SECTION 010020 - GENERAL REQUIREMENTS FOR ENGINEERING

1.0 This Standard Design Guide (hereinafter referred to as the Guide) has been prepared to familiarize the A/E with the University's design requirements and procedures, preferred systems and materials, utility operating characteristics, and energy available on campus.

2.0 Several Departments within the University are actively involved in the procurement of consultants and the appointment of a University Representative. The primary A/E procurement departments are the Office of the University Architect, and Design and Construction. In general the Design and Construction group will be the primary lead and overall coordinator of the project with support/direction coming from the University Architect/Engineer groups.

3.0 Nothing within this Guide shall be construed as limiting the design innovation of the A/E. The University recognizes the need to maintain design flexibility and processes that result in functional, energy efficient, and code compliant designs that are congruent with the intent of the project program.

4.0 The University, through its design review procedures, comments, and recommendations, does not release or alleviate the A/E from responsibility relating to equipment, materials, code compliance, serviceability of systems, capacity, Guide compliance, budget, site observation of the work in progress, system operation, shop drawing review, contract document interpretation, schedule, errors, omissions and/or all other non-delegable duties and obligations as a Professional.

5.0 It is the duty of the Prime Professional, as well as all Consultants, Sub-Consultants, Sub-Professionals, Specialized Firms, etc., to ascertain that the entire Mechanical and Electrical Systems can be installed, maintained, serviced and replaced without the removal, relocation, or disturbance of adjacent or unrelated systems, disturbance of the building structure, or affect any part of the building structure for the entrance and exit of equipment. Furthermore, it is the duty of the Prime Professional to directly contact the University's Representative to relate project program requirements, design conditions and/or existing conditions which will render the above requirements unattainable or impractical. All communications with the University will be through the Prime Professional.

6.0 The University is the sole entity with the authority to waive the requirements of this Guide and exercises such authority only through the submission of waiver documents as detailed herein.

7.0 The Prime Professional submits all questions concerning the Guide and makes all submissions to the University Representative who shall distribute the material to all affected University offices. Modifications to the Guide can only be made by the Vice President of Facilities Services or duly appointed designee.

8.0 There are mechanical/electrical infrastructure projects done through Operations and Maintenance which may not follow the processes described in the Guide for design review/approval. It is expected however, that these projects will comply with all technical requirements of the Guide.

9.0 Definitions

A.	University	The University of Pennsylvania.
B.	A/E:	Architect/Engineering Team consisting of the Prime Professional and all Consultants and Sub-Consultants engaged to provide services on a particular project.
C.	University's Representative	Designated University Employee and/or Project Manager who shall function as an interpreter of this document and be the focal point for the transfer of all information between the various Departments and Committees within the University and the A/E. The representative shall ascertain that the University's interests and program are being properly served as the project progresses. Refer to the General Appendices herein for Departmental Administrative charts
		Using Agency or User: Any of the various Departments within the University who will receive beneficial use of the completed project and who has a vested interest in its timely and successful completion.
		Using Agency's Representative(s): Designated employee(s) or consultant of the Using Agency who shall function as the focal point for the transfer of information between the University's Representative and pertinent Using Agency Personnel
		Prime Professional: The A/E of record with whom the University enters into a formal agreement for design services.
		Consultants, Sub-Consultants: Professionals and/or other firms with specialized experience engaged by the Prime Professional, or a third party engaged by a firm under contract with the Prime Professional

10.0 Processing of Work

A. Prior to the acceptance of proposals or contract negotiations, the prime professional shall issue a complete list of proposed Sub-Consultants to the University's Representative for review and approval of projects requiring the design of HVAC and electrical systems, the University Representative arranges a meeting with the mechanical and electrical engineers proposed for the project. The University Representative (or designee) summarizes the results of the interview and submits it to the Chair of the Selection Advisory Committee.

B. Immediately after selection of and approval of the A/E, the University's Representative will schedule an Initial Planning Conference/Kick-Off Meeting

1. Attendees include:

    a. Building Committee

    b. Prime Professional

    c. Facilities Services

2. The Kick-Off Meeting reviews:

    a. Project purpose, goals, and scope

    b. The Prime Professional’s organization for the project

    c. The University's organization and division of responsibilities for project design

    d. The steps and activities in designing the project and preparing construction documents

    e. Schedule for preparing design and construction documentation, and University reviews.

11.0 Several submissions of design documents are required at various stages. The University's Representative, upon receipt and distribution of the documents, will schedule a review meeting between the A/E and various University Personnel. The University's Representative will coordinate the scheduling of the meeting between the various University Departments and the Prime Professional. Upon satisfactory completion of a particular design stage, the University may, at its sole discretion, notify the A/E to proceed with the next stage of project design and documentation.

A. The design and documentation process has three phases – Schematic Design, Design Development, and Construction Documentation. At the completion of each phase the Prime Professional makes a presentation to the Building Committee. Depending on the project scope, design documents also are sent to various University administrative offices for review to assure conformance with design guidelines, safety, and operations requirements.

