01330
Designer Submittals

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A. Summary

This section contains detailed mechanical and electrical submission requirements applicable to engineers performing design services under Divisions 15000 and 16000.

B. Submittals

Table 1 identifies the submittal requirements for mechanical and electrical engineers.

Table 1. Submittal Requirements for Mechanical and Electrical Engineers

Item	PD*	CD*	CA* & Closeout
Title Sheet	X	X	
Demolition Plans(if necessary)	X	X	
Site Plan	X	X	
Utility Plans	X	X	
Engineer Floor Plans	X	X	
Details and Schedules	X	X	
MEP Design Progress Report	X		
MEP Plans	X	X	
MEP Schedules	X	X	
MEP Riser Diagrams	X	X	
Mechanical Flow Diagrams	X	X	
Equipment Sequence of Operation	X	X	
Electrical One-Line Diagrams	X	X	
Outline Specifications (systems format)	X	X	
Component Specifications (16-division CSI format)	X	X	
Project Manual		X	
Construction Cost Estimate	X	X	
Life-Cycle Cost Analysis	X		
Code Review or Analysis	X		
Code Compliance Calculations		X	
Block Heating & Cooling Loads	X		
Mechanical Load Calculations	X	X	
Control Points List	X	X	
Controls Location Plan	X	X	
Electrical Load Calculations	X	X	
Submittal List		X	
List of Proprietary or Non-University Standard Items	X	X	
Archive Documents		X	X

* PD = Preliminary/Enhanced Schematic Design
* CD = Construction Documents
* CA & Closeout = Construction Administration and Closeout

Table 1. Submittal Requirements for Mechanical and Electrical Engineers – Continued

Item	PD*	CD*	CA* & Closeout
Record Product Data and Samples			X
Operations and Maintenance Data			X
Warrantees and Bonds			X
Spare Parts/Maintenance Materials			X
Progress Photographs			X
As-Built Documents (if required)			X
* PD = Preliminary/Enhanced Schematic Design * CD = Construction Documents * CA & Closeout = Construction Administration and Closeout			

C. Information Requirements

1. Drawings

a. General

(1) Ensure that all drawings are neat, clear, and of appropriate scale and completeness to easily determine the intended work.

(2) Draw floor plans on 24" x 36" sheets at a minimum scale of 1/4" = 1'0". Draw site plans on 24" x 36" sheets at an appropriate scale.

(3) Show demolition on separate drawings.

(4) Drawings must be compatible with the CADD platform specified in *CADD Requirements for Outside Consultants*. Each drawing must contain all layers listed in the CADD requirements document, whether or not they are actually used.

(5) Where ductwork, piping, conduit, and bus bars interface with the systems or equipment of other divisions, make a clear distinction between division 15 and 16 work and the work of other divisions. Do not make references by subcontractor or trade.

(6) Show the key plan, North arrow, and room locations**.**

(7) Provide separate floor plans for removals and demolition. Show all existing equipment, piping, ductwork, and electrical components within the area of work. Clearly identify all of the equipment, piping, ductwork, and electrical components that will remain or be removed.

(8) Provide floor plans for new work.

(9) All new systems should clearly show connections to the existing systems (ductwork, piping, reused equipment electrical parts, and portions of mechanical and electrical rooms). Remove piping, ductwork, and electrical wiring and conduit back to the first "live" branch or main. Cap off mechanical components with a valve and live cap electrical conductors. If the complete circuit is removed, lock and tag the circuit breaker.

(10) Equipment locations must show work access spaces, filter removal areas, coil pull areas, clearance in front of switchgear, motor control centers, and code required work space.

(11) For renovation projects, coordinate the new equipment numbers and operation with the existing equipment. Use Yale University acronyms for all equipment shown on the drawings.

(12) Provide record drawings in Mylar® and on diskettes upon completion of construction.

(13) Ensure that symbols and abbreviations used on drawings are in accordance with the latest Yale University standards for symbols and abbreviations.

b. Mechanical

(1) Draw ductwork double-lined, and clearly indicate the direction of air flow. Show supply, return, and exhaust ductwork with a different intensity of shading. Clearly indicate all rises and drops. If ductwork is not shown in section, indicate the height of the bottom of the duct.

(2) Draw all piping larger than 2-1/2" double lined, and clearly indicate the direction of flow and use. When piping of different usage is shown on the same drawing, show each group of piping with a different intensity of shading. Clearly indicate all rises and drops. If piping is not shown in section, indicate the height of the bottom of the pipe. Show floor plans, building sections, isometric diagrams, and details. Plumbing and fire protection may be included on the same drawings unless they are extensive enough to warrant separate floor plans.

(3) Draw all equipment to scale. Clearly indicate service and pull spaces. Use shading to distinguish new equipment from existing equipment. Identify equipment according to the designation on the drawing schedule. Duct work and equipment may be included on the same drawing with HVAC piping unless they are extensive enough to warrant separate floor plans. Ductwork and equipment drawings should include the proper designation for all air handling equipment and show all local exhaust, general exhaust, fume hoods, VAV boxes, VVE boxes, and other similar equipment.

(4) Controls drawings must contain control and wiring diagrams, point lists, and a written sequence of operation. Associated electrical work must be shown clearly on electrical drawings and referenced on mechanical and/or controls drawings. Engineering consultants must work with Yale University and controls vendors selected by the University to define control systems and strategies.

(5) Riser diagrams must include air flow, gpm, cfm, and direction of flow arrows. Provide riser diagrams for such systems as:

- Cold and hot water piping supply and return
- DI water piping
- Watering systems for animals
- Sanitary or waste drainage, including pumps
- Vent piping
- Acid waste piping
- Storm drainage, including pumps
- Process piping: natural gas, vacuum, nitrogen, $C0_2$, compressed air, and oxygen
- Fire suppression systems: wet and dry sprinkler piping systems
- Special systems
- HVAC air flow for HVAC systems, including fume hood and general exhaust
- Toilet exhaust
- Animal room exhaust
- Radioactive exhaust with HEPA filters
- Chilled water flow for HVAC systems
- Hot water flow for HVAC systems, including heat exchangers
- High, medium, and low-pressure steam
- High, medium, and low-pressure condensate
- PRV stations, condensate pumps, and condensate receivers
- Refrigerant piping

(6) Provide block or one-line diagrams for HVAC control diagrams. Show all interlock equipment, such as fans, VAV boxes, and motorized dampers. Show all interlocks for fume hood exhaust VVE boxes, general exhaust VVE boxes, and supply air VAV boxes. State how room pressurization is maintained as the fume hood sash is opened, and show how air locks are used.

(7) Provide sections or elevations for:

- Air handling units
- Cooling towers
- Main mechanical rooms
- Floor plans for main distribution

c. Electrical

Where wiring interfaces with equipment or systems of other divisions, clear distinction shall be made between work of division 16 and work of other divisions; Do not make references by subcontractor or trade.

(1) Provide separate floor plans or removals and demolition, and for power, lighting, and fire alarm systems.

(a) Equipment locations for other systems, such as intrusion detection and telecommunications systems, may be included on power plans, unless the other systems are extensive enough to warrant separate floor plans.

(b) Include relevant building information, such as ceiling heights and slopes, exposed joists, beam and girder locations, and fan CFMs, on fire alarm system floor plans.

(2) Provide one-line diagrams for power distribution systems.

(a) Indicate on the diagram the short-circuit energy available at each bus or tabulate it on the drawing.

(b) Indicate grounding methods and locations for all separately-derived systems. Where extensive or complex grounding arrangements are required (including ground-fault protection systems), provide separate grounding diagrams.

(3) Provide riser diagrams for such systems as fire alarm, intrusion detection, and telecommunications. Include the locations of vertical chases.

(4) Equipment schedules for feeders, switchboards, panelboards, and lighting fixtures must be in accordance with standard details shown in the relevant standards.

(5) Calculate demands for the following loads:

- Loads operating at 120 volts
- Lighting loads
- All other normal loads
- Emergency loads, excluding fire pumps (include itemized list)
- Fire pump, with horsepower rating
- Standby loads (include itemized list)
- Maximum coincident demand expected on the normal source and the alternate source

(6) Where multiple buildings are fed from a load center, list the following information for each building:

- The expected power factor prior to power factor improvement measures
- Duty cycles for each category of equipment
- Sizing calculations for switches over 100 amperes
- Calculations for selection and sizing of all transformers, including connected load, future loads, harmonics, and temperature considerations
- Calculations for sizing bus ducts
- Lighting fixtures catalog cuts
- Lighting calculations or isofootcandle layouts demonstrating that required illumination levels will be achieved throughout all egress routes

2. Specifications

Write specifications in accordance with current CSI guidelines for section titles and numbering, section format, and page format.

3. Cost Estimates

a. Arrange cost estimates according to major project divisions. Present costs within each major division according to the CSI broad-scope section number. Life-cycle cost is the basis of system evaluation. The standard life-cycle cost is based on system service life (or 20 years minimum) and use a 7.5-percent discount rate, unless the Yale University Project Manager provides a different rate.

b. Design for new and replacement mechanical systems and equipment must include a life-cycle cost analysis that includes the initial cost, cost of capital, inflation rate, energy cost, maintenance cost, salvage value, and space cost. The life-cycle cost must include all replacement costs for the full system service life. Consult with the Yale University Project Manager to obtain the applicable rates for use at Yale University.

4. Supporting Information

Provide Yale University with supporting information that clearly shows the basis for the design of each part of the project. Where applicable, supporting information must include the following, and may include additional information described elsewhere in these standards or requested by Yale University when individual equipment or installation conditions require special attention.

a. When calculations are performed by computer, include input values in the submittal, and indicate program title and version number. Calculations must highlight all assumptions made.

b. For renovation projects, submit copies of documentation generated during field investigations. Such documentation includes field notes, sketches, and photographs of all pertinent portions of the existing installation. Develop a list of all existing equipment to coordinate the new equipment numbers.

c. Provide heating and cooling load calculations based on Yale University design standards and the latest codes. Compare the results with the applicable energy requirements of the State Building Code.

d. Provide hydraulic calculations for fire protection piping.

e. Submit load calculations based on loads shown in panelboard and switchboard schedules. Provide breakdowns of power consumption per square foot for lighting, air conditioning, and other major categories of utilization, together with total consumption. Separate analyses may be required for various building areas. Compare the results with the applicable energy requirements of the State Building Code.

f. Submit harmonics calculations in accordance with standard IEEE 519. The calculations must indicate the basis for neutral conductor sizing and selection of transformer k rating.

g. Submit short-circuit calculations showing contributions from each source, the characteristics of each circuit element, and the short-circuit energy available at each bus. The calculations must indicate the selection criteria for conductors in addition to overcurrent devices.

h. Submit coordination analyses for all types of overcurrent devices in series. The equipment manufacturer will complete a short-circuit and coordination study.

i. Submit lighting calculations for each type of space in accordance with IES standards and based on the zonal cavity method for interior lighting and on manufacturers' isofootcandle curves for exterior lighting. The calculations must clearly indicate assumptions of reflectances, maintenance factors, and ballast factors and present the results in footcandles and in watts per square foot.

5. Design Intent

a. Basic commissioning includes the design intent documentation, one-line diagrams, and operating descriptions for full and part-load conditions to help communicate design intentions to current and future building operators. The description of the mechanical system and its intended operation and performance must include the following information, which must also be included on the drawings:

- Design intent
- Assumptions
- Noise criteria
- Facility occupation and utilization
- Basic system type
- Major components
- Interrelationship of components
- Capacity and sizing criteria
- Equipment selection and redundancy criteria
- Control strategies (The intended operation under all loads, changeover procedures, part-load operational strategies, design setpoints with permissible adjustments, operation of system components in life-safety modes, energy conservation procedures, and any other engineered operational mode of each system.)

b. Submit a design intent document for indoor air quality that includes:
   - Method of ventilation, occupancy times, and number of people
   - Method and equipment for fume hood exhaust systems
   - Chemicals proposed in tabs for use in fume hoods
   - Expected noise level in occupied spaces
   - Design temperature in the space
   - Design relative humidity (summer and winter)
   - Type of HVAC system and selection criteria
   - Kitchen hood exhaust methods
   - Air distribution zoning
   - Filter types and efficiency
   - Method of room pressurization for labs

c. Submit a design intent document for energy conservation methods that includes:
   - Methods of free cooling using outside an air economizer and condenser water economizer
   - Methods of heat recovery using runaround coils, Zduct, heat wheel, or other similar equipment.
   - Energy-saving methods for semester break in December and January

d. Submit a design intent document for heating of spaces using:
   - Perimeter radiation
   - Warm air
   - Panel units
   - Unit heaters

e. Submit a design intent document for equipment sizing criteria and calculations for chillers, boilers, VAV boxes, VVE boxes, VFDs, mixing boxes for existing dual duct systems, and other similar equipment.

f. Submit a