rabbit	61 to 72
Cat, dog	64 to 84
Farm animals and poultry	61 to 81

Note: These ranges permit scientific personnel who will use the facility to select optimum conditions (set points). The ranges do not represent acceptable fluctuation ranges.

Table 2 Heat Generated by Laboratory Animals

Species	Weight (lb)	Heat Generation, Btu/h per Normally Active Animal		
		Sensible	Latent	Total
Mouse	0.046	1.11	0.54	1.65
Hamster	0.260	4.02	1.98	6.00
Rat	0.62	7.77	3.83	11.6
Guinea pig	0.90	10.2	5.03	15.2
Rabbit	5.41	39.2	19.3	58.5
Cat	6.61	45.6	22.5	68.1
Nonhuman primate	12.0	71.3	35.1	106.0
Dog	22.7	105.0	56.4	161.0
Dog	50.0	231.0	124.0	355.0

- 5. Design Considerations:** If the entire animal facility or extensive portions of it are permanently planned for species with similar requirements, the range of individual adjustments may be reduced. Each animal room or group of rooms serving a common purpose should have separate temperature and humidity controls. The animal facility and human occupancy areas should be conditioned separately. The human areas may use a return air HVAC system and may be shut down on weekends for energy conservation. Separation prevents exposure of personnel to biological agents, allergens, and odors from animal rooms. Control of air pressure in animal housing and service areas is important to ensure directional airflow. For example, quarantine, isolation, soiled equipment, and biohazard areas should be kept under negative pressure, whereas clean equipment and pathogen free animal housing areas and research animal laboratories should be kept under positive pressure. Supply air outlets should not cause drafts on research animals. Efficient air distribution for animal rooms is essential; this may be accomplished effectively by supplying air through ceiling outlets and exhausting air at floor level. Supply and exhaust systems should be sized to minimize noise. It is recommended that the evaluation of a full-size mock-up of the animal room and its HVAC system was a cost-effective way to select a system that distributes air to all areas of the animal-holding room. Room air distribution should be evaluated using ASHRAE *Standard* 113 procedures to evaluate drafts and temperature gradients.

HVAC ductwork and utility penetrations must present a minimum number of cracks in animal rooms so that all wall and ceiling surfaces can be easily cleaned. Exposed ductwork is not

generally recommended; however, if constructed of 316 stainless steel in a fashion to facilitate removal for cleaning, it can provide a cost effective alternative. Joints around diffusers, grilles, and the like should be sealed. Exhaust air grilles with 1 in. washable or disposable filters are normally used to prevent animal hair and dander from entering the ductwork. Noise from the HVAC system and sound transmission from nearby spaces should be evaluated. Sound control methods such as separate air-handling systems or sound traps should be used as required. Multiple-cubicle animal rooms enhance the operational flexibility of the animal room (i.e., housing multiple species in the same room, quarantine, and isolation). Each cubicle should be treated as if it were a separate animal room, with air exchange/balance, temperature, and humidity control.

6. Alarms: Controls should include alarm systems to notify multiple staff persons, including by emergency email and phone calls, of any system failure or deviations from established temperature/humidity requirements.
7. **Caging Systems:** Animal facilities use a number of different caging systems that can significantly affect the environment within the cage or the total heat load in the room.
 - a. The purpose of the caging systems is to:
 - Protect the health and wellbeing of animals
 - Protect support staff from antigens released or shed by the animals
 - Minimize exposure of animals to pheromones released by other animals in the space
 - b. To provide the appropriate design, the HVAC engineer must be aware of the type of caging system to be used. Some common caging systems include the following:
 - Cage boxes made of sheet metal, plastic, or wire mesh, with the space inside the cage open to the room so that the room's macro environment is essentially identical to the cage's microenvironment.
 - Cage boxes made primarily of plastic, with the top shielded from the room by a filter material to provide some level of isolation from the room. The filter is usually not sealed to the cage, so some open space between the room and the interior of the cage remains. Exchange of air, vapors, particulates, and gases between the room and the cage interior does occur, but the rate of exchange is reduced by the filter. The microenvironment of the interior of the cage is usually different from that of the room.
 - Plastic and wire cages that are part of a cage rack assembly, which provides varying degrees of isolation from the room. These usually provide filtered (generally HEPA-filtered) air directly to each individual or shelf of cage boxes. In some cases, both a fan-powered supply and an exhaust unit are used. In other cases, cage units are connected to the facility exhaust system to provide airflow. Facilities with this kind of caging system must be designed to accommodate the heat gain in the space if the exhaust is released in the room. Some heat gain may be excluded if the caging assembly is connected directly to the facility exhaust system. When the facility is used to provide the exhaust by direct connection to the caging assembly, the design must include provisions to control the airflow to ensure that the overall proper airflow and relative static pressure of the room and each cage rack assembly is maintained, especially when caging and rack connections may be changed over time. The temperature and specific humidity within each cage will be higher than the ambient conditions of the room.
8. **Ancillary Spaces for Animal Laboratories:** In addition to animal holding rooms, a facility intended to provide for an animal colony generally requires other areas, such as:

- a. **Cage washer:** Usually provided with some temperature control to minimize heat stress for occupants. In addition, specific exhaust hoods and separate exhaust ductwork should be considered for the space and equipment.
- b. **Feed storage:** Usually provided with temperature and humidity control to protect quality and shelf life of feed.
- c. **Diagnostic laboratory:** Usually provided with laboratory-quality air conditioning.
- d. **Treatment laboratory:** Usually provided with laboratory-quality air conditioning.
- e. **Quarantine spaces:** To separate incoming animals from the remainder of the colony until their health can be evaluated. These rooms are frequently located near the receiving location. Animal room quality air conditioning is provided.
- f. **Surgery suite:** Sterile-quality air conditioning is provided. The suites frequently have provisions to exhaust anesthetic gases.
- g. **Necropsy laboratory:** Usually provided with laboratory-quality air conditioning and frequently fitted with special exhaust tables or other means of protecting laboratory workers from exposure to chemical preservatives or biological contamination. For high-risk or high-hazard work, Type III biological safety cabinets may be provided.
- h. **Waste-holding room:** Usually only provided with heating and ventilation, but maintained at negative pressure relative to adjacent areas. When used to store carcasses, a refrigerated storage unit of appropriate size should be provided.

E. BIO-SAFETY, CLINICAL AND TEACHING LABORATORIES

1. Bio safety Level 1

Bio safety Level 1 is suitable for work involving agents of no known hazard or of minimal potential hazard to laboratory personnel and the environment. The laboratory is not required to be separated from the general traffic patterns in the building. Work may be conducted either on an open benchtop or in a chemical fume hood. Special containment equipment is neither required nor generally used. The laboratory can be cleaned easily and contains a sink for washing hands. The federal guidelines for these laboratories contain no specific HVAC requirements, and typical college laboratories are usually acceptable. Many colleges and research institutions require directional airflow from the corridor into the laboratory, chemical fume hoods, and approximately three to four air changes per hour of outside air. Directional airflow from the corridor into the laboratory helps to control odors.

2. Bio safety Level 2

- a. Bio safety Level 2 is suitable for work involving agents of moderate potential hazard to personnel and the environment. DHHS (1999) contains lists that explain the levels of containment needed for various hazardous agents. Laboratory access is limited when certain work is in progress. The laboratory can be cleaned easily and contains a sink for washing hands. Biological safety cabinets (Class I or II) are used whenever
- b. Procedures with a high potential for creating infectious aerosols are conducted. These include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials, inoculating animals intranasally, and harvesting infected tissues or fluids from animals or eggs.
- c. High concentrations or large volumes of infectious agents are used. Federal guidelines for these laboratories contain minimum facility standards. At this level of biohazard, most research institutions have a fulltime safety officer (or safety committee) who establishes facility standards. The federal guidelines for Bio Safety Level 2 contain no specific HVAC requirements; however, typical HVAC design criteria can include the following:
 - 100% outside air systems

- 6 to 15 air changes per hour
 - Directional airflow into the laboratory rooms
 - Site-specified hood face velocity at fume hoods (many institutions specify 80 to 100 fpm)
 - An assessment of research equipment heat load in a room.
 - Inclusion of biological safety cabinets
- d. Most biomedical research laboratories are designed for Bio Safety Level 2. However, the laboratory director must evaluate the risks and determine the correct containment level before design begins

3. Clinical Laboratories

Clinical laboratories are found in hospitals and as stand-alone operations. The work in these laboratories generally consists of handling human specimens (blood, urine, etc.) and using chemical reagents for analysis. Some samples may be infectious; because it is impossible to know which samples may be contaminated, good work practices require that all be handled as biohazardous materials. The primary protection of the staff at clinical laboratories depends on the techniques and laboratory equipment (e.g., biological safety cabinets) used to control aerosols, spills, or other inadvertent releases of samples and reagents. People outside the laboratory must also be protected. The building HVAC system can provide additional protection with suitable exhaust, ventilation, and filtration. The HVAC engineer is responsible for providing an HVAC system that meets the biological and chemical safety requirements. The engineer should consult with appropriate senior staff and safety professionals to ascertain what potentially hazardous chemical or biohazardous conditions will be in the facility and then provide suitable engineering controls to minimize risks to staff and the community. Appropriate laboratory staff and the design engineer should consider using biological safety cabinets, chemical fume hoods, and other specific exhaust systems.

4. Teaching Laboratories

Laboratories in academic settings can generally be classified as either those used for instruction or those used for research. Research laboratories vary significantly depending on the work being performed; they generally fit into one of the categories of laboratories described previously. The design requirements for teaching laboratories also vary based on their function. The designer should become familiar with the specific teaching program, so that a suitable hazard assessment can be made. For example, the requirements for the number and size of fume hoods vary greatly between undergraduate inorganic and graduate organic chemistry teaching laboratories. Unique aspects of teaching laboratories include the need of the instructor to be in visual contact with the students at their work stations and to have ready access to the controls for the fume hood operations and any safety shutoff devices and alarms. Frequently, students have not received extensive safety instruction, so easily understood controls and labeling are necessary. Because the teaching environment depends on verbal communication, sound from the building ventilation system is an important concern.

5. Wet Labs

Wet Laboratory space types are defined as laboratories where chemicals, drugs, or other material or biological matter are tested and analyzed requiring water, direct ventilation, and specialized piped utilities. Wet Laboratory space types do not include biohazards in Levels BL-2, BL-3, and BL-4 as defined by the 2007 NIH/CDC guideline "Bio safety in Microbiological and Biomedical Laboratories." The Wet Laboratory space types typically located within a building specifically designed to house them (see WBDG Research Facilities.

Offices, general storage, and warehouse spaces associated with laboratories are covered in their own respective space types.

Wet Laboratory space types are unique in that they must accommodate simultaneous and separate ventilation and utility connections at individual lab modules to ensure both the reliability and accuracy of results as well as occupant safety throughout the space. Typical features of wet laboratory space types include the list of applicable design objectives elements as outlined below. For a complete list and definitions of the design objectives within the context of whole building design, click on the titles below.

Surfaces: Resilient surfaces are an integral part of the Wet Laboratory space type design. Use epoxy paint for lab walls and monolithic, seamless, chemical-resistant vinyl flooring with integral coved base and mylar finish.

Separate Laboratory Modules: A Wet Lab space is typically divided into separate laboratory modules that contain individually controlled connections to HVAC, utilities, and safety devices. Modules are defined spatially by floor-to-ceiling structural slab with under-floor plenum divider.

Constant and Reliable HVAC: As some equipment and experiments are temperature- and humidity-sensitive, constant conditions are required in Wet Laboratory spaces to ensure that equipment can perform properly and that experiments produce accurate results. Laboratories are usually supplied with variable volume, terminal reheat system with pre-filters and after-filters for 90% efficiency. In general, laboratory spaces have negative pressure relative to other spaces with no return air from the laboratory to the other spaces.

Dust Control: Just as experiments and equipment may be sensitive to changes in temperature and humidity, so might they be to dust and other foreign particulates.

Gas/Utility Services: Utility connections in Wet Laboratory space types can include vacuum, pneumatic supply, natural gas, O₂ and CO₂, and distilled water. The fittings and connections for each module are connected to the building distribution system for six nominal piping systems.

Fume Hoods: Design Wet Laboratory space types to accommodate one 6'-0" chemical fume hood for each laboratory module, and provide direct 100% exhaust. It is also typical of this space type to include an acid and corrosives vented storage cabinet located under the fume hood, as well storage for emergency equipment.

Laboratory Occupancy: Occupancy Group Classification for Wet Laboratory is B2, Sprinkler protected construction, as per IBC, with a GSA Acoustical Class C1 for enclosed spaces and Class C2 for open spaces.

Fire and Life Safety: All Laboratory spaces should contain a hand-held chemical emergency fire extinguisher in an emergency equipment cabinet. There is generally one fire alarm pull station by each egress point and an audible and visible (strobe) alarm in each occupiable space (not including closets, storage rooms, or coat racks). Also include toxic gas monitors in each lab module and a gas storage area with audio and visual (strobe) alarms both inside and outside the lab. Eyewash and deluge shower should be located at each module quad.

6. Sustainable lab Design

- a. The key aspects of sustainable laboratory design include:
 - Increased energy and water conservation and efficiency
 - Reduction or elimination of harmful substances and waste

- Improvements to the interior and exterior environments, leading to increased productivity
 - Efficient use of materials and resources
 - Recycling and increased use of products with recycled content
- b. The following table should be used and expanded as a sustainable design criteria chart set up for a specific laboratory project. Each criterion must be reviewed for each specific project.

Sustainable Design Criteria				
Parameter	Code Minimum	Code Reference	Standard Practice	Design Target
Ventilation				
Filtration				
Indoor Design Temperature				
Humidity Control				
Equipment Heat Dissipation*				
Toilet Exhaust				
Connected Lighting Heat Load				
Lighting Levels				
Building Shell Infiltration				
Building Shell Infiltration (alternate)				
Exterior Wall Insulation				
Exterior Wall Moisture Control				
Roof Insulation				
Windows				
Glazing type				
Visible transmittance				
Shading Coefficient				
U value				
Heat Degree Days				

* Provide calculations

F. CONTROL

Laboratory controls must regulate temperature and humidity, control and monitor laboratory safety devices that protect personnel, and control and monitor secondary safety barriers used to protect the environment outside the laboratory from laboratory operations (West 1978).

Reliability, redundancy, accuracy, and monitoring are important factors in controlling the lab environment. Many laboratories require precise control of temperature, humidity, and airflows. Components of the control system must provide the necessary accuracy and corrosion

resistance if they are exposed to corrosive environments. Laboratory controls should provide failsafe operation, which should be defined jointly with the safety officer, and shall incorporate alarm systems.

G. COMMISSIONING

In addition to HVAC systems, electrical systems and chemical handling and storage areas must be commissioned. Training of technicians, scientists, and maintenance personnel is a critical aspect of the commissioning process. Users must understand the systems and their operation. It should be determined early in the design process whether any laboratory systems must comply with Food and Drug Administration (FDA) regulations because these systems have additional design and commissioning requirements. Commissioning process is outlined in ASHRAE *Guideline 1*. Laboratory commissioning is more demanding than that described in ASHRAE *Guideline 1* because areas must be considered that are not associated with the normal office complex. Requirements for commissioning should be clearly understood by all participants, including the contractors and the owner's personnel. Roles and responsibilities should be defined, and responsibilities for documenting results should be established. Laboratory commissioning starts with the intended use of the laboratory and should include development of a commissioning plan, as outlined in ASHRAE *Guideline 1*. The validation of individual components should come first; after individual components are successfully validated, the entire system should be evaluated.

This requires verification and documentation that the design meets applicable codes and standards and that it has been constructed in accordance with the design intent. Before general commissioning begins, the following data must be obtained:

1. Complete set of the laboratory utility drawings
2. Definition of the use of the laboratory and an understanding of the work being performed
3. Equipment requirements
4. All test results
5. Understanding of the intent of the system operation - For HVAC system commissioning, the following should be verified and documented
6. Fume hood design face velocities have been met.
7. Manufacturer's requirements for airflow for biological safety cabinets and laminar flow clean benches have been met.
8. Exhaust system configuration, damper locations, and performance characteristics, including any required emission equipment, are correct.
9. Control system operates as specified. Controls include fume hood alarm; miscellaneous safety alarm systems; fume hood and other exhaust airflow regulation; laboratory pressurization control system; laboratory temperature control system; and main ventilation unit controls for supply, exhaust, and heat recovery systems. Control system performance verification should include speed of response, accuracy, repeatability, turndown, and stability.
10. Desired laboratory pressurization relationships are maintained throughout the laboratory, including entrances, adjoining areas, air locks, interior rooms, and hallways. Balancing terminal devices within 10% of design requirements will not provide adequate results. Additionally, internal pressure relationships can be affected by airflow around the building itself. See Chapter 16 of the 2005 *ASHRAE Handbook—Fundamentals* for more information.

11. Fume hood containment performance is within specification.
12. ASHRAE *Standard* 110 provides criteria for this evaluation.
13. Dynamic response of the laboratory's control system is satisfactory. One method of testing the control system is to open and shut laboratory doors during fume hood performance testing.
14. System fault tree and failure modes are as specified.
15. Standby electrical power systems function properly.
16. Design noise criterion (NC) levels of occupied spaces have been fault tree can be developed to evaluate the impact of the failure of any control system component and to ensure that safe conditions are maintained.

H. ECONOMICS

1. In laboratories, HVAC systems make up a significant part (often 30 to 50%) of the overall construction budget. The design criteria and system requirements must be reconciled with the budget allotment for HVAC early in the planning stages and continually throughout the design stages to ensure that the project remains within budget. Every project must be evaluated on both its technical features and its economics. The following common economic terms are defined as follows:
2. **Initial cost:** Costs to design, install, and test an HVAC system such that it is fully operational and suitable for use.
3. **Operating cost:** Cost to operate a system (including energy, maintenance, and component replacements) such that the total system can reach the end of its normal useful life.
4. **Life-cycle cost:** Cost related to the total cost over the life of the HVAC system, including initial capital cost, considering the time value of money.
5. Many technical considerations and the great variety of equipment available influence the design of HVAC systems. Factors affecting design must be well defined to ensure appropriate comparisons between various systems and to determine the impact on either first or operating costs.

I. CUCF LAB, DESIGN PARAMETERS

The following parameters shall be followed for determining the heating and cooling, and ventilation loads for the CUCF labs:

1. **Temperature and Relative Humidity**
 - a. Winter outdoor air condition 11 F
 - b. Winter indoor design 72 F 30% R.H.
 - c. Summer outdoor air condition 92 F D.B 77 F W.B.
 - d. Summer indoor design 72 F 50% R.H
2. Labs shall be designed with 100% outside air and 100% exhaust.
3. Labs shall be designed with negative pressure to eliminate exfiltration of contamination. There shall be a dedicated exhaust system.
4. For labs using fume hoods, required supply and exhaust cfm shall be calculated based on the hoods exhaust requirement first. If the cfm based on the hoods requirement satisfies 1

cfm/sq.ft., 6 ACH and the required sensible heating and cooling loads then this cfm will be used. Otherwise, one of the following which is most stringent (that covers the other requirements) shall be used for calculating the required supply and exhaust cfm:

- a. 1 cfm/sq.ft. plus sensible heating/cooling loads
 - b. ACH (this must cover sensible heating/cooling loads)
5. DDCM/CUCF requires a minimum of 6ACH for occupied labs. and a minimum of 4 ACH for unoccupied labs.
 6. The ASHRAE 110-1995 Standards require 3 tests for fume hoods.
 - a. Face velocity test (must comply with latest NYC Fire Dept. Code and latest NFPA 45)
 - b. Smoke test
 - c. Tracer gas test
 - d. All three tests must be passed in order to accept the fume hood.
 7. Lab fume hoods shall be designed for consistent and safe air flow through the hood face. Fume hoods shall be so vented that a minimum average face velocity of 100 feet per minute shall be maintained at 18" sash opening.
 8. Use Strobic exhaust fans using direct drive, high dilution, and high plume discharge fan system in compliance with ANSI Z9.5 (1992). The dilution capability shall be up to 170% of free outside air being introduced into the air stream above the roof.
 9. Design fume hood exhaust fan with variable speed rather than constant flow and constant exit velocity. This will provide savings for operational cost.
 10. Include zone presence sensors at each hood with auto sash closers to close the hood sash when not in use. This will have more initial cost but it provides great savings.
 11. Branch ducts and main exhaust risers for Perchloric acid fume hoods and
 12. Radioisotope substances shall be designed with stainless steel.

J. CUCF HVAC NON-LABORATORY DESIGN PARAMETERS

1. Temperature and Relative Humidity:

- a. Winter: Outdoor Air 11 degrees F
- b. Winter: Indoor condition 70 F and 30% R.H.
- c. Summer: Outdoor Air 92 degrees F D.B. 77 degrees W.B.
- d. Indoor condition: 75 degrees F and 50% R.H.

Note: The above Temperature and Humidity criteria are for normal comfort condition only. For specific environmental requirements for specialized spaces such as laboratories, computer facilities, animal quarters, art studios etc. refer to facilities program for temperature and humidity requirements. In addition to this, the consultant shall follow the ASHRAE Guidelines along with Industry Standards as required.

2. Classrooms and Offices shall be designed with VAV System.
3. Provide separate 100% make-up air unit to pressurize staircases.
4. Provide separate A.C. units for corridors and bathrooms (no return from bathroom). This system shall be Constant volume.
5. Provide separate exhaust system for the bathrooms.

K. LIGHTING

1. Follow IES-Illuminating Engineering Society standards for Lighting design illumination, and foot-candle requirements.
2. Follow ASHRAE 90.1 for the compliance with their requirements for Watt per Square Feet for the laboratories and other spaces.

APPENDIX H

FIRE ALARM SYSTEMS

A. GENERAL

1. Fire alarm system design shall be in accordance with the latest rules and regulations of the New York City Buildings Department (NYC DOB), the New York City Fire Department (FDNY) and the Americans with Disabilities Act (ADA).
2. The design of fire alarm systems shall be closely coordinated with FDNY in order to obtain approval for the applicable fire alarm classification of the building.
3. The Consultant must obtain the approval from FDNY and NYC DOB prior to project bidding.
4. If the existing building does not have a certificate of occupancy, the consultant must prepare a narrative to describe the occupancy/use of the building, the classification of the existing fire alarm system, type of fire suppression system, etc. in lieu of the certificate of occupancy.
5. If the building has an existing fire pump, the consultant must evaluate the condition of the pump and show the pump on the fire alarm drawings, file the pump as part of the fire alarm filing application with DOB and FDNY and obtain approvals.

B. EVALUATIONS AND MODIFICATIONS OF EXISTING SYSTEMS

1. Identify all existing systems and evaluate the capability of these systems to work together and with systems to be added.
2. Perform a complete document search at the Building and Fire Departments to find all documents with respect to: the building's classification, latest fire alarm system classification, public assembly areas, status of filing and/or approval of each, status of existing code violations and level of compliance with the latest codes.
3. Identify all code related deficiencies with respect to the NYC DOB, NYC FDNY and ADA, including but not limited to, identifying and evaluating deficiencies in the alarms, smoke purge systems, fan shutdown systems, smoke actuated duct damper systems, flow switches, fire pump, standpipe, sprinkler and deluge systems.
4. If upgrade of the mechanical components of the smoke purge system or deluge system is not part of the fire alarm project, correction of the electrical/control portion of these systems and the connection to the fire alarm system shall be incorporated into the design of the new fire alarm system.
5. Evaluate all special occupancy areas within the building such as public assembly spaces, day care centers, commercial kitchens, etc. and identify the associated occupancy and fire alarm system classification in each area.
6. Evaluate and identify fire alarm classification required, based on existing construction and occupancy classification. Take into account all building areas including areas with different occupancy and/or fire alarm classifications. Contact NYC DOB & FDNY and obtain their preliminary approvals of occupancy and fire alarm classifications and design of the fire alarm systems. Final bid documents must be submitted to NYC DOB & FDNY and approval must be obtained prior to bid.

7. Incorporate all components of the existing mechanical ventilation and elevator system for smoke purging fan shut down and emergency elevator recall operation as per code. This shall include, air handling units and associated fire smoke dampers (both at the units and within ventilation ducts), all elevator systems that should be put on firemen's emergency service and elevator recall operation upon a fire emergency. Fire alarm projects shall include the design and modification of the elevator control panel and elevator cab panel; identification of all fire smoke dampers and replacement of defective ones; and connection to, programming and modification of the buildings' HVAC control management system.
8. Demolition and removal of an existing fire alarm system or portions of the system shall be carefully coordinated and scheduled to ensure that the existing system will be kept operational until the new system is functional. If the existing fire alarm system is inoperative, or is rendered inoperative during construction, the Contractor shall provide the necessary fire watch in compliance with NYC DOB & FDNY rules and regulations.
9. In addition to the design, all specified materials and system components shall be reviewed and approved by DDCM and the College prior to bid.

APPENDIX I

ENERGY CODE REQUIREMENTS

A. OVERVIEW

1. DDCM/CUCF requires the consultant to comply completely with the latest New York City Energy Conservation Code (NYCECC).
2. It is the Consultant's responsibility to determine the NYCECC requirements, compliance procedures and the correct forms to be filed with the NYC Department of Buildings.
3. The Consultant will be proactive in initiating the required energy analyses and developing energy-reduction strategies early in the design process.
4. DDCM/CUCF requires compliance with New York City Local Law 86 energy reductions for its community colleges and Executive Order 88 for its senior colleges.

B. NEW YORK CITY ENERGY CONSERVATION CODE

1. To meet the City's goal of reducing greenhouse emission intensity by 40% by 2030, the New York City Energy Conservation Code (NYCECC) sets energy-efficiency standards for new construction and alterations to existing buildings.
2. All New Building and Alteration applications must comply with the New York City Energy Conservation Code (NYCECC).
3. To demonstrate compliance with the latest NYCECC, for all New Buildings and Alterations Type 1, 2 and 3, applications, the Consultant must include the items listed below. The Consultant will refer to the Code and other updated information provided by the NYC Department of Buildings to determine specifics regarding these and any other items.
 - a. Professional Statement of Compliance by the design professional
 - b. Energy Analysis demonstrating Compliance
 - c. Drawing set demonstrating Energy Analysis.

APPENDIX J
REQUIREMENTS FOR SHOP DRAWING STAMP

- A.** Shop drawings, after having been reviewed by the Consultant, shall be stamped and signed by the Consultant. The stamp shall have the following approval designations and text listed below.
- ☐ APPROVED
 - ☐ DISAPPROVED
 - ☐ APPROVED AS NOTED
 - ☐ REVISE AND SUBMIT
- B.** The above approval shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract. The Contractor shall be responsible for the accuracy of the Shop Drawings and samples and for the conformity of Shop Drawings and samples with the Contract unless the Contractor has notified the Consultant of the deviation in writing at the time of submission and has received the Consultant's written approval of the specified deviations. The above approval shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or samples.
- C.** The above approval is given subject to any corrections noted on the drawings, and subject to the condition that the Contractor is not relieved of the responsibility for correct measurements, dimensions, quantities, material, proper connection or requisite fitting of parts either to adjacent work or to parts of the same work, or for fully complying with the requirements of the contract drawings and specifications.
- D.** Drawings have been checked for conformance with over-all design requirements and in particular, where applicable, as to structural strength of permanent structure and electrical current characteristics of electrically operated equipment.
- E.** All measurements and conditions shall be checked and verified by the Contractor at the site.
- F.** Corrections shown on this drawing shall not be deemed an order for extra work.
- G.** No change shall be made on any approved drawing without the written authorization of DDCM/CUCF.

CONSULTANT NAME & ADDRESS: _____

CONSULTANT TELEPHONE & FAX: _____

REVIEWED BY: _____ DATE: _____

Signature

APPENDIX K

SPECIAL INSPECTIONS

A. OVERVIEW

1. Special inspection is a requirement of the NYC Construction Codes.
2. The special inspection process is in addition to typical inspections conducted by the NYC Department of Buildings (DOB) inspector and by the registered design professionals as part of periodic observations.
3. Special inspectors, who shall be independent of the contractors responsible for the work, furnish continuous or periodic inspection as prescribed in the NYC Construction Codes.

B. GENERAL RESPONSIBILITIES

1. The **Special Inspection Consultant** will perform all inspections in accordance with the NYC Department of Buildings requirements and file the appropriate reports with DOB.
2. **CUCF** will typically select the special inspection consultant to perform all the required special inspections for a particular project either during the construction document review phase or at the preconstruction phase, depending on the project schedule and timeline.
3. The **Architect or Engineer of Record (RA/PE)** shall determine the types of inspections and make the initial filing with the NYC Department of Buildings, using the latest DOB forms and process for filing. The RA/PE shall provide the project documents to the special inspection consultant and assist with any clarifications.
4. The **Construction Manager (CM) or General Contractor (GC)** is responsible for coordination and for notifying the special inspection consultant to perform the special inspection work. The CM/GC is responsible for providing access to and the means for safe and proper inspection of such work. Inspections may be denied if safe access is not provided at the job site.

C. SPECIAL INSPECTIONS-SPECIFIC REQUIREMENTS AND RESPONSIBILITIES

1. **DOB Compliance:** Only special inspectors and special inspection agencies that have been approved by the NYC DOB may perform inspection and testing functions and provide the information described in the NYC Construction Codes, and they shall comply with all the DOB requirements.
2. **Verification of Extent of Special Inspections:** Special inspectors are responsible for verifying that those items detailed in the plans, specifications, and TR-1s are built into the project.
 - a. Special inspectors are expected to understand the information that has been provided and evaluate and determine if that information is sufficient to successfully perform the inspection. They shall thoroughly review the documents ahead of construction to establish that they can inspect each item entrusted to them.
 - b. If some of the required information is not available and/or if there are errors and/or omissions in the documents, the special inspectors must obtain the necessary information in approved written form and resolve any doubts or ambiguity.
 - c. The special inspectors shall record that sufficient clear information was furnished for each item observed or inspected.

3. **Responsibility:** The special inspector is totally responsible for obtaining the information to properly perform the work and there is absolutely no release for not having information, not being able to find information or having ambiguous information.
4. **Notification:** The Special Inspector shall notify the NYC DOB Inspector of commencement of inspection of a job.
5. **Time of Inspection:** All visual inspection shall be continuous unless approval is obtained from DDCM or allowed by the NYC Building Code for progress special inspection.
6. **Identification:** Special inspectors shall display a badge-type name tag, identifying the company and the individual's name, at all times when an inspector is performing special inspection duties at any project.
7. **Observation of Work:** The special inspection firm shall observe the work for conformance with the stamped approved plans, plan revisions and supporting documents. Other construction documents that do not carry a NYC DOB approval stamp may only be used as an aid to inspection.
8. **Report on non-conforming items:**
 - a. The special inspection firm shall bring nonconforming items to the immediate attention of DDCM/CUCF by the issuance of a Notice of Non-Compliance and note all such items in the daily report. The special inspection firm shall also notify the Engineer or Architect of Record, the CM and the contractor.
 - b. Notices of non-compliance shall be written in a format acceptable to the NYC DOB. One copy of the Non-Compliance shall be posted on the jobsite, and one copy shall be faxed to DDCM/CUCF. The report should note discrepancies, which should contain, as a minimum, the following information about each nonconforming item:
 - Description and exact location
 - Reference to applicable detail of approved plans/specifications
 - Name and title of each individual notified and method of notification
 - Resolution or corrective action taken
 - Date of occurrence/observation
 - c. This Notice of Non-Compliance gives the authority to suspend all work in the areas of such non-compliance, until the non-compliance is corrected and a field report indicating compliance has been issued by the special inspection firm.
9. **Notifications to DOB:** The special inspection firm is responsible to immediately notify the NYC DOB of any structural failure, collapse or condition that, in the opinion of the special inspection firm, may possibly lead to a structural failure.
10. **Daily Reports:** The special inspection firm shall complete and sign a daily inspection report. A daily report is required for any time spent at a project site. All supporting documentation shall also be signed by the special inspector. All inspection reports, Notices of Non-Compliance, testing results and all project documents reviewed by the special inspector shall be placed in the project file and remain at the project for observation by the NYC DOB Inspector until all special inspection activity for the project is completed to the satisfaction of the NYC DOB. Reports shall be written to the satisfaction of DDCM/CUCF and the NYC DOB Inspectors. The Special Inspection inspector shall maintain records of each special inspection on a building by building basis for a period of six years. A copy of these reports shall be provided to DDCM/CUCF for their records. In these reports, special inspectors should:
 - a. Describe inspections and tests made with applicable locations
 - b. Indicate how nonconforming items were resolved
 - c. List unresolved items, parties notified, and time and method of notification

- d. Itemize changes authorized by the registered design professional in charge if not included in nonconforming items.

D. QUALITY CONTROL

1. **High Standards:** Special Inspection firms must be responsible for inspections of a high standard by virtue of their in depth knowledge of the subject.
2. **Supervision:** Special inspection firms shall be responsible for supervising all special inspectors and testing technicians. Each firm shall assign only trained, experienced, City of New York approved, special inspector and/or testing technician to projects requiring special inspection and/or testing. The firm is responsible for all actions of their approved special inspectors and testing technicians.
3. **Technical Services Requirement:** The NYC Construction Codes require that inspection and testing of piling, drilled piers and caissons, grading, excavation, and filling shall be inspected by a NYC professional Engineer
4. **Negligence:** If CUCF determines that an approved special inspector is negligent in the performance of his assigned duties through a failure to be present to perform necessary inspections, or failure to provide acceptable daily reports, or is engaged in a conflict of interest, or fails to conform to the requirements of the technical guidelines, than that inspector shall be subject to removal from the approved DDCM/CUCF list for the particular inspection item involved in the negligent act until the negligent act is resolved. All negligent items must be cleared up and resolved within three working days. A second negligent act would require the firm inspector's supervisor or Quality Control Manager to present a training plan to cover the areas of deficiency. A third negligent act within a quarter will result in the removal or suspension of the special inspector from the approved list for the item or items involved. Failure of the firm to correct the deficiency causing the removal of the firm special inspector will result in disciplinary action and/or suspension from the NYC DOB approved list.
5. **Inspector Independence:** Firm special inspectors cannot be in the employ of the contractor, subcontractor or material supplier.

E. FINAL REPORTS

1. **Submittal to DDCM/CUCF:** The special inspection firm shall initially submit final signed reports to DDCM/CUCF stating whether all work requiring special inspection was inspected, reported and found to be in substantial compliance with the approved plans, specifications and the NYC DOB's Rules and Regulations.
2. **Non-compliance items:** The final reports shall not be submitted to the NYC DOB until all non-compliances have been cleared or have been identified in the final report as being unresolved and accepted by DDCM/CUCF.
3. **Certification:** ANYS-licensed professional Engineer or Architect, working for the special inspection firm in the appropriate discipline, must stamp, sign and date each final report. Final report and report packages shall include all inspection, testing and engineer signed reports. The final report certifies that all inspections, engineering and testing tasks required by the project were completed as required or exceptions taken and documented as being acceptable to the NYC DOB.
4. **DOB Forms.** The Special Inspection Consultant is responsible for using the latest DOB forms in filing reports.
5. **Submittal of Final Report to DOB:** Special inspectors or inspection agencies shall submit a final signed report to the NYC Department of Buildings stating that all items requiring special inspection and testing were fulfilled and reported and, to the best of their knowledge in

conformance with the approved plans, specifications and the applicable provisions of the NYC Building Code. Items not in conformance, unresolved items or any discrepancies in inspection coverage (i.e., missed inspections, periodic inspection when continuous was required, etc.) should be specifically itemized in this report.

APPENDIX L

DESIGN PREFERENCES AND REQUIREMENTS

A. General: To assist the Consultant, DDCM identified some, not all, design preferences and requirements. Highlighted below are interior finishes preferences, exterior design preferences, design approach considerations, lighting concerns, specific items for various types of spaces (classrooms, lecture halls/auditoria, offices, lounge/study areas, restrooms, and labs) and HVAC requirements. DDCM will periodically supplement and update these listings.

B. Interior Finishes Preferences:

1. 2' x 2' lay-in acoustical tile ceilings
2. Epoxy terrazzo in public areas on main levels for durability
3. Linoleum (a green material) for academic corridors above and below main level(s) and for classrooms if budget permits
4. Carpet tiles not rolled goods (with attic stock)
5. Recessed entry mat
6. Protection of sheetrock walls in high use areas with corner guards, chair rails, etc.
7. No vertical blinds

C. Exterior Design Preferences:

1. Cool roofs
2. Pervious paving
3. No exterior horizontal surfaces that lend themselves to pigeon roosting

D. Design Approach:

1. Main entrance at grade level or only slightly above grade level; avoid below grade main entrance
2. Stairs: Encourage active use of stairs
 - a. Stairs: Visible placement and design of stairs in locations to encourage active use – near entrances and integral to circulation; consider use of fire stairs for travel between floors and include attractive design elements.
 - b. Elevators: Locate elevators to discourage their use for travel that can easily occur with stairs.
 - c. Escalators: Do not include or limit including escalators.
3. Daylighting Enhancement: Optimize daylight and views in regularly occupied spaces and maximize daylight into corridors wherever possible.
4. Interior soffits: Ensure that soffits are accessible for cleaning or design soffits to limit dust accumulation.
5. Accessible entrances: Preference is for manual rather than mechanical access.
6. Electromagnetic Shielding: Evaluate electromagnetic shielding requirements when there is high tension service and use results in determining layout of program spaces.

E. Lighting:

1. Maximize the use of LED fixtures.
2. Limit the number of different types of lamps in a project.

3. As much as possible, specify standard lamp types commonly used on campus.
4. Ensure lamps are accessible and can be easily changed.
5. Provide shielded outdoor lighting in accordance with NY State provisions.
6. See lighting Appendices M and N for additional information.

F. Classrooms:

1. Confirm with the college whether coat hooks are required.
2. Confirm with the college whether they require chalkboards or white boards.
3. Provide high quality white boards that are easily erasable.
4. To the fullest extent possible, classrooms should be laid out so that students are seated with windows to their side (rather than in front or behind).

G. Lecture Halls/Auditoria:

1. Design a form/configuration that naturally provides good acoustics.
2. Ensure that site lines are maximized.
3. Consider ADA requirements for seating including disbursed seating, access to stage and path of travel to exits, restrooms, etc. at the conceptual design phase.

H. Public Assembly Spaces:

1. Perform a detailed analysis, with calculations, to ensure compliance with all regulatory agency and code requirements, including but not limited to:
 - a. Lighting (i.e., exit, emergency, footcandles along all egress paths, etc.)
 - b. Egress, doors, and travel distances
 - c. ADA (i.e., dispersed seating, access to raised platforms and pools, etc.)
 - d. Safe areas
 - e. Ventilation and life safety systems
2. File comprehensive PA Documents (including seating plan options) with NYC Department of Buildings to obtain a Public Assembly Certificate of Operation.
3. Filing documents with DOB shall reflect compliance with regulations from other agencies (Fire Department, Department of Health, etc.) For example, pool capacity calculations from the DOH may be more stringent than those in the DOB Construction Codes.

I. Offices:

1. Provide a minimum of two duplex or one quad outlet at each desk, in addition to any other outlets in the room.

J. Lounges/Study Areas:

1. Provide appropriately-sized, well-located receptacles for trash. Provide separate compartments for trash and for various recyclables (paper, bottles, and metal). If workable with overall design, consider creating a furred-out space for these receptacles. Specify

products that are easily accessible to college maintenance personnel. Review quantities and locations with the college.

2. Provide outlets for recharging phones and laptops

K. Restrooms:

1. The ceramic wall tile shall be full height.
2. No stainless steel restroom partitions.
3. Provide a shelf at mirrors in restrooms. If individual sinks are provided (vs. counters), provide a shelf above the sink for placing personal articles (e.g. eyeglasses).
4. Locate appropriately-sized paper towel dispensers in close proximity to sinks. If sinks are arranged in a long row, consider locating a dispenser in the middle or on the opposite wall in addition to at the end of the row.
5. Locate an adequate number of soap dispensers over the sinks (vs. in between sinks) so that they do not drip on the floor.
6. Specify semi-recessed or surface-mounted trash receptacles with large capacities. For group bathrooms, totally recessed receptacles do not have sufficient capacity.
7. Do not specify battery-operated hands-free faucets or flushometers. These should be hard wired.

L. Lab Standards:

1. Casework:
 - a. Drawer bodies of lab casework - stainless steel or painted metal
 - b. Bench tops - composite/resin in medium grey, not black, and any movable drawer/storage casework topped with composite/resin.
 - c. Shelves over floating benches - full depth, no intermediate stops
 - d. Over counter under (shelf-mounted) lights - fixed, not magnetic, with LED preferred.
2. Research Lab Layout:
 - a. For labs, provide open design layout with maximum flexibility.
 - b. Equipment rooms – separate from labs and provide adequate emergency generator services.
 - c. Consider linear equipment rooms.
 - d. Fume hoods – locate in separate rooms.
 - e. Split movable benches are preferred, with overhead feed of services.
 - f. Offices and staff lunch facilities - locate convenient to, but separated from, labs.
 - g. Design casual communal space throughout, with tables/chairs, seating groups and writing surfaces to encourage interdisciplinary interaction.
 - h. Provide labs with a high level of security; swipe card access is minimal standard.
3. Equipment:
 - a. Do not anchor sensitive equipment (NMRs) to bedrock; isolation slabs are preferred.
 - b. Always assume equipment will be operated at maximum resolution/tolerances and environment designed to allow for operation at least 95% of the time.
 - c. Provide continuous power for all critical equipment required for research continuity.

M. Data Centers

- a. For general lighting, specify LED flat panel lighting fixtures with dimming capability and provide occupancy sensors.

N. HVAC Specifications

- a. Specify pressure-independent valves for heating and cooling systems including hot water and chilled water coils on all air handling units. The valves shall be pressure-independent, modulating 2-way control valves.
- b. Specify stainless steel cooling towers with sweeper system.

APPENDIX M

LIGHTING PERFORMANCE REQUIREMENTS

A. SCOPE STATEMENT – SUMMARY

1. This appendix identifies the lighting philosophy of the CUCF and DDCM.
2. Lighting renovations, substantial improvements and new installations shall strategically incorporate emerging technologies (e.g., LED source technologies and advanced adaptive controls).
3. The lighting design for CUNY facilities shall represent a balanced approach to the objectives of saving energy and creating a quality lit environment in support of educational and, as such, must consider and accommodate the following:
 - a. Operational Criteria, such as:
 - Energy consumption
 - Ease of operation and
 - Continuing maintenance.
 - b. Performance Criteria, such as:
 - Student outcomes
 - Alertness
 - Human health and comfort.
 - c. Luminaire Manufacturing Criteria that are a benefit or a deterrent to CUCF/DDCM's lighting philosophy, such as:
 - Available lumen packages that may cause over-lighting and over-consumption if utilized in "one-for-one" replacement models
 - Manufacturers without partner control devices that can provide a single source of warranty for system operation.

B. DESIGN PARAMETERS

1. Refer to the sample lighting form at the end of the appendix.
2. The following design parameters must be established for each major interior space:
 - a. Activity within the space
 - b. Age of users of the space; identified within categories of classification as required by the lighting design reference standards utilized for the project type; specifically, the age of the human eye provides important information relative to the quality of the illumination required in a space.
 - c. Usage profile for the space, including hours of use and percentage of usage time allocated to each user age group
 - d. Baseline ambient illuminance values (without electric light)
 - e. Furniture and Equipment layouts within the space
 - f. Absorption values for architectural surfaces and finishes
 - g. Sequence of control and operation
 - h. Time of Use control
 - i. Horizontal maintained Illuminance values
 - j. Vertical maintained illuminance values for primary orientation
 - k. Required standards that must be referenced for compliance.

3. It is important to:
 - a. Establish listing of major interior spaces for the project with DDCM/CUCF.
 - b. Review design parameters with DDCM including applicable codes, standards and recommendations.
 - c. Determine the applicability of all regulatory agency requirements.
 - d. Comply with the NYC Construction Codes and Energy Conservation Code.
 - e. Establish the desirable operation and usage conditions for each major interior space.
 - f. Create a “Basis of Design Narrative” that contains, but is not limited to, the following:
 - The design team assumptions and given information relative to the design parameters established in this Appendix.
 - The basis of design illuminance levels for each space.
 - g. Provide a summary of the design parameters, identified in section B of this appendix, for each major interior space. Use the “Lighting Design Sample Form” template, found at the end of this appendix, which organizes all the required design parameters for submission to DDCM at designated milestones.

C. LIGHTING DESIGN FOR VISUAL OUTCOMES

1. IES (Illuminating Engineering Society) Criteria:
 - a. Minimum horizontal and vertical illuminance levels must be met.
 - b. Deviations from IES recommendations and/or practices must be identified and supporting documentation shall be provided to DDCM/CUCF for evaluation during Design Development.
2. ASHRAE/IES 90.1 (American Society of Heating, Refrigerating, and Air-Conditioning Engineers/Illuminating Engineering Society) Criteria:
 - a. Maximum lighting power density (LPD), expressed in watts per square foot, allowances shall be met.
3. DDCM/CUCF Criteria:
 - a. Lighting design must be performed relative to and accommodating of ambient daylight conditions in the space.
 - b. With the exception of integrated lighting technologies, lighting system components in new spaces shall not be utilized for non-lighting tasks. (For example, air handling luminaires must not be utilized; however, luminaires with integrated sensor technologies for daylight accommodation and vacancy sensing that can be integrated with BACnet building controls systems for the purpose of campus operational analytics may be utilized.)
 - c. Localized control systems must be expandable to allow future remote control from a centralized campus control system.
 - d. Energy considerations that are designed to exceed (i.e., be better than) NYC/NYS code requirements shall be made in the context of lowering waste stream and maintaining – or improving – a quality educational environment.
 - e. The spectrum and color rendering ability of sources shall meet the requirements of the educational environment in which they are employed. Spectral Power Distribution (SPD) curves for each source must be provided during submittals for evaluation.
 - f. Minimum acceptable CRI for Interior Spaces must be 80.

- g. Maximum acceptable Luminance Level of a light source must be 6,000 cd/m².
 - h. Finish selections must consider absorption and relationship to achieving vertical illuminance requirements and contrast ratios in the space.
4. Other reference standards based on application
- a. Application specific reference standards may be used for design in specialized areas.
 - b. Examples of specialized spaces include, but are not limited to:
 - Athletic Spaces - NCAA (National Collegiate Athletic Association) Best Lighting Practices
 - Laboratories
 - Theatrical and Stage
 - Security Checkpoints
 - Horticulture and Husbandry
5. Additional lighting design requirements for specific spaces include:
- a. Classrooms and Small Lecture Rooms must have lighting arranged to allow vertical illumination on primary instructional surface(s). Provide task lighting at podium and work surfaces if applicable. General lighting in the space shall have direct and indirect components to improve the feeling of brightness.
 - b. Lecture Theaters must have lighting arranged to allow vertical illumination on primary instructional/presentation surfaces and vertical illumination in audience area for facial recognition. Provide task lighting at podium and horizontal illumination at work surfaces if applicable. General lighting shall have direct and indirect components to improve the feeling of brightness and must be capable of achieving a minimum of two (2) illumination levels—one to accommodate young adults and the second to accommodate advanced adult visual acuity.
 - c. Performance Spaces, Theatres and Concert Halls shall have house luminaires and theatrical luminaires as appropriate. Theatrical luminaires must not be utilized to achieve emergency and/or egress illumination levels.
 - d. Laboratories must have lighting arranged to allow vertical illumination on primary instructional surface(s) and work bench areas, and may have task lighting, as appropriate, for the tasks being performed on work benches. Seating areas for lecture shall have horizontal levels appropriate for reading and writing tasks.
 - e. Libraries and Media Centers must have lighting arranged to provide vertical illumination on book stacks and media storage areas. Functional lighting in work and study spaces shall consider task lighting as the primary means of illumination for horizontal surfaces. General lighting can be decorative.
 - f. Computer and Technology Labs shall have task lighting at work surfaces. Contrast ratios shall be maximum of 3:1 with screen and background.
 - g. Physical Education and Gymnasium Spaces must consider horizontal and vertical illuminance levels consistent with pace, type, and level of play.
 - h. Offices shall have task lighting at work surfaces.
 - i. Lobbies, Atriums, Corridors, and Circulation Spaces shall have lighting arranged to provide vertical illumination to increase the feeling of brightness and spaciousness.
 - j. Mechanical and Maintenance Spaces shall have general lighting solutions with task lighting provided for specialized work and control panel areas.

D. LIGHTING DESIGN FOR NON-VISUAL OUTCOMES

1. There has been significant research and gained understanding of the impact of light on human health, alertness, performance and circadian entrainment. Technical standards and recommended practices, relative to non-visual outcomes for the “lighting design” and “user of light” communities are in the process of being written by global standards organizations.
2. It is the goal and intent of DDCM/CUCF to create a lit environment for our students, faculty, employees and guests that is conducive to learning and working while providing the best opportunity for continuing success and outcomes.
3. Given the nature of the rapidly evolving area of lighting for non-visual outcomes, it is important for the design team to utilize the project design parameters and refer to the most recently published, related guidelines from the following organizations:
 - a. IES
 - b. CIE (French: Commission Internationale de l'Eclairage; English: International Commission on Illumination)

E. LIGHTING CONTROL

1. Type and amount of control must meet minimum requirements of DDCM/CUCF and/or the authority or regulatory agencies having jurisdiction – whichever is most stringent.
2. Unless compliance standards indicate otherwise (for example, NCAA), if daylight is available in the space, lighting shall be reactive (that is, responsive) to amount of daylight in the space.
3. Additional control requirements for specific spaces include:
 - a. Classrooms and Small Lecture Rooms shall have instructor adjustable controls. Minimum light level adjustments shall include dimming and on-off control of luminaires for projection, lecture, and general lighting scenes. General lighting must provide control to create a minimum of two illumination levels; one to accommodate young adults and the second to accommodate advanced adult visual acuity. In a standard classroom, one (1) control location, near the main entrance and in proximity to the teaching area, may be provided. For larger area rooms, two (2) control locations may be provided; one (1) at primary room entrance and one (1) at the primary teaching area.
 - b. Lecture Theaters shall have instructor and A/V professional adjustable controls (found in a control room and utilized by trained individuals). Control locations shall be at front of theatre (podium) and at control room. Minimum light level adjustments shall include dimming and on-off control of luminaires for projection, lecture/presentation, general, and egress lighting scenes. General lighting must provide control to create a minimum of two illumination levels; one to accommodate young adults and the second to accommodate advanced adult visual acuity.
 - c. Performance Spaces, Theatres, and Concert Halls shall have adjustable controls that are managed and operated by an A/V professional. Lighting control shall be separated into house luminaires and theatrical luminaires.
 - d. Laboratories General lighting must include control to create a minimum of two active work zones in the space to allow localized lighting such that fewer work benches can be utilized and lit.
 - e. Libraries and Media Centers shall have local control for task lighting.
 - f. Computer and Technology Labs shall include dimming and on-off control of luminaires near technology equipment and screens. Task lighting on work surfaces shall be locally controlled.
 - g. Physical Education and Gymnasium Spaces must have control that will provide

lower illumination levels for general education and higher illumination levels for competitive sports and televised broadcast. Controls must be accessible, only, to authorized personnel including, but not limited to, coaches and facility staff members.

- h. Offices shall include local control of task lighting.
- i. Lobbies, Atriums, Corridors, and Circulation Spaces shall include dimming and scene control as appropriate for use. For example, gallery wall installations in these areas will need specialized control zoning considerations.
- j. Mechanical and Maintenance Spaces shall include occupancy control where feasible and safe to do so.

F. LIGHTING DESIGN SUBMISSION REQUIREMENTS

1. In addition to the submission requirements defined elsewhere in this document, at the Schematic Design Phase project submission to DDCM, provide a lighting design narrative.
2. In addition to the submission requirements defined elsewhere in this document, at the 60% Construction Documents project submission to DDCM, provide the following additional information for review:
 - a. For each specified luminaire, candlepower distribution and photometric information including, but not limited to:
 - Total Lumens
 - Luminaire Efficiency
 - Luminaire Lumens/Watt
 - Color Temperature of Source
 - CRI of Source
 - Spectral Power Distribution curve of Source
 - For LED Sources, R1 through R14 of CIE defined colors
 - b. For each specified luminaire:
 - Compliance with observed power quality conditions for the area of installation
 - Compliance of (on-board) integral sensing technologies with designed mounting heights and areas of coverage
 - c. For each source, the mercury content per unit (mg).
 - d. For each area, Photometrics per IES grid standards for given area. Indicate assumed maintenance factors utilized to generate the calculated values.
 - e. Some university buildings are known to experience power quality issues, including sustained and transient over-voltage conditions. As part of the project's basis-of-design, the designer shall arrange for seven (7) calendar days of continuous power quality monitoring on the panelboards that will be supplying the project lighting. The power quality monitoring will include over/under voltage conditions, harmonics, and power factor. A power quality monitoring plan shall be submitted and approved by DDCM, which will include location of meters, values to be metered, metering equipment datasheets, and the format of the conditions summary report.

G. LIGHTING COMMISSIONING

1. Lighting systems must be commissioned and commissioning participation will be required of the Contractor and the Lighting Designer (or responsible design team professional). Training of university stakeholders, including but not limited to educators, operations, and facility personnel, is a critical aspect to the ongoing performance of quality lighting systems. Users must understand the systems and operation to ensure that designed

lighting quality and economy goals are achieved. Training must be accomplished by factory/manufacture experts and/or the design team in the forms of hands-on training, demonstration training, and orientation presentation.

2. In general, the designed lighting systems must have performance verification and documentation that the installed system meets applicable codes, standards, and design criteria and DDCM/CUCF requirements, and has been constructed in accordance with the design intent.
3. Commissioning of lighting systems must be performed after dark.
4. Prior to commissioning activities, the following information must be obtained and available for reference by the commissioning team during commissioning activities.
 - a. Complete set of construction documents, including as constructed mark-ups
 - b. Designed illuminance levels for each space
 - c. Operation and usage conditions of each space
 - d. Luminaire and Control device and system equipment cutsheets
5. Prior to commissioning activities, the contractor shall:
 - a. Ensure all luminaires, sources and luminaire control devices (for example: snoots, filters, baffles) are installed and operational.
 - b. Perform preliminary control system settings.
 - c. Ensure necessary equipment and personnel are available for commissioning –including, but not limited to: laptops, ladders, tools, gloves, flashlights, firmware/software and illuminance meters.
6. Unless defined otherwise by project documentation, minimum lighting system commissioning activities shall include:
 - a. Verification of manufacturer, type, and quantity of installed lighting system components
 - b. Verification of designed illuminance levels for horizontal and vertical surfaces
 - c. Aiming of luminaires
 - d. Control system set-up
 - e. Control scene performance verification
 - f. Daylight sensor commissioning
 - g. Occupancy/vacancy sensor commissioning
7. A minimum of six months post installation commissioning services must be provided.

H. LIGHTING DESIGN SAMPLE DOCUMENTS

1. Following is a sample lighting form that is a useful tool for consolidating lighting information (parameters, design, etc.) for each space.
2. The Lighting Consultant shall provide the information delineated in the form to DDCM.
3. In addition, refer to Appendix N for samples of Lighting Specification sections to assist in the consultant's preparation of the lighting design documents.

LIGHTING DESIGN SAMPLE FORM

Project: [Name]
(Number)

Space Designation (Campus/Building/Room)	Activity in Space
---------------------------------------------	-------------------

	Unoccupied	Age <25	Age 25 - 65	Age >65
Usage Hours Per 24-hour day for each age group. Sum total should equal 24.				

	Measurement Date	Horizontal	Vertical
Baseline Ambient Illuminance Value Recorded as Average and Measured at Noon.			

Design Team Assumptions	(Include relevant given information about the space that impacts lighting decisions)
-------------------------	--------------------------------------------------------------------------------------

	Ceiling	Walls	Floor	Furnishings
Finish Absorption Values Recorded as a Percentage				

	Justification	Horizontal	Vertical
Design Illuminance Value	(Provide Reference Standard Process followed to Arrive at Design Illuminance Value for Space)		
Calculated Illuminance Value			

Lighting Control	(Description of control and zoning in the space)
------------------	--------------------------------------------------

Document	Attached
Lighting Plan	
Furniture / Equipment Layout	
Point – by - Point	
Luminaire Cutsheet(s)	

APPENDIX N

LIGHTING AND LIGHTING COMMISSIONING SPECIFICATIONS

GENERAL

- A. To assist consultants in the preparation of lighting and lighting commissioning specifications, sample specifications for four lighting sections follow.
- B. These sample specifications include:
 - 1. Lighting Control – Section 26 09 22
 - 2. Lighting Performance Requirements - Section 26 51 10
 - 3. Interior Lighting Emerging Technologies – Section 26 51 25 and
 - 4. Lighting Commissioning – Section 01 9x xx.
- C. Consultants may use these specifications as a basis, refining and adding any project-specific criteria as required.

SECTION 26 09 22 - LIGHTING CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section identifies considerations relative to control of emerging lighting technologies for interior lighting retrofit and new construction projects at The City University of New York (CUNY) facilities.
- B. There are a variety of space types for consideration in CUNY campuses and facilities. Specific philosophy for lighting control for these areas can be found in Appendix M of the DDCM/CUCF Consultant Design Guidelines. In general, these spaces include – but are not limited to – the following:
 - 1. Classrooms and Small Lecture Rooms
 - 2. Lecture Theaters
 - 3. Performance Spaces, Theaters, and Concert Halls
 - 4. Laboratories
 - 5. Libraries and Media Centers
 - 6. Computer and Technology Labs
 - 7. Physical Education and Gymnasium Spaces
 - 8. Offices
 - 9. Lobbies, Atriums, Corridors, and Circulation Spaces
 - 10. Mechanical and Maintenance Spaces
- C. Section Includes:
 - 1. Daylight Controls
 - 2. Dimming Controls
 - 3. Smart Classroom Controls
 - 4. Occupancy/Vacancy Controls

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related requirements are also included in the following Sections:
 - 1. Division 26 Section "Lighting Performance Requirements" for CUNY interior lighting philosophy, goals, and objectives.
 - 2. Division 26 Section "Interior Lighting Emerging Technologies Considerations" for CUNY interior lighting requirements.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. Daylight Controls – Sensors and Devices for the purpose of creating an electric lighting usage profile that is responsive to the presence (or absence) of daylight in the interior environment.

1.4 REFERENCE STANDARDS

- A. Comply with the following standards:
 - 1. NEMA Standards applicable to lighting controls.
 - 2. UL Standards applicable to lighting controls.
 - 3. ANSI and ASTM standards mentioned in this Section and included in the UL and NEMA Standards applicable to lighting controls.

1.5 ENVIRONMENTAL CONDITIONS

- A. Provide interior lighting controls equipment and components fabricated from materials resistant to corrosion and suitable for the application in the locations where installed, in conformance with NEC requirements for installation in “damp”, “wet”, and hazardous (classified) areas.

1.6 SUBMITTALS

- A. Product Data: For interior lighting control equipment, components, and accessories.
- B. Shop Drawings: For the following interior lighting control equipment, components, and accessories. Include plans, elevations, sections, details, and attachments to other work as required to accurately depict intent.
 - 1. Custom enclosures and cabinets.
 - 2. Interconnection diagrams showing field installed wiring.
 - 3. Riser Diagrams for power, signal, and control wiring.
- C. Samples for Verification: Where indicated on contract documents.
- D. Qualification Data: For manufacturer, testing agency, integrator, and commissioning agent. Manufacturer must have ten (10) years of demonstrated experience in the research, design, and/or construction of associated interior lighting controls. Testing agency must be independent from manufacturer and must perform certified test reports for the products submitted. Integrator and/or commissioning agent must have ten (10) years of demonstrated experience in systems integration and commissioning activities.
- E. Source quality-control test reports.
- F. Or Equal Consideration: Products that meet the requirements of the contract documents and the intent of design and operational performance can be considered. Refer to Division 01 sections for submittal and approval requirements for consideration of alternative products.
- G. Sequence of Operation: For interior lighting control equipment, components, and accessories furnished and installed, provide the following:
 - 1. Description of sequence of automatic operation for each system.
 - 2. Description of sequence of user operation for each system.
 - 3. Description of sequence of owner operation and functionality for each system.
 - 4. Description of Campus control.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70 and NEMA standards.
- C. Components that make-up the interior lighting control system (devices, modules, panels, interfaces, software, and wired or wireless connectivity) must be guaranteed to perform as a system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This part provides minimum control system, equipment, and component requirements acceptable for installation at CUNY facilities and for specialized space types at CUNY facilities.

2.2 CONTROLS MANUFACTURERS

- A. Provide products by the following manufacturers:
 - 1. Acuity Brands
 - 2. Cooper Industries
 - 3. GE
 - 4. Leviton
 - 5. Lutron
 - 6. Philips
 - 7. Or approved equal. For submission requirements for equal approval, see 1.6 "Submittals".

2.3 CABLE MANUFACTURERS

- A. Provide products by the following manufacturers:
 - 1. Belden
 - 2. Corning
 - 3. General Cable
 - 4. Mohawk
 - 5. North Wire
 - 6. Okonite
 - 7. SAB North America
 - 8. Manufacturer Supplied or Recommended. For the lighting control devices provided for the project.
 - 9. Or approved equal. For submission requirements for equal approval, see 1.6 "Submittals".

2.4 OCCUPANCY/VACANCY CONTROLS

- A. Provide products by the following manufacturers:
 - 1. Leviton
 - 2. Wattstopper

3. Sensor Switch
 4. For luminaire mounted sensors (onboard sensors), as provided by the specified manufacturer.
- B. Electronic, solid-state device. Wired or wireless.
1. Failure of device must be to manual operation.
 2. Time delay must be adjustable.
 3. Line voltage input and switching unless noted otherwise in contract documents.
 4. UL listed with five (5) year manufacturer warranty.
 5. Provide features as required by manufacturer to achieve the indicated control.
- C. Submittal must contain the following information:
1. Major Motion and Minor Motion sensitivities for project specific mounting locations and mounting heights.
 2. Range and Coverage Diagrams.

2.5 DAYLIGHT CONTROLS

- A. Provide products by the following manufacturers:
1. Leviton
 2. Wattstopper
 3. Lutron
 4. Or approved equal. For submission requirements for equal approval, see 1.6 "Submittals".
- B. Electronic, solid state device. Wired or wireless. Open Loop control that provides linear response to sensed light level.
1. Sensitivity 0 – 107,000 Lux
 2. Control of up to 10 devices.
 3. 10- year battery life guarantee.
 4. RoHS compliant.
 5. Operating Temperature 32 degrees to 104 degrees F.
 6. Non-Volatile Memory

2.6 DIMMING CONTROLS

- A. 120 V dimming is preferred. Identify 0 – 10 V dimming components when provided.
- B. Provide coordinated riser diagram to document interface components required for all formats of dimming control utilized on the project.

2.7 CONNECTIVITY

- A. Wired: (Insert project specific Requirements and Manufacturer(s) here.)
- B. Wireless: (Insert project specific Requirements and Manufacturer(s) here.)
- C. Campus Wide System: (Insert project specific Requirements and Manufacturer(s) here.)

2.8 MODULES

- A. Modules for dimming and system control must be coordinated with the loads to which they are assigned.

- B. Provide manufacturer confirmation that control module has been tested with system, source, and luminaire to which it is assigned.
- C. Module manufacturer must be the same as approved control system manufacturer.

2.9 INTERFACE EQUIPMENT

- A. General: (Insert project specific Requirements here)
- B. Owner Interface Equipment
 - 1. Network Terminal: (Insert project specific Requirements and Manufacturer(s) here.)
 - 2. Laptop: (Insert project specific Requirements and Manufacturer(s) here.)
- C. User Interface Terminals and Devices (Insert project specific Requirements and Manufacturer(s) here.)

2.10 NETWORK MANAGEMENT SYSTEM

- A. All software for the programming and operation of control systems, both open source and proprietary, must be provided to DDCM/CUCF with licenses for unabated use.

2.11 SPACE SPECIFIC REQUIREMENTS

- A. Refer to DDCM/CUCF Consultant Design Guidelines, Appendix M. Lighting Performance Requirements, Item D. Lighting Control for Space Specific Requirements within CUNY Facilities.

PART 3 - EXECUTION

3.1 GENERAL

- A. This part provides minimum controllability, control components, control accessories, and component installation requirements acceptable to CUNY facilities and for specialized space types at CUNY facilities.

3.2 INSTALLATION – GENERAL

- A. Provide control wiring per manufacturer and component requirements. Sharing of neutrals when dimming shall not be acceptable.

3.3 INSTALLATION – DEVICES

- A. Coordinate device layout and installation on ceilings and walls with other construction trades.
- B. Prioritize device locations based on transmission limitations of each device and system.

3.4 INSTALLATION – HEADEND EQUIPMENT

- A. Locate headend equipment based on transmission limitations of devices controlled, ability to secure the location, and ability to create necessary environmental conditions.
- B. Coordinate start-up of equipment to follow the commissioning of the HVAC and security systems of the headend equipment location.

3.5 INSTALLATION - MODULES

- A. Ensure modules are properly loaded for source type to which they are connected and that minimum loading requirements of the module are met.
- B. Provide manufacturer documentation indicating that module has been tested and operation confirmed for system, headend equipment, sources, and luminaires to which it is connected.

3.6 INSTALLATION – NETWORK MANAGEMENT SYSTEM

- A. Install control program and provide initial scene set-up and sequencing per operation directives indicated in the contract documents.
- B. During commissioning, demonstrate pre-set control scenes and modify as directed by lighting designer and Owner.

3.7 INSTALLATION – SPACE SPECIFIC REQUIRMENTS

- A. Coordinate installation schedules with use schedules of the facility.

3.8 COMMISSIONING

- A. Refer to DDCM/CUCF Consultant Design Guidelines, Appendix M. Part 2. Lighting Performance Requirements, Item G. Lighting Commissioning for Specific Requirements within CUNY Facilities.
- B. Perform operational testing after device installation and after electrical circuitry has been energized. Confirm proper unit operation.
- C. Test and adjust controls. Replace damaged and malfunctioning controls and equipment.
- D. When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting of sensors to meet actual occupancy conditions. Provide up to two after-hour commissioning visits after substantial completion.
- E. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 22

SECTION 26 51 10 - LIGHTING PERFORMANCE REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section identifies the lighting philosophy of The City University of New York (CUNY) and outlines the intent of the specification(s) relative to emerging lighting technologies and the implementation of the same throughout the CUNY system of facilities.
- B. This Section identifies the basis of design for interior lighting and controls and must be utilized as the reference standard for project specific modifications to specification sections related to interior lighting.

1.2 LIGHTING PHILOSOPHY

- A. CUNY lighting renovations, substantial improvements, and new installations shall strategically incorporate emerging lighting technologies.
- B. The lighting design represented in the contract documents represents a balanced approach to the objectives of saving energy and creating a quality lit environment.
- C. Suggestions for alternatives, substitutions, and value engineering must retain the original design balance of energy and lighting considerations.

1.3 RELATED DOCUMENTS

- A. Related requirements are also included in the following Sections:
 - 1. Division 26 Section "Lighting Control" for CUNY interior lighting control requirements.
 - 2. Division 26 Section "Interior Lighting Emerging Technologies Considerations" for source and luminaire performance requirements.

1.4 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. CCT (Correlated Color Temperature) – A representation of the color appearance of the light emitted by a source (lamp). The apparent color is related to the perceived color of light emitted from a reference source when heated to a particular temperature. Represented in degrees Kelvin (K).
 - 2. CRI (Color Rendering Index) – A numerical representation of a source's ability to render color relative to a reference sample. A CRI of 100 represents a lamp that renders color the same as the reference standard lamp.
 - 3. Daylight Harvesting – The control of electric light to accommodate the presence or absence of daylight in the space.
 - 4. LPW (Lumens per Watt) - an expression of the amount of light emitted from the lamp/source for the energy expended.
 - 5. Ri (where 'i' represents the numbers 1 through 14) – The CIE defined test colors to evaluate CRI. Numbers 1 through 8 are considered the typical colors of generally existing things. Number 9 through 12 are the strong ("primary") colors and 13 is the light yellowish pink hue associated with human complexions.

6. SPD (Spectral Power Distribution) – An indication of the amount of relative energy in each wavelength for a given light source (that is, lamp).
7. IES TM-30-18 IES Method for Evaluating Light Source Rendition – A system of calculations that quantifies the differences between a source and a reference illuminant of the same CCT.

1.5 REFERENCE STANDARDS

- A. Comply with the following standards:
 1. IES (Illuminating Engineering Society) for recommended practices.
 2. ASHRAE/IES Standard 90.1 for minimum lighting power density in watts per square foot.
 3. DDCM/CUCF Consultant Design Guidelines
 4. Other codes and reference standards recognized by the authority having jurisdiction.

1.6 ENVIRONMENTAL CONDITIONS

- A. CUNY facilities support an educational environment. Typical higher education environments include laboratories, classrooms, offices, and theatres and each of these specialized spaces have differing requirements for lighting products and performance.
- B. Operations require consideration of energy and operational efficiencies in all applications, however in no instance shall energy and operational considerations impact the quality of the lit environment created for education and higher learning.

1.7 SUBMITTALS

- A. Product Data
 1. For each specified luminaire, candlepower distribution, photometric information, and manufacturer cut sheet indicating:
 - a. Total Lumens
 - b. Luminaire Efficiency
 - c. Luminaire Lumens per Watt
 - d. Color Temperature of Source
 - e. CRI of Source
 - f. Spectral Power Distribution Curve of Source
 - g. For LED sources, R1 through R14 values for CIE defined colors
 2. For each source:
 - a. Mercury content per unit, in mg.

1.8 QUALITY ASSURANCE

- A. Lighting Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70 and NEMA standards.
- C. Luminaires of the same type, purchased under the same contract, must be from the same manufacturer.

- D. The maximum bin size for color variation of the source must be per ANSI C78 377A, which is the minimum requirement for Energy Star Certification.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Product manufacturers must have a minimum of ten (10) years of experience in the manufacturer, testing, and listing of luminaires.
- B. All specified sources must be available from the manufacturer in a minimum of three (3) CCT.
- C. Minimum acceptable CRI for interior spaces must be 80.
- D. Minimum acceptable Manufacturer's Product Warranty must be five (5) years for all lighting system components.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. Each lighting system must be commissioned to demonstrate designed performance criteria are met.
- B. Provide a minimum of two (2) after-hour commissioning sessions for a total of eight (8) contact hours.

3.2 OPERATIONS AND MAINTENANCE MANUALS

- A. Provide luminaire and source warranty and manufacturer and distributor contact information for each luminaire and source type provided under this contract.

END OF SECTION 26 51 10

SECTION 26 51 25 - INTERIOR LIGHTING EMERGING TECHNOLOGIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section identifies considerations relative to emerging technologies for interior lighting retrofit and new construction projects at The City University of New York (CUNY) facilities.
- B. There are a variety of space types for consideration in CUNY campuses and facilities. Specific philosophy for interior lighting for these areas can be found in Appendix M of the DDCM/CUCF Consultant Design Guidelines. In general, these spaces include – but are not limited to – the following:
 - 1. Classrooms and Small Lecture Rooms
 - 2. Lecture Theaters
 - 3. Performance Spaces, Theaters, and Concert Halls
 - 4. Laboratories
 - 5. Libraries and Media Centers
 - 6. Computer and Technology Labs
 - 7. Physical Education and Gymnasium Spaces
 - 8. Offices
 - 9. Lobbies, Atriums, Corridors, and Circulation Spaces
 - 10. Mechanical and Maintenance Spaces
- C. Section Includes, for emerging technology sources and/or luminaires:
 - 1. Interior lighting fixtures, lamps, and ballasts.
- D. This Section must be read in conjunction with other Division 26 sections relative to Interior Lighting.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related requirements are also included in the following Sections:
 - 1. Division 26 Section "Interior Lighting"
 - 2. Division 26 Section "Lighting Performance Requirements" for CUNY interior lighting philosophy, goals, and objectives.
 - 3. Division 26 Section "Lighting Control" for CUNY interior lighting control requirements.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. CCT (Correlated Color Temperature) – A representation of the color appearance of the light emitted by a source (lamp). The apparent color is related to the perceived

- color of light emitted from a reference source when heated to a particular temperature. Represented in degrees Kelvin (K).
2. CRI (Color Rendering Index) – A numerical representation of a source's ability to render color relative to a reference sample. A CRI of 100 represents a lamp that renders color the same as the reference standard lamp.
 3. LER (Luminaire Efficacy Rating) – an expression of the amount of usable light realized from the luminaire for the energy spent.
 4. LPW (Lumens per Watt) - an expression of the amount of light emitted from the lamp/source for the energy expended.
 5. Lumen – Measured amount of light.
 6. Luminaire – Complete lighting fixture.
 7. Ri (where 'i' represents the numbers 1 through 14) – The CIE defined test colors to evaluate CRI. Numbers 1 through 8 are considered the typical colors of generally existing things. Number 9 through 12 are the strong ("primary") colors and 13 is the light yellowish pink hue associated with human complexions.
 8. SPD (Spectral Power Distribution) – An indication of the amount of relative energy in each wavelength for a given light source (that is, lamp).
 9. IES TM-30-18 IES Method for Evaluating Light Source Rendition – A system of calculations that quantifies the differences between a source and a reference illuminant of the same CCT.

1.4 REFERENCE STANDARDS

- A. Comply with the following standards:
1. NEMA Standards applicable to interior lighting.
 2. UL Standards applicable to interior lighting.
 3. ANSI and ASTM standards mentioned in this Section and included in the UL and NEMA Standards applicable to interior lighting.

1.5 ENVIRONMENTAL CONDITIONS

- A. Provide interior lighting sources, luminaires, and components fabricated from materials resistant to corrosion and suitable for the application in the locations where installed, in conformance with NEC requirements for installation in "damp", "wet", and hazardous (classified) areas.

1.6 SUBMITTALS

- A. Product Data: For interior lighting sources, luminaires, and components, arranged in order of fixture designations. Include candlepower distribution, photometric information, and manufacturer cut sheet indicating the following:
1. Total Lumens
 2. Luminaire Efficiency
 3. Luminaire Lumens per Watt
 4. Color Temperature of Source
 5. CRI of Source
 6. Spectral Power Distribution Curve of Source
 7. For LED sources, R1 through R14 values for CIE defined colors
 8. For LED sources, manufacturer compliance for luminaire emergency performance expectations.
 9. For replacement lamps, compliant with luminaire manufacturer.

10. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 11. Testing Agency Certified Data: For indicated fixtures, photometric data must be certified by a qualified independent testing agency. Photometric data for remaining fixtures must be certified by manufacturer.
 12. For each source:
 - a. Mercury content per unit, in mg.
 - b. Lighting Facts, A Program of the U.S. DOE.
- B. Shop Drawings: For the following interior lighting sources, luminaires, and components. Include plans, elevations, sections, details, and attachments to other work as required to accurately depict intent.
1. Custom luminaires.
 2. Custom attachments, hangers, and assemblies.
- C. Samples for Verification: Where indicated on contract documents.
- D. Qualification Data: For manufacturer and testing agency. Manufacturer must have ten (10) years of demonstrated experience in the research, design, and/or construction of associated interior lighting emerging technology(ies). Testing agency must be independent from manufacturer and must perform certified test reports for the products submitted. Calculated test reports, reports generated by numerical methods alone, and software-derived estimates of luminaire performance shall not be accepted.
- E. Source quality-control test reports.
- F. Or Equal Consideration: Products that meet the requirements of the contract documents and the intent of the design and operational performance can be considered. Refer to Division 01 sections for submittal and approval requirements for consideration of alternative products.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IES Lighting Measurements Testing & Calculation Guides.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70 and NEMA standards.
- D. All products supplied under this contract shall be Energy Star Qualified.
- E. Components that make-up the luminaire system (sources, drivers, ballasts, housings, and method of control) must be guaranteed to perform as a system.
- F. Warranty: Provide sample of warranty certificates.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This Part provides minimum source, luminaire, and component requirements acceptable for installation at CUNY facilities for the following source and luminaire types:
 - 1. Light Emitting Diode (LED)
 - 2. Ceramic Metal Halide (CMH)
 - 3. High Output Fluorescent (Fluorescent HO)
- B. Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, product(s) indicated on the Drawings.

2.2 INTERIOR LIGHTING MANUFACTURERS

- A. Provide products by the following manufacturers:
 - 1. Acuity Brands
 - 2. Eaton Cooper Industries
 - 3. Current by GE
 - 4. Philips
 - 5. Or approved equal. For submission requirements for equal approval, see 1.6 "Submittals".

2.3 SOURCE AND LAMP MANUFACTURERS

- A. Provide products by the following manufacturers:
 - 1. Cree
 - 2. Current by GE
 - 3. Osram-Sylvania
 - 4. Philips
 - 5. Sorra
 - 6. Xicato
 - 7. Or approved equal. For submission requirements for equal approval, see 1.6 "Submittals."

2.4 SOURCES AND LAMPS

- A. LED
 - 1. Remote phosphor technology to eliminate pixilation. Alternatively, the luminaire must come supplied with a softening lens and associated accessory holder.
 - 2. Light engine - consisting of LED array, driver, and control – must have the ability to maintain lumen output and uniform beam spread over the life of the installation regardless of (despite the) increases in technology efficiencies.
 - 3. Must be tested in accordance with IES LM 79 and LM 80.
 - 4. Luminaire input watts must be identified. LED wattage will not be acceptable in the absence of luminaire input wattage.
 - 5. Color binning must be within maximum bin size per ANSI C78 377A.

6. Identify compatible dimmers and control.
7. L70 minimum of 50,000 hours.
8. Maximum Shielding Angle for downlights shall be 50 degrees.
9. Replacement Lamps:
 - a. Beam Angle must be provided.
 - b. Minimum life of 25,000 hours.
 - c. Must be lensed.
 - d. Minimum 55 LPW.
 - e. Confirm performance with luminaire manufacturer
 - f. Certify emergency performance requirements and compliance

B. CMH

1. Lamp to lamp color consistency over life, for same lamp types by same manufacturer.
2. Color stability over life of lamp within +/- 200K.
3. Color binning must be within maximum bin size per ANSI C78 377A.
4. Universal mounting position.

C. High Output Fluorescent

1. Luminous flux >90% between 5 and 79 degrees C.
2. Lumen maintenance >90% for rated lamp life.
3. Color binning must be within maximum bin size per ANSI C78 377A.
4. Average Life 24,000 hours
5. Dimmable
6. Exposed HO sources shall have a maximum source luminance of 6,000 cd/m².

2.5 AMOUNT OF LIGHT

A. Minimum acceptable efficacy, in LPW:

1. Downlights 65
2. Cove 80
3. Linear 100

2.6 COLOR TEMPERATURE

A. Submitted products and manufacturers must have a minimum of three (3) CCTs available in their standard available product line.

1. 3000 K, 3500 K, and 4000 K nominal

B. For exterior products, comply with recommendations from relevant agencies.

2.7 COLOR RENDERING

A. Minimum acceptable CRI: 80

B. Refer to TM-30 and provide commentary regarding color rendering concerns.

2.8 SPECTRAL POWER DISTRIBUTION (SPD)

A. Submitted SPD must correspond to required space use and finishes.

2.9 R VALUES

- A. R1 through R14 values must be provided for each lamp type on this contract.

PART 3 - EXECUTION

3.1 GENERAL

- A. This PART provides minimum source, luminaire, and component installation requirements for emerging technologies acceptable at CUNY facilities.
- B. LED replacement lamps, where utilized in existing luminaires, must be confirmed as operational for use in specific luminaire in which they will be placed and compliant with emergency operation (if required). Provide manufacturer verification.
- C. Execution requirements documented in Section 26 Interior Lighting must apply.

END OF SECTION 25 51 25

DIVISION 01- GENERAL REQUIREMENTS

SECTION 01 9x xx – LIGHTING COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Documents, including but not limited to the Drawings and individual Specification Sections and the Commissioning Plan, apply to this Section.
- B. Selected building systems and equipment to be commissioned, in accordance with this section, are identified in Division 26 Section 265110 "Lighting Performance Requirements".
- C. References:
 - 1. Illuminating Engineering Society: IES DG-29-11 "The Commissioning Process Applied to Lighting and Control Systems"
 - 2. Dormitory Authority State of New York: Building Commissioning Guidelines – 2013
 - 3. ASHRAE Guideline 0-2005: The Commissioning Process
 - 4. ASHRAE Guideline 1.1-2007: HVAC & R Technical Requirements for the Commissioning Process.

1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of commissioning as it pertains to lighting and lighting control systems.

1.3 DEFINITIONS

- 1. Contract Documents: A collection of documents that record concepts, calculations, decisions, and product selections to meet DDCM/CUCF requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The documents include, but may not be limited to: drawings, specifications, sketches, instructions, calculations, and similar items that support the design process.
- 2. Commissioning (Cx): A quality assurance process that documents specified systems and components are provided and tested to meet the Owner's needs and the design intent in accordance with the Contract Documents.
- 3. Commissioning Proposal: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- 4. Commissioning Agent (CA): The individual (or company) with expertise related to the systems identified for commissioning, engaged by the contractor to perform the commissioning activities identified in the contract documents. The CA is independent of the CxA.
- 5. Commissioning Authority (CxA): The Professional, appointed by the Owner, to direct and coordinate the commissioning process.
- 6. Commissioning Plan (Cx Plan): A document, prepared by the Commissioning Authority, defining the commissioning process including schedules, responsibilities, documentation requirements, and functional performance test requirements.

7. Functional Initiation Agent (FIA): The individual (or company) engaged to perform initial system setup, including but not limited to: aiming, dimming, establishing scenes of control, and establishing initial dimmed scene settings.
8. Commissioning Team: Individuals assigned by the Contractor, the CxA, and the Owner to implement the commissioning process as identified in the contract documents and the Commissioning Plan.

1.4 COMMISSIONING TEAM

- A. Members Appointed by the Contractor(s):
 1. Commissioning Agent: Individuals with the authority to act on the behalf of the contractor to implement the commissioning process through coordinated action or direction provided by the Commissioning Authority and the Functional Initiation Agent.
- B. Members Appointed by the Owner:
 1. Commissioning Authority: Individual or company that plans, schedules, and coordinates the commissioning team to implement the commissioning process.
 2. Representatives of facility user and operation and maintenance personnel as appropriate.
 3. Architect and engineering design professionals.
 4. Functional Initiation Agent: Individual or company that performs initiation of designed lighting systems to meet the performance expectations outlined in the contract documents. The FIA may be the lighting designer.

1.5 OWNER RESPONSIBILITIES

- A. Assign operation and maintenance personnel and schedule participation as required to implement commissioning activities.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Assign representatives, including a commissioning agent, with expertise and authority to act on its behalf and shall schedule such representatives to participate in and perform commissioning activities identified in this Section and related documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS

- A. Following the work of the FIA, each lighting system component shall be commissioned to demonstrate design performance criteria are met. Commissioning of lighting systems will include both daytime and nighttime work.

B. Components of Commissioning Process

1. Sensor Testing
2. Testing of Controls
3. Light Level Adjustment
4. Verification

3.2 SUBMITTALS

A. Testing

1. Procedure for testing of each sensor and control type.
2. Final test report documenting results of all testing procedures for each sensor and control type.
3. Final report documenting three-month luminaire inspection.
4. Final reports shall document final condition after all deficiencies have been cleared.

3.3 PRE-COMMISSIONING

A. Prior to Substantial Completion

1. Perform operational testing after device installation and after electrical circuitry has been energized. Confirm proper unit operation.
 - a. Approximately three (3) months after Substantial Completion, and prior to Final Completion, inspect installed luminaires for non-functioning luminaires and components.
 - b. Provide a report confirming findings.
2. Ensure luminaire control devices are installed and operational.
3. Perform preliminary control system settings.
4. Ensure necessary equipment and personnel are available for commissioning – including, but not limited to: laptops, ladders, tools, gloves, and illuminance meters.
5. Ensure marked up Contract Drawings are available for review on site during commissioning.

B. Testing of Controls

1. Test and adjust controls.
2. Replace damaged and malfunctioning controls and equipment.

C. Light Level Adjustments

1. Set up initial scene controls, daylight accommodations, and illumination levels utilizing a programming matrix that will be provided by the lighting designer and/or the FIA.
2. Provide a minimum of two (2) after-hour commissioning sessions for a total of eight (8) contact hours to make light level adjustments as required by the FIA.
3. Aim luminaires as required with direction from the FIA.

D. Verification

1. The FIA will be verifying all applicable commissioning attributes (e.g. illumination levels, control scene setting, daylight accommodation, occupancy/vacancy settings) for a minimum of 25% of the space included in the scope of work. No fewer than one (1) of each space type will be verified for each building.
2. If, upon verification of 25% of the space, deficiencies are discovered, a larger sample size will be commissioned to determine if the deficiencies are localized or systemic.

3. If deficiencies are localized, they will be noted for the punch-list.
4. If deficiencies appear to be systemic, consecutively larger sample sizes will be tested until the root cause of the deficiency can be documented for the punch-list.

3.4 COMMISSIONING

A. CxA

1. Provide commissioning plan.
2. Convene commissioning meetings.
3. Provide project-specific functional procedures and checklists.
4. Prepare and Maintain an Issues Log.
5. Verify execution of the commissioning process activities by random sample of spaces for compliance. Non-Compliances will be recorded on the Issues Log or Punch List. Verification will include, but may not be limited to:
 - a. Equipment submittals
 - b. Training
 - c. O&M data
 - d. Tests and Test Reports
6. Compile commissioning documentation, inspection reports, and certificates into a systems manual.

B. CA

1. Perform commissioning activities as outlined in the commissioning plan.
2. Attend commissioning meetings.
3. Submit completed functional test reports to the CxA.

3.5 POST OCCUPANCY

A. Controls

1. Luminaires and rooms with sensors and timer controls will be tested immediately after the space is fully occupied.
2. Approximately three (3) months after Substantial Completion, and prior to Final Completion, confirm proper operation of sensors and timer controls.
3. When requested, but within 12-months from date of Substantial Completion, provide on-site assistance in adjusting of sensors to meet actual occupancy conditions. Provide up to two (2) after-hour commissioning visits after substantial completion for these adjustments. A minimum of one (1) after-hour visit for on-site assistance in adjusting must be performed.

END OF SECTION 01 9x xx

APPENDIX O

WATER TREATMENT PROCEDURE

A. DESIGN PHASE

1. The design consultant shall retain a qualified sub-consultant with expertise in the design of HVAC water treatment systems to provide all required design documents including drawings, specifications, testing procedures, training requirements, etc. for the following HVAC systems:
 - a. Chilled water
 - b. Hot water
 - c. Reclaim water
 - d. Glycol water
 - e. Cooling towers/Condenser water
 - f. Steam boiler water
 - g. Steam condensate
2. For each of the above noted systems, the water treatment design documents must include floor plan drawings, schematic drawings, flow diagrams, specifications, details, required water treatment program and specific testing procedure. The floor plan schematic drawing and the flow diagram for each system must be comprehensive to show all of the HVAC system equipment, water treatment equipment, piping, controllers, etc.
3. The design documents must include the complete, specific procedure for cleaning and flushing of the new equipment, new chilled water, new condenser water, new hot water, new steam, new condensate, and new glycol piping systems. The procedure for cleaning and sanitization of the new cooling towers must also be included. The sanitization of the cooling towers must be in accordance with the latest requirements of NYC Local Law 77 to be complied with during the sanitization of the cooling towers.
4. The sub-consultant must prepare a separate set of schematic equipment and piping flow diagrams to show all the required isolation valves, temporary pump(s), bypass piping, injection ports and drainage connections for the purpose of cleaning and flushing of the condenser and chilled water systems. The flow diagram must be reviewed and approved by DDCM. Isolation valves must be provided to isolate the new chilled water, hot water, condenser water, steam, and condensate piping systems from the existing building distribution systems.
5. Electrical devices, motors, wiring and conduit in accordance with the applicable sections of the electrical specifications must be provided.
6. The design documents must include an initial treatment program for all new equipment and piping systems to be implemented during the construction phase on a complete system fluid analysis prior to the equipment installation.
7. The final design documents must be reviewed and approved by DDCM/CUCF's water treatment consultant.
8. The quantity of all required chemicals for each system for all water treatment to be implemented during construction must be included in the contract specifications.
9. Once the water treatment system design is completed by the sub-consultant and reviewed and approved by DDCM/CUCF's independent water treatment consultant, the design

documents must be included in the 100% construction documents. The bidders must provide the following breakdown in their bids for water treatment services:

- a. Quantity of each type of chemical
 - b. Cost for each type of chemical.
 - c. Equipment Cost
 - d. Applicable labor cost
 - e. Field visit services
 - f. Other applicable costs
10. The design documents must specify that the contractor must perform the installation of the specified water treatment systems.

B. CONSTRUCTION PHASE

1. During the construction phase, for each system, once the isolation valves are opened to test, operate, and connect the new equipment to the existing building distribution piping system, the water treatment services will be turned over to the college. From this point forward, the college must utilize and pay their own vendor to provide water treatment services for the entire system under the supervision of DDCM/CUCF's independent consultant.
2. The cleaning/flushing of the existing piping distribution systems is the responsibility of the college and must be scheduled and performed prior to connecting the new equipment and piping to the existing distribution systems. Once the installation of the isolation valve is completed, the CM/contractor must immediately inform the college in writing to schedule the cleaning/flushing of the existing piping distribution systems. The college must be given at least a minimum of 60 days to schedule and perform the flushing and cleaning of the existing piping systems.
3. The contractor must provide shop drawings in accordance with the contract specifications. The shop drawings must show the exact dimensions and location of the water treatment equipment, devices, controllers, piping, conduits such as chemical tanks, pumps, control panels, etc. The shop drawings must be reviewed and approved by the sub-consultant and DDCM/CUCF's independent water treatment consultant.
4. The water treatment vendor retained by the contractor shall provide and store all the required chemicals for each system. The proposed chemicals must be reviewed and approved by both the water treatment sub-consultant and DDCM/CUCF's water treatment consultant.
5. The water treatment system installation must be performed by the contractor under the supervision of the water treatment sub-consultant and DDCM/CUCF's water treatment consultant. Any water treatment system installation guidance proposed by the water treatment vendor must be reviewed and approved by the consultants.
6. As per contract specifications, the service visits, water treatment analysis, equipment inspection, chemical treatment requirements, corrective actions, technical assistance, and field report must be provided by the water treatment vendor. The vendor must also provide all required laboratory and technical services during the construction phase.

7. The water treatment vendor retained by the contactor must report, communicate and schedule the work directly with the contractor. The contractor and the water treatment vendor are responsible for the water treatment work as per contract specifications. The DDCM/CUCF independent water treatment consultant will be scheduled by DDCM to visit the site to perform routine inspections and provide supervision. The Contractor/ DASNY must notify DDCM 5 days in advance to schedule any site visit with the water treatment consultant. DDCM/CUCF's independent water treatment consultant must issue a typewritten report in PDF format to the construction management team after each site visit.
8. All required coordination with the college shall be scheduled by DDCM.

APPENDIX P

BOILER STARTUP PROCEDURE

A. FACTORY PERFORMANCE TEST:

1. The **factory performance test** will take place after the manufacturer has installed the burner, including all safety and operating controllers, tested it on all required fuels to within acceptable levels, and submitted the factory test sheets for approval by DASNY and DDCM/CUCF.
2. **Water treatment:** Acceptable treated water must be used for the pressure (hydro) and performance tests. The manufacturer shall provide their water treatment program and the latest water treatment analysis five days prior to the performance test for review and approval by DASNY and DDCM.
3. **Hydrostatic test:** The hydrostatic test shall be performed per manufacturer testing procedure. The test report and certification shall be provided to the consultant, DASNY, and DDCM for their records.
4. **Performance test for Steam Boilers:** The input/output method as per ASME PTC4.1 test procedure must be performed to determine the boiler fuel to steam efficiency and evaporation ratio. In addition to the input/output performance test, a calibrated combustion analyzer must be utilized by the manufacturer to measure the combustion efficiency at 25%, 50%, 75%, and 100% firing rate. All testing devices and components must be calibrated and the calibration report must be provided to DASNY and DDCM at the time of testing. If fuel oil is being utilized, the manufacturer must provide the Heating value analysis of the fuel oil at the time of the testing. In addition to the efficiency test, the boiler steam quality must be measured as a part of performance testing of the boilers. Calibrated calorimeter must be used for the steam quality test. The minimum steam quality of 98% must be achieved during the performance test.
5. **Performance test for Hot Water Boilers:** The performance test method shall be as per applicable AHRI (Air Conditioning, Heating and Refrigeration Institute) procedure. In addition to the input/output performance test, a calibrated combustion analyzer must be utilized by the manufacturer to measure the combustion efficiency at 25%, 50%, 75%, and 100% firing rate. All testing devices and components must be calibrated and the calibration report must be provided to DASNY and DDCM at the time of testing. If fuel oil is being utilized, the manufacturer must provide the Heating value analysis of the fuel oil at the time of the testing.
6. **The contractor must notify DASNY and DDCM 4 weeks prior to the factory performance test. Representatives from DASNY, DDCM, the College, the consultant, and the contractor must witness the combustion and the performance tests prior to accepting the boilers for shipment.**

B. SHIPMENT REQUIREMENTS

1. After the performance test and once the boilers are accepted for shipment by DASNY and DDCM, the boilers are to be readied for shipping dry as described below. One additional set of Dry Layup product will be supplied for each boiler, to be used after the boil-out or setup if deemed necessary.

2. Dry Layup Procedure (Steam and Hot Water Boilers):
 - a. If possible, all horizontal and non-drainable boiler tubes and superheater tubes are to be blown out with compressed air. Particular care must be taken to purge water from long horizontal tubes that may have bowed slightly.
 - b. Heat should be applied to dry the unit, and then the unit should be closed to reduce air circulation. Whenever necessary, to maintain the temperature of all surfaces above the dew point, heaters should be installed.
 - c. Immediately after surfaces are dried, one of the two following desiccants is to be spread on water-tight wood or corrosion-resistant trays:
 - Silica Gel-used at a rate of 8 pounds per 100 cubic feet of volume
 - Activated Alumina-used at a rate of 8 pounds per 100 cubic feet of volume
3. Locate trays in each drum of a water tube boiler or on the top flues of a firetube unit. Allow 50 percent freeboard in trays in order to contain desiccant swelling. Tightly blank and close all manholes, handholes, vents and connections.
4. Once the boilers are delivered to the site or kept in the rigger yard, the boilers should be opened every three or four months for inspection of the desiccant. Renew if necessary. The contractor must submit a type written report to DASNY and DDCM when boilers are opened for inspection of the desiccant.

C. SITE PREPARATION REQUIREMENTS

1. Wet Layup Procedure for Steam and Hot Water Boilers (if approved by DDCM):
 - a. A wet method is acceptable whenever boilers are on emergency standby. This method is not practical if the ambient air temperature may drop below freezing in the boiler plant.
 - b. The boilers should be filled to the normal water level with deaerated feedwater. Then, 3.0 pounds caustic soda and 1.5 pounds sodium sulfite per 1,000 gallons of water contained in the boiler (minimum 400 ppm phenol- Phthalein alkalinity as CaCO₃ and 100 ppm sulfite as SO₃) should be added to the boiler. The boiler water should test at no less than 10.0 pH. With vents open, moderate heat should be applied to boil the water for one hour with the vent steaming. The unit is then tightly closed.
 - c. If the boiler is equipped with a non-drainable superheater, the superheater is filled with condensate or demineralized water treated with 3.0 pounds of caustic soda and 1.5 pounds of sodium sulfite per 1,000 gallons. After the superheater is filled completely, fill the boiler completely with deaerated feedwater.
 - d. If the superheater is drainable or the boiler does not have a superheater, the boiler should be allowed to cool slightly after firing. Then, before a vacuum is created, completely fill the unit with deaerated feedwater.
 - e. After filling the boiler completely, a surge tank (such as a 55 gallon drum) containing a solution of treatment chemicals or a nitrogen tank at five pounds per square inch (psig) pressure is connected to the steam drum vent. This supply will compensate for volumetric changes due to temperature variations.
 - f. The drain between the nonreturn and the main steam stop valve should be left open wide. All other drains and vents are to be closed tightly.
 - g. The boiler water should be tested regularly each week, with additional treatment being added whenever necessary to maintain the minimum treatment levels. When chemicals are added, the boiler water is to be circulated by means of an external

pump or by reducing the water level to the normal operating level and steaming the boiler for a short time. If steaming is necessary, the boiler should be filled completely in keeping with the above recommendations.

2. Once all the required boiler attachments are made and the boilers are ready for startup, the boil-out can proceed by the following steps:
 - a. The boiler is filled to the normal operating level.
 - b. Using the desired fuel, the burner should be test fired to verify that it will be capable to adequately meet the needs of the boil-out. This test fire should be performed by the manufacturer-certified burner technician who can also use this time for initial burner adjustments, interlock, and cutout testing.
 - c. Prior to the boil-out, the safety valves must be removed or otherwise protected. This is a manufacturer requirement on both steam and hot water boilers, and it is designed to protect the safety valves from any potential compromise that may be caused by any construction contaminants that may be present inside the boiler.
 - d. The boil-out is to proceed as per manufacturer procedures unless otherwise directed by DDCM. As part of the normal boil-out process, the boiler should be periodically overflowed. This will allow for the removal of floating contaminants, which would otherwise coat the internal surfaces of the boiler upon draining.
 - e. After the boil-out and boil-out drain are completed, the boiler will be filled and drained and then flushed through manholes/hand-holes using a hose.
 - f. All doors and openings that are exposed to boil-out chemicals are to be opened and new gaskets are to be installed.
 - g. Once the boil-out is complete, arrangements can be made for the burner technician to finish setting up the boiler/burner. For this, it is desirable to achieve steady-state full load operation. For a steam boiler, it may be required to install a steam vent.
 - h. Support systems will need to be operational for boiler/burner setup. This may include the following:
 - Boiler feedwater source including makeup water, feedwater pumps, condensate pumps, circulating water pumps, expansion tanks, etc.
 - Water conditioning including pre-heat, chemical treatment pumps, which should be tested with water prior to any attempt with chemicals.
3. The burner technician is to test and document all of the required interlocks and safety cutouts. The high pressure recycling cutout and high pressure lockout are to be tested under actual conditions and not with a 'bench-test' pump. Temperature cutouts will also be tested under actual conditions.
4. Upon successful completion of the interlock and safety testing, the burner technician will finish tuning the boiler/burner. This is to be performed for each type of fuel. This will include but will not be limited to the following:
 - a. Emissions at minimum, 25%, 50%, 75%, 100%
 - b. Burner opacity
 - c. Flame shape, stability, and color
 - d. Proper turndown
 - e. Proper maximum fuel input
 - f. Proper boiler output – steam in lb/hr or water temperature control

- g. Proper burner ramp rate
 - h. Efficiency
5. Under operating conditions, the boiler blowdown system(s) should be tested, including any quench system.
 6. Upon successful completion of the above, the boilers can either be readied for use, or if decided, to be placed into a storage mode.

APPENDIX Q

CHILLER STARTUP PROCEDURE

A. FACTORY PERFORMANCE TEST

1. The **factory performance test** will take place after the manufacturer has completed the fabrication of the chillers, including the compressors, VFDs, controllers, control panels, and all safety and operating controllers, tested the chillers on 25%, 50%, 75%, and 100% loads to within acceptable levels, and submitted the factory test sheets. Factory test sheets must be reviewed and approved by DASNY and DDCM.
2. **Water treatment:** Acceptable treated water must be used for the pressure and performance tests. The manufacturer shall provide their water treatment program and the latest water treatment analysis five days prior to the performance test for review and approval by DASNY and DDCM.
3. **Hydrostatic test:** The hydrostatic test shall be performed per manufacturer testing procedure. The test report and certification shall be provided to the consultant, DASNY, and DDCM/CUCF for their records.
4. **Accurate measurement** is required for the performance testing. All the following instrumentation must be calibrated and traceable to NIST, the National Institute of Standards and Technology: wattmeter, temperature sensors, flow meters, and pressure transmitters. This ensures the instrumentation meets or exceeds the accuracy requirements of AHRI ((Air Conditioning, Heating and Refrigeration Institute) Standard 550/590. A copy of the latest calibration report must be provided to the representatives of DDCM and DASNY at the time of testing.
5. **Redundant measurements:** Redundant measurement devices and sensors must be installed to verify test data and to measure evaporator water flow, evaporator water temperatures and unit power consumption. Agreement between the calibrated sensors is required to confirm that the data taken is accurate. Continuous real-time monitoring of these measurements is required during the performance test.
6. The chillers must be tested at full load and part load to determine the capability and efficiency/KW/ton of the unit. For part-load measurements, the chillers must be tested at 75%, 50%, and 25% load per AHRI 550/590.
7. The following AHRI tolerances must be considered for all tests:
 - a. Flow rates $\pm 5\%$
 - b. Water pressure drop $< 115\%$ of the rated pressure drop
 - c. Leaving evaporator and entering condenser water temperatures $\pm 0.5^{\circ}\text{F}$ of target
 - d. Voltage $\pm 10\%$ of nameplate
 - e. Frequency $\pm 1\%$ of nameplate
 - f. AHRI 575 factory sound test
8. The sound pressure test must be performed and must meet the AHRI Standard 575 requirements.
9. **The contractor must notify DASNY and DDCM 4 weeks prior to the factory**

performance test. Representatives from DASNY, DDCM, the College, the consultant, and the contractor must witness the performance test prior to accepting the chillers for shipment.

B. SHIPMENT REQUIREMENTS

1. After the performance test and once the chillers are accepted for shipment by DASNY and DDCM, the chillers are to be readied for shipping as described below.
2. Chiller Layup Procedure:
 - a. The chillers shall be shipped either with a full refrigerant charge or with nitrogen (if the refrigerant is shipped separate from the chiller). Either method is acceptable. Nitrogen tank assembly must be installed in the chiller room to recharge the nitrogen if deemed necessary. The wetted surfaces should be coated with a corrosion-resistant finish in accordance with the manufacturer's recommendations. The chillers must be fully protected by the manufacturer during shipping to prevent the weather from encroaching into the chiller components.
 - b. If possible, all horizontal and non-drainable sections including the condenser section of the chiller are to be blown out with compressed air. Particular care must be taken to purge water from long horizontal sections.
 - c. Heat should be applied to dry the condenser section of the chiller, and then the unit should be closed to reduce air circulation. Whenever necessary, to maintain the temperature of all surfaces above the dew point, heaters should be installed.
 - d. Immediately after surfaces are dried, one of the two following desiccants is to be spread on water-tight wood or corrosion-resistant trays:
 - Silica Gel-used at a rate of 8 pounds per 100 cubic feet of volume
 - Activated Alumina-used at a rate of 8 pounds per 100 cubic feet of volume.
 - e. Tightly blank and close all open connections.

C. SITE-PREPARATION REQUIREMENTS AND STARTUP

1. Once the chillers are delivered to the site or kept in the rigger yard, the chillers should be opened every three or four months for inspection of the desiccant. Renew if necessary. The contractor must submit a typewritten report to DASNY and DDCM when chillers are opened for inspection of the desiccant.
2. Six (6) weeks prior to startup of the chillers for operation, the followings steps must be taken:
 - a. The chillers and the cooling towers including the chilled water and condenser water piping system must be chemically flushed and cleaned. The condenser water and chilled water piping systems within the chiller plant are new. If the condenser water piping and the cooling towers are existing, the contractor must clean the piping system and sanitize the cooling towers in accordance with NYC DOH (Department of Health) requirements. The contractor must notify the college early so that the college can simultaneously schedule cleaning/flushing of the existing building chilled water system.
 - b. The design consultant must prepare a separate set of schematic equipment and piping flow diagrams to show all the required isolation valves and temporary pump(s) for the purpose of cleaning and flushing of the condenser and chilled water systems. The flow diagram must be reviewed and approved by DDCM. Isolation valves must

be provided to isolate the new chilled water piping system from the existing building distribution system.

- c. The isolation valves, temporary pumps, and pipes must be installed two weeks prior to the cleaning and flushing work.
 - d. Once the cleaning and flushing work is completed and accepted by DDCM, the contractor shall retain a qualified metrological testing company to perform eddy current testing on all evaporator and condenser tubes of the chillers. The testing company must be approved by DDCM. The testing company must utilize a level 3 engineer to perform the testing. The test results must be reviewed and approved by DDCM. Any tubes identified as dented, whiskered, blocked, and/or thickness loss must be replaced by the contractor at no extra cost.
3. The chiller startup must be performed by a certified manufacturer technician.