B. Designs for new structures, major additions or renovations, significant landscape improvements, or modifications to a building's public spaces are submitted to the Design Review Committee after the completion of Schematic Design and Design Development phases. At the Schematic Design review, the Committee examines the relationship between the proposed facility and surrounding structures, the materials to be used on the buildings and the components and materials of landscape design. After Design Review Committee review, the Schematic Design submission is presented to the Trustee's Facilities and Campus Planning Committee for information and comments. The Design Development submission to the Committee includes revised drawings incorporating the comments of the Design Review Committee made during the Schematic Design presentation and samples of proposed exterior building materials. Following Design Review Committee examination of the Design Development submission, it is presented to the Trustee's Facilities and Campus Planning Committee. The Prime Professional may be involved in all presentations.

C. Following approval of the Design Development documents, the project's scope and budget are fixed. Changes will not be made which will increase fees and related costs, or affect

the completion schedule.

D. Only after approval of each design phase submission by all affected University offices and review bodies, does the University Representative authorize the Prime Professional to proceed to the subsequent project development phase.

12.0 Submittals shall be submitted to the University's Representative for distribution to the various in-house Departments responsible for the review of the documents. The quantity of documents and distribution of such will be determined during the Initial Planning Conference.

A. After an initial in-house review period, the University's Representative will schedule a Design Stage Review Conference. Attendance by the entire A/E Team is mandatory. During this meeting, the Professional of record for each discipline will present his/her portion of the project and address questions from University Personnel. All unanswered questions will be recorded and included, with appropriate responses, in the minutes of the Conference. Upon receipt of the minutes, the University Representative will collect and forward all comments to the A/E for review, action and response.

B. Further work beyond the specific design review stage is prohibited until all comments have been addressed to the satisfaction of University Personnel, at which time a notice to proceed with further documentation may be issued at the University's discretion. The recording of the events and preparation of conference memoranda is the responsibility of the Prime Professional. Within seven (7) working days of any conference, a memorandum containing a complete summation of the meeting shall be prepared by the A/E and submitted to the University's Representative, in sufficient quantities, for further internal distribution. Conference memoranda shall be numbered in consecutive order and include the University's project identification number as well as the Prime Professional's project number. The summation of events will be in outline form with numbered paragraphs and “”Action By” designations.

13.0 During the Design Phase of the project, the University typically decides on how it will procure construction services.

A. Alternate Methods:

1. The Vice President for Facilities and Real Estate Management, in consultation with the Directors of Design and Construction, confirms the method of procuring construction services and the type of construction contract. Alternate approaches available to the University include but are not limited to a general contractor, or a construction manager using a lump sum contract or guaranteed maximum price. Regardless of the contracting method used, competitive bidding of work is required and the University reserves the right to accept or reject all contractors and subcontractors.

B. General Contractor:

1. The Design and Construction group in consultation with the offices of the University Architect, University Engineering Department, and Purchasing Department, coordinates the preparation of a list of builders who will be invited to bid on the construction work.

2. The Purchasing Department issues the invitation to bid, arranges the pre-bid meeting, and receives the bids.

3. Following receipt of bids, Project Management de-scopes the bidders, negotiates costs, schedule and conditions of the contract with the bidders.

4. A presentation is made to the Vice President of Facilities Services at which time the successful bidder is selected.

C. Construction Manager:

1. The Vice President of Facilities Services appoints a Selection Advisory Committee consisting of five members, including the chair.

2. Design and Construction in consultation with the Building Committee Chair, University Engineering Department, University Architect, and the Director of Purchasing establishes a list of candidate firms, and issues a Request for Proposal for Construction Management Services to each one.

3. Following receipt of bids, Project Management de-scopes the bidders, negotiates costs, schedule and conditions of the contract with the bidders.

4. A presentation is made to the Vice President of Facilities Services at which time the successful bidder is selected.

14.0 Standard University Format

A. The Standard University Format is as follows:

1. Drawings - must be on individual sheets for each discipline and prepared on a CADD System. The system must be compatible with Auto CAD (current University of Pennsylvania standard version) and follow AIA and/or CSI Guidelines. A complete set of drawings must be in AutoCAD.DWG format (current University of Pennsylvania standard version), and in .pdf format. Provide list of layers used.

2. The University Representative may require that the project be documented in Revit by Autodesk. Those requirements and acceptable standard versions will be provided during the A/E procurement process. In this case, a full building system model shall be turned over to the University upon completion of the project.

3. Specifications, spreadsheets, calculations, correspondence must be prepared using Microsoft Office (current University of Pennsylvania standard version) 97 software.

4. The Data and Documentation Department of Design and Construction determines University of Pennsylvania standard versions.

B. Provide CADD and MS Office (current University of Pennsylvania standard version) disks to the Owner with each submission, at the completion of the design, with each addendum, construction period bulletin, and after the completion of record drawings.

15.0 Submittal Requirements:

A. Each submission shall be covered with a standard transmittal form (refer to Appendix). The A/E must certify compliance with the University's Program and this Guide.

B. In the event that a program or Guide requirement cannot be reasonably met, a waiver request form (refer to Appendix) must be executed and endorsed by the Prime Professional and forwarded to the University's Representative for in-house review and approval. Submission of a waiver request form does not constitute acceptance. A formal written response to the waiver request will be issued and appropriate action indicated on the waiver form. If necessary, a review meeting may be scheduled to address the waiver request. The University's Representative will coordinate the scheduling of the meeting. The Prime Professional is responsible for documenting the meeting and copying all parties in attendance.

C. Projects involving critical areas, i.e. laboratories, research areas, utility plants, animal facilities, etc. shall include a detailed systems commissioning plan in accordance with ASHRAE Standards.

D. Schematic Submission Requirements:

1. Brief written or graphic description of Project intent, design conditions, space requirements, and purpose and definition of submittal intent.

2. Statement of probable cost.

3. Draft Energy Budget.

4. Basis of Design/Design Intent Narrative Outline specification indicating materials and type of systems proposed. Include a description of each including design criteria and parameters of equipment and utilities i.e., entering and leaving conditions of different services, cooling coils, heating coils, voltages, design pressures, etc. and mechanical and electrical system design concepts.

5. Submission drawings should be progress prints made from partially finished contract drawings and shall indicate the following:

    a. Full plot plan indicating area of work within the building.

    b. Design calculations and analysis of loads.

    c. Preliminary catalog cuts of proposed major pieces of equipment.

    d. Points of interconnection to existing utility infrastructure systems with projected peak demands including as applicable: chilled water (tons, gpm, supply temperature, return temperature), steam (pressure, lbs/hr), electrical (kw).

6. Life Cycle Cost/Systems Analysis (mechanical and electrical) addressing the following for alternative systems:

    a. Code impact

    b. Operating costs including housekeeping, landscaping, and utility costs. The operating cost analysis must be comprehensive as it will be used to predict utility and maintenance budgets.

    c. Maintenance costs

d. Construction costs

e. System life expectancy

f. Rationale for zoning

g. Life Cycle Costs – to include all owning and operating center over a 25 year period. Use standard spreadsheet (available electronically) attached to summarize life cycle costs for each option.

h. Impact upon existing utility infrastructures

7. Outline of Commissioning Plan suitable for use by the University in soliciting proposals for commissioning services.

8. LEED Credits Evaluation (if applicable).

E. Design Development Submission Requirements:

1. Brief written description of project intent and purpose and definition of submittal intent.

2. Revised Statement of Probable Cost.

3. Revised Energy/Budgets.

4. Updated Basis of Design/Design Intent Narrative.

5. 50% complete technical specifications including a detailed sequence of operation of all mechanical and electrical equipment.

6. 35% complete contract drawings including the routing of ductwork, piping and accurate A.T.C., airflow and piping diagrams, and electrical single line diagram.

7. Drawings shall indicate all necessary equipment service clearances as well as adequate access to all equipment for replacement without distributing other systems and/or the building structure.

8. Complete operating cost analysis with a summary sheet indicating individual utility energy consumption, predicted dollar expenditure and maintenance costs for the life of the mechanical and electrical equipment.

9. Include a detailed description of each proposed system along with an analysis of noise and vibration control.

10. Specific manufacturers' catalog cuts giving a complete description of all proposed equipment.

11. Determine if connecting points and rough-in of existing utilities should include present loads, available capacities, and impact on existing systems.

12. Explanation of any concept, equipment or material change from the previous submission.

13. All assumptions including those pertaining to field conditions should be verified by this time. Any that are not should be listed and brought to the attention of the University.

14. Commissioning Program and detailed commissioning schedule for the project by Commissioning Agent (when applicable).

15. Completed wind/wake analysis (if applicable). This analysis should be 100% complete by this time with all questions answered.

16. Completed geotechnical analysis (if applicable). This analysis should be 100% complete by this time with all questions answered.

17. Completed analysis of utilities infrastructure with all proposed tie-in points identified.

18. Updated LEED credits evaluation (if applicable).

F. Construction Documentation Submission Requirements:

1. Revised final Statement of Probable Cost.

2. Revised Energy Budget based on 8760 hour energy model. Submit summary report of energy model describing all inputs and results

3. Updated Basis of Design / Design Intent Narrative.

4. 100% complete bound specification booklet complete with general and technical sections which have been reviewed for proper coordination between trades.

5. 100% complete contract drawings which detail the installation of all equipment and materials to effect a functional system in accordance with the intent of the program

6. The contract documents must require the Contractors to submit maintenance instructions containing:

   a. A list of all equipment and components, their location, within the building and required preventative maintenance schedules.

   b. All equipment shall incorporate an accessible label, with the proper ID in accordance with the Maintenance Information Management System.

7. Revised operating cost analysis and a life cycle cost analysis which properly addresses maintenance costs for building systems. The costs must be comprehensive, as they will be used for projecting utility maintenance budgets. It should include the costs of operating and maintaining the building systems including utilities (power, steam, CHW, domestic water and sewer), water treatment, special maintenance contracts, specialty equipment, landscape and outside lighting, and life cycle cost replacement of all building system components. Explanation of any concept, equipment or material change since the previous submittal.

8. All equipment and materials indicated on the drawings must be cross referenced to the system which they serve. The method of cross-reference shall be included

in the drawing legend.

9. Final design drawings must include schematics of:

   a. Air Flow: Complete diagram showing air handlers (CFM, brake HP, dampers, coils, smoke detectors), return fans (CFM, HP, dampers, smoke detectors), room CFM, fire dampers, distribution system and duct sizes;

   b. Water Flow: (Cooling, radiation, others as applicable.) Diagram to show all pumps (GPM, heads, brake HP), valves, strainers, gages, converters, meters (expected demand, meter constants), zoning, locations, sizes;

   c. Steam Flow: Diagram to show coils, converters, traps, valves, PRVs, and meters, all with required capacities, demands, constants;

   d. Temperature Control PID Diagrams may be combined with above schematics; Electrical single line showing the service entrance, distribution system, panels, motor control centers, conversions to mechanical equipment, fire alarm system, zoning, smoke/heat detectors etc.

10. With each submission, the Prime Professional shall submit a checklist of all items listed for each submission as detailed above.

11. Submit required documentation defining compliance with ACT 222, ASHRAE 90A, ASHRAE 62.1 (latest edition).

12. Completed Systems Commissioning Plan (by Commissioning Agent when applicable).

13. Comprehensive Operations and Maintenance Budget – This should give a budgeting of all operating and maintenance costs including those associated with the building systems described above for a minimum of 5 years operation. This shall be provided by the Commissioning Agent (if applicable) or by the A/E if there is no Commissioning Agent. University personnel will be available to consult in creating this budget. Provide benchmark data from buildings of similar complexity to help justify.

14. Updated LEED credits evaluation (if applicable).

16.0 Project Implementation

A. Job Meetings

1. While the project is under construction, periodic meetings are held to review progress and discuss issues such as schedule, logistical problems, interpretation of construction documentation, field conditions and change order requests. Those present at the preconstruction meeting are typically invited to attend the job meetings. Others are invited to attend the meetings as the agenda may require.

2. The Project Manager chairs the job meeting and the project designer prepares the agenda and issues job meeting minutes.

17.0 Project Close-Out

A. The Prime Professionals and contractors deliver to the University information needed for the effective operation and maintenance of the facility and the Project Manager verifies that construction problems identified in Punch-list inspections (examinations of work to determine conformance with construction documentation) have been or are scheduled to be corrected. The project closeout process consists of the following activities:

1. Job walk-throughs (preliminary and final).

2. Equipment demonstrations.

3. Delivery of project equipment documentation.

4. Delivery of Commonwealth approvals of elevators and high-pressure vessels.

5. Delivery of Certificate of Occupancy.

6. Final record drawings/disks, including as-builts.

7. REVIT operating model (if applicable)

8. Drawings certified by the installing contractor/s of all underground or above ground utilities external to the building showing routing, size of piping, conduit etc and depth. Include pictures if access is difficult to verify.

9. Air and hydronic system balance reports.

10. Instructions to mechanics and operators.

11. Copies of all software programs used within the project including but not committed to ATC, fire alarm, special equipment/electrical/mechanical.

18.0 Evaluation

A. After the project has been occupied for between nine to twelve months, or one full cycle of seasons, a Facilities Management team meets with representatives of the end users including the Chair of the Building Committee and the Building Administrator to review the results of the project. Facilities Management learns from this process how to improve the delivery of future facilities projects. The Evaluation reviews:

1. The effectiveness of the programming and design process.

2. How well the facility meets the program needs.

3. Program changes which have occurred since occupancy.

4. Operation and maintenance experiences of building operating systems.

19.0 General University Information

A. Prior to the preparation of specifications, the A/E shall obtain from the University Representative a copy of the standard "Scope Document" and incorporate such into the specifications. The document addresses such items as the University's:

1. Asbestos policy.
2. Scheduling.
3. Location.
4. Safety regulations.
5. Demolition requirements.
6. Parking.
7. System shutdown requirements & policy.
8. Safety shutdown for welding.
9. MIMS Standards.

20.0 Responsible Use of Energy and Natural Resources

A. The University is dedicated to the principle of conserving energy. The University is a signee of the Second Nature Climate Commitment and is committed to working toward the eventual goal of carbon neutrality. In alignment with the goal, the University's Climate Action Plan (latest version) seeks to integrate sustainability into every aspect of the University including campus planning and design and campus operations. Teams working on facilities design and construction must be familiar with this document.

B. The University will scrutinize proposed designs for means of reducing not only first cost, but also long range operating costs. A/E must work in close cooperation with their engineers to design new buildings and to remodel existing buildings to make the most efficient use of building materials and energy sources available.

C. LEED certification is required for all major projects with minimum achievement levels as follows:

1. New Construction: LEED Silver Minimum

D. Penn's *Green Guidelines for Renovation* shall provide direction on all renovation work.

1. Projects that meet all five criteria in the Green Guidelines shall consider design, construction and certification of the project to a minimum Silver Level under LEED for Commercial Interiors (CI) as directed by Penn's project team.
2. Renovation projects under $7M construction cost and smaller than 10,000 sf must follow the Green Guidelines for Renovation.
3. For all building renovation projects, develop an energy reduction plan or conform to an already established energy reduction plan for the impacted buildings.

E. The architectural design is expected to be the primary component in making the structure energy efficient. An important feature of low energy design is intelligent population and function segregation.

F. Consideration must be given to the building utilization by planning for conservation of energy during school breaks and other periods of minimum occupancy. Research laboratories, spaces for animals and other spaces, which might require operation 24 hours a day, should be served by systems separate from those for classrooms and offices.

G. The A/E shall provide a comprehensive energy budget to the University. The budget shall show the estimated use of energy for the structure calculated on a kW and BTU per square foot per year (Energy Use Index EUI) basis and as follows:

1. Chilled Water:

   a. Peak Demand - Tons and GPM

   b. Consumption - Ton-hours/year

   c. EUI = $\frac{\text{(ton-hours/yr) x 0.7 kw/ton x 3.413 btu/kw}}{\text{Building gsf}}$

   (Note: 0.75 kw/ton represents the energy required to deliver chilled water to the building.)

2. Steam:

   a. Peak Demand - Lbs./Hr.

   b. Consumption - MLBS./Yr.

   c. EUI = $\frac{\text{mlbs/yr x 1000 lbs/mlbs x 1200 btu/lb}}{\text{Building gsf}}$

3. Electric:

   a. Peak Demand - kW

   b. Consumption - kWh/yr

   c. EUI = $\frac{\text{kwh/yr x 3413 btu/kw}}{\text{Building gsf}}$

4. Domestic Water:

   a. Peak Demand - GPM

   b. Consumption - CCF/Yr.

5. Natural Gas:

   a. Peak Demand - CFH

   b. Consumption - Therms/Yr.

c. $EUI = \frac{\text{therms/yr} \times 100{,}000 \text{ btu/therm}}{\text{Building gsf}}$

6. For each renovation project, the design team should quantify its contribution to the Energy Reduction Plan for the buildings impacted.

7. Infrastructure replacements shall target the same as renovations described above.

21.0 The maximum BTU allotment or maximum allowable energy loads and specific requirements for U-values of walls and roofs for each building must comply with ASHRAE Standards 90A-(latest version) and Commonwealth of Pennsylvania Act 222 requirements. Refer to the Electrical Section of this Document for lighting standards and power factor requirements.

22.0 Noise and Vibration Control

A. A sound and vibration analysis should be performed for all major or critical pieces of equipment. The A/E shall define the major and critical pieces of equipment within the documents. A copy of the list shall be submitted to the University Representative for internal distribution.

B. The control of noise and vibration resulting from mechanical and electrical equipment and/or distribution systems is the responsibility of the A/E and must be considered in the design of every new building and HVAC system, in the renovation of existing spaces, and in the replacement of existing equipment. Coordination between the architect, HVAC engineer, electrical engineer, and structural engineer is particularly important and should take place early in the project to obtain the most rational and cost-effective mechanical room layouts, equipment selection, acoustical shielding, and structural supports required to minimize the generation and transmission of unwanted sound and vibration. Principal considerations which must be addressed are:

1. Noise control to provide for maximum usefulness of the facility by keeping levels of sound within ranges which are conducive to study and work or other uses for which the facility is designed.

2. Noise control in compliance with OSHA requirements for the health and safety of building occupants; control shall be for all areas of the facility, particularly equipment rooms, PRV stations and fan rooms.

3. Vibration control in compliance with the latest edition of the ASHRAE Applications Handbook to limit sound produced by equipment and for protection of the equipment and the building structure.

4. Ranges of limits required for indoor design as shown in the Appendix. These standards must be followed. Noise and vibration shall be considered when selecting and locating equipment. Do not locate equipment near critical acoustical areas or sensitive equipment. Similarly, the Architect shall not locate spaces that will be negatively impacted by noise near mechanical or other equipment rooms.

5. Inertia pad requirements shall be checked for all rotating equipment. Inertia pads shall be required for all pumps, compressors, high-pressure fans, etc., that are above the ground floor and, on occasion, the floor on grade.

6. For roof-mounted and other exterior equipment, the potential for noise transmission through the bottom of the equipment and into the space below shall be evaluated. Consider providing an air space and either acoustical material, light weight concrete or standard weight concrete between the roof and the bottom of the equipment.

7. The effect that noise generated by cooling towers, evaporative coolers, condensing units and other outdoor and/or rooftop equipment or by indoor equipment, may have on adjacent buildings or areas shall be analyzed. Conform to current City of Philadelphia Noise Ordinance.

8. Duct design must include an analysis of sound generated by fans and air handlers, and sound generation, transmission and attenuation in ductwork. The University does not allow acoustic lining in new ductwork, so rules of thumb regarding attenuation are not applicable. Sound attenuators (duct silencers) may be required and should be scheduled on the drawings with design pressure drops and performance characteristics listed by octave bands. Schedules shall also include information on both duct-borne and radiated sound generated by equipment. Specifications should clearly require sound data as part of the equipment submissions.

C. Applicable standards reference the Room Criteria Method of defining acoustical design goals, which places emphasis on the 500-2000 Hz. range of frequencies (critical in speech interference) while maintaining a balanced sound spectrum. Designers shall design for a balanced sound spectrum that is not rumbly, or tonal. Part load equipment performance must also be considered (i.e., VAV boxes at partial loads and effect on space tonal spectrum). Designers shall refer to the ASHRAE Handbooks and other applicable acoustical design books for more information.

D. A post-construction sound and vibration test shall be specified to prove the integrity of sound and vibration control where such is critical, and on a random sampling basis in other areas if deemed necessary. A copy of the test methods shall be submitted to the University Representative prior to any such testing. Sound level meters shall be required to meet ASA/ANSI S1.4-1983 and S1.4a-1985 requirements.

E. A sound and vibration analysis shall be submitted for all major or critical pieces of equipment. The A/E shall define the major critical pieces of equipment within the documents. A copy of the list shall be submitted to the Department of Facilities Services, University Engineer Office for review during the documentation phase of the A/E design.

23.0 Temperature Control Requirements

A. The Program developed for each project will generally list any specific temperature and/or humidity requirements for the facility, which are necessary for the execution of the space function. In the event that no temperature and/or humidity levels are indicated in the program, the A/E is responsible for verifying, through the University Representative, that the intended space functions are not temperature and/or humidity critical.

B. All non-critical temperature/humidity areas shall be designed to maintain the following conditions:

1. Summer periods: 78 F maximum, 50% RH maximum in areas requiring space cooling.

2. Winter periods: 70 F minimum, no minimum RH

3. Unoccupied areas, intermittently occupied areas and non critical storage areas: 55 F minimum.

4. All equipment rooms and non critical storage areas shall be mechanically ventilated.

24.0 Site Utilities

A. Chilled Water

1. Central Chilled Water is available year round and is controlled based upon ambient temperatures as follows:

Ambient	Supply Temp. ^{o}F.	Differential Pressure*
Above 55^{o}F	45^{o}F	minimum 0.0 PSIG
54^{o}F to 45F	45^{o}F to 50^{o}F (varies linearly)	0.0 PSIG
Below 45^{o}F	50^{o}F	0.0 PSIG
*Pressure may be higher depending upon point of interconnection.		

B. Systems serving critical areas may require use of higher design chilled water supply temperature as approved by the University Engineering Department.

C. For systems which require temperatures below 45 degrees F, separate isolated systems must be designed and installed in accordance with this Guide. Systems requiring supply temperatures of 40 degrees F or less must utilize a propylene glycol based system.

D. All chilled water systems must be designed to operate with a minimum temperature rise of 15 Deg F at maximum load, unless specific humidity requirements dictate otherwise.

E. System pressurization is critical. The pressure is maintained at 100 to 130 PSIG at elevation 20.0 ft. (City of Philadelphia Datum). Buildings which can potentially increase system pressures must be designed with interim lower level mechanical rooms to limit static head on the chilled water system or use pressure isolating heat exchangers. Building secondary pumps for instance produce a differential pressure which may add to the system pressure.

F. A building secondary pump is required where new systems are interconnected with the central plant system. A hydronic system analysis of the required system pressure differential shall be performed in cooperation with the University Engineering Department.

G. Each primary chilled water piping system entering the building must be designed and installed in accordance with the standard detail contained herein in Appendix A.

H. Prior to initiating the design of a system intended to interface with the central chilled water

system, approval for the interconnection must be obtained from the University Engineering Department. Consideration for approval requires that the following information be supplied:

1. Location of building.

2. Peak load to be imposed upon the system, including month and time of day.

3. Peak expected load and time of day during the months of May and September.

4. Design temperatures (entering water and leaving water), required GPM, design pressure differential.

I. The basis for approval is the available chiller plant capacity, ability to diversify loads to other plants, and anticipated plant capacity modifications.

25.0 Steam Distribution System

A. Steam is available throughout the campus at high or medium pressure depending on the location and season. The high-pressure lines are 170.0 to 225.0 PSIG, the medium pressure lines are 70.0 to 110.0 PSIG. During non-heating seasons, all systems are regulated from 70.0 to 130.0 PSIG.

B. The use of steam must be confined to mechanical rooms wherever possible. Steam supplies to duct-mounted humidifiers where individual room control requires such, or to steam sterilization equipment, is permitted.

C. Prior to the initial stages of design, approval for interconnection to the steam system must be obtained from the University Engineering Department. The following information must be provided for steam system evaluation:

1. Location of the building and intended point of interconnection to the existing system.

2. Required peak demand in lbs. per hour and minimum required pressure.

3. Proposed method of steam condensate cooling and disposal.

D. System thermal expansion must be analyzed at the point of interconnection and for all new steam piping. The analysis must be submitted to the University Engineering Department for review and approval.

26.0 Potable Water Systems

A. Potable water is usually available within each existing building. Existing systems must be analyzed to determine available system capacity. For new structures, water must be extended from City of Philadelphia street mains.

B. City of Philadelphia water temperature varies from 50 deg. F to 80 deg. F. Care should be taken in the selection of autoclaves and other equipment using potable water for cooling back-up that they will work over this temperature range. (Potable water shall not serve as the primary means of cooling any equipment.)

C. The City water pressure varies on campus. Therefore, the A/E must contact the University

Engineering Department when connecting to existing building systems and the City of Philadelphia's Water Department when interconnecting to the street mains.

D. All domestic water piping must conform to City of Philadelphia Codes and this Guide.

E. Each service must be designed with a backflow prevention device acceptable to the City of Philadelphia Water Department.

27.0 Sanitary and Storm Sewers

A. The City of Philadelphia uses a combined system. All sanitary and storm drainage piping and sewers must be designed and installed in accordance with City of Philadelphia Codes. All work must comply with Philadelphia Stormwater Regulations and the Philadelphia Industrial Waste Guidelines.

B. The A/E is responsible for the submission of sanitary and storm drainage design documents to the City of Philadelphia for preliminary review and approval.

28.0 Electrical Distribution

A. Prior to the initial design stage, the University Engineering Department must be consulted as to the choice of primary supply voltage, its location, routing of conduits or ductbanks, and additional demand versus the available capacity, as well as the staging and sequencing of the tie-in. The connection must be approved by the University Engineering Department.

B. The primary voltage available on from the campus distribution system is 13.2 kV (nominal voltage). In general, any new building construction will be fed from this system at 13.2 kV.

C. On all projects on which the electrical load on the an existing building system substation will be increased by more than 50 kW, or where major modifications to the building's power distribution are being considered, a load study of the existing substation will be performed, consisting of installing a kWh meter on the existing system substation (typically at each secondary main breaker) for a period of two (2) weeks. This work must be coordinated with the University Representative. Costs associated with the study will be paid by the University.

29.0 Equipment Accessibility and Servicing Space

A. All efforts shall be made to locate all equipment requiring service out of occupied spaces.

B. All equipment mechanical and electrical shall have maintenance platforms and access ladders as required to reach central equipment and utility systems.

C. Provision for removal of equipment shall be shown on the documents. Equipment requiring service shall not be located in contaminated spaces. Access to equipment and equipment service shall comply with OSHA Standards.

30.0 Equipment cuts and system layouts, piping, duct, electrical conduit, etc. shall be sufficiently documented to verify that the systems are constructible as designed. Sufficient space shall be allotted for installation of equipment in all areas, particularly in areas requiring direction changes.

31.0 Special Consideration

A. Except where entering buildings, ALL utilities shall NOT encroach property boundaries.

32.0 General Considerations

A. The Prime Professional and all consultants are responsible for the preparation of a specification section within Division 1 which addresses and makes clear to the contractors the following:

1. A brief statement describing the intent of the project.

2. A statement describing the scope of work for each discipline.

3. A description of the project location.

4. A definition of the project construction schedule.

5. List of contract documents.

6. Define the bidding process and requirements.

7. List all alternates of scope and unit pricing. Alternates must be numerically designated and coordinated by trade.

8. Define the shop drawing review process including the quantity of submittals required, chain of distribution, required review period (Professional and University), and format of submittals for samples, catalog cuts, identification and required contractor review stamps.

9. State that the continuity of services to occupied portions of the Campus is mandatory. Inadvertent interruptions must be corrected immediately. The contractor is responsible for providing all necessary labor, including additional crews and overtime labor, and all materials as required to assure a prompt resolution at no expense to the Owner.

10. The prime contractor shall be designated as the party responsible for designating the on-site point of disposal for all site generated debris and for the timely removal of the collected debris from the site. The University has adopted strict recycle policies, and construction debris is not permitted in University dumpsters or other trash recycling containers.

11. Define the contractor's responsibility to properly notify the Prime Professional of the contractor's desire to deviate from the equipment and materials designated within the contract documents.

12. Define the contractor's responsibility to unconditionally guarantee, in writing, all materials and workmanship for a period of one (1) year from the date of final acceptance by the Owner.

13. Define the contractor's responsibility for maintaining an accurate set of as-built drawings.

14. Define the contractor's responsibility for temporary utilities, services, facilities, including heating and cooling systems of the construction area, if necessary.

15. Define University salvage rights.

33.0 Asset Identification Procedure

Prior to the development and assignment of identification numbers, or the use of a convention for the purpose of identifying building equipment (Assets), the user must reference the; University of Pennsylvania, Division of Facilities and Real Estate Services, FRES Instruction 960x – x.1 revision 2, 2/27/2013, ASSET IDENTIFICATION procedure, and collaborate with the Preventive Maintenance Coordinator for further guidance in the formulation and creation of asset identification.

34.0 Life Cycle Costs Analysis standard spreadsheet

University of Pennsylvania
Life Cycle Cost Analysis - Standard Spreadsheet Version 1.0

Date: _____

Project: _____

Option: _____

Year	Date	Component Cash Flows									Present Value Cash Flows				
		Capital Investment		Replacement / Salvage		Utilities		Maintenance		Total Cash Flow	(Note 3) Capital Investment - Rate: 5.00%	(Note 3) Replacement / Salvage - Rate: 5.00%	(Note 3) Utilities - Rate: 5.00%	(Note 3) Maintenance - Rate: 5.00%	Total
		(Note 1) Amount	(Note 2) w/Escalation - Rate: 3%	(Note 1,4) Amount	(Note 2) w/Escalation - Rate: 3%	(Note 1) Amount	(Note 2) w/Escalation - Rate: 3%	(Note 1) Amount	(Note 2) w/Escalation - Rate: 3%						
0	Initial	$ 1,000,000	$ 1,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,000,000	$ 1,000,000	$ -	$ -	$ -	$ 1,000,000
1	2012	$ -	$ -	$ -	$ -	$ 10,000	$ 10,300	$ 2,000	$ 2,060	$ 12,360	$ -	$ -	$ 9,810	$ 1,962	$ 11,771
2	2013	$ -	$ -	$ -	$ -	$ 10,000	$ 10,609	$ 2,000	$ 2,122	$ 12,731	$ -	$ -	$ 9,623	$ 1,925	$ 11,547
3	2014	$ -	$ -	$ -	$ -	$ 10,000	$ 10,927	$ 2,000	$ 2,185	$ 13,113	$ -	$ -	$ 9,439	$ 1,888	$ 11,327
4	2015	$ -	$ -	$ -	$ -	$ 10,000	$ 11,255	$ 2,000	$ 2,251	$ 13,506	$ -	$ -	$ 9,260	$ 1,852	$ 11,112
5	2016	$ -	$ -	$ -	$ -	$ 10,000	$ 11,593	$ 2,000	$ 2,319	$ 13,911	$ -	$ -	$ 9,083	$ 1,817	$ 10,900
6	2017	$ -	$ -	$ -	$ -	$ 10,000	$ 11,941	$ 2,000	$ 2,388	$ 14,329	$ -	$ -	$ 8,910	$ 1,782	$ 10,692
7	2018	$ -	$ -	$ -	$ -	$ 10,000	$ 12,299	$ 2,000	$ 2,460	$ 14,758	$ -	$ -	$ 8,740	$ 1,748	$ 10,489
8	2019	$ -	$ -	$ -	$ -	$ 10,000	$ 12,668	$ 2,000	$ 2,534	$ 15,201	$ -	$ -	$ 8,574	$ 1,715	$ 10,289
9	2020	$ -	$ -	$ -	$ -	$ 10,000	$ 13,048	$ 2,000	$ 2,610	$ 15,657	$ -	$ -	$ 8,411	$ 1,682	$ 10,093
10	2021	$ -	$ -	$ 200,000	$ 268,783	$ 9,000	$ 12,095	$ 1,800	$ 2,419	$ 283,298	$ -	$ 165,010	$ 7,425	$ 1,485	$ 173,920
11	2022	$ -	$ -	$ -	$ -	$ 9,000	$ 12,458	$ 1,800	$ 2,492	$ 14,950	$ -	$ -	$ 7,284	$ 1,457	$ 8,741
12	2023	$ -	$ -	$ -	$ -	$ 9,000	$ 12,832	$ 1,800	$ 2,566	$ 15,398	$ -	$ -	$ 7,145	$ 1,429	$ 8,574
13	2024	$ -	$ -	$ -	$ -	$ 9,000	$ 13,217	$ 1,800	$ 2,643	$ 15,860	$ -	$ -	$ 7,009	$ 1,402	$ 8,411
14	2025	$ -	$ -	$ -	$ -	$ 9,000	$ 13,613	$ 1,800	$ 2,723	$ 16,336	$ -	$ -	$ 6,876	$ 1,375	$ 8,251
15	2026	$ -	$ -	$ -	$ -	$ 9,000	$ 14,022	$ 1,800	$ 2,804	$ 16,826	$ -	$ -	$ 6,745	$ 1,349	$ 8,094
16	2027	$ -	$ -	$ -	$ -	$ 9,000	$ 14,442	$ 1,800	$ 2,888	$ 17,331	$ -	$ -	$ 6,616	$ 1,323	$ 7,939
17	2028	$ -	$ -	$ -	$ -	$ 9,000	$ 14,876	$ 1,800	$ 2,975	$ 17,851	$ -	$ -	$ 6,490	$ 1,298	$ 7,788
18	2029	$ -	$ -	$ -	$ -	$ 9,000	$ 15,322	$ 1,800	$ 3,064	$ 18,386	$ -	$ -	$ 6,367	$ 1,273	$ 7,640
19	2030	$ -	$ -	$ -	$ -	$ 9,000	$ 15,782	$ 1,800	$ 3,156	$ 18,938	$ -	$ -	$ 6,245	$ 1,249	$ 7,494
20	2031	$ -	$ -	$ -	$ -	$ 9,000	$ 16,255	$ 1,800	$ 3,251	$ 19,506	$ -	$ -	$ 6,126	$ 1,225	$ 7,352
21	2032	$ -	$ -	$ -	$ -	$ 9,000	$ 16,743	$ 1,800	$ 3,349	$ 20,091	$ -	$ -	$ 6,010	$ 1,202	$ 7,212
22	2033	$ -	$ -	$ -	$ -	$ 9,000	$ 17,245	$ 1,800	$ 3,449	$ 20,694	$ -	$ -	$ 5,895	$ 1,179	$ 7,074
23	2034	$ -	$ -	$ -	$ -	$ 9,000	$ 17,762	$ 1,800	$ 3,552	$ 21,315	$ -	$ -	$ 5,783	$ 1,157	$ 6,939
24	2035	$ -	$ -	$ -	$ -	$ 9,000	$ 18,295	$ 1,800	$ 3,659	$ 21,954	$ -	$ -	$ 5,673	$ 1,135	$ 6,807
25	2036	$ -	$ -	$ (60,000)	$ (125,627)	$ 9,000	$ 18,844	$ 1,800	$ 3,769	$ (103,014)	$ -	$ (37,098)	$ 5,565	$ 1,113	$ (30,420)
										Totals	**$ 1,000,000**	**$ 202,108**	**$ 185,104**	**$ 37,021**	**$ 1,424,232**

Note 1: Costs expressed in year 0 dollars.
Note 2: Obtain current cost escalation rates from Penn project manager.
Note 3: Obtain current interest/discount rates from Penn project manager.
Note 4: **Replacement** Cost is the cost to replace equipment within the period of the life cycle cost analysis. It is typically based on expected service life of equipment, such as that defined in the ASHRAE handbooks. It is useful for life cycle costs analyses when comparing systems/equipment that have different service expectations. The value is a positive number, meaning it is a future cost. **Salvage** Value refers to the worth of a piece of equipment or system at the end of a life cycle study period. It is typically a depreciated value of the replacement cost of the equipment. It is a negative number representing the worth or value remaining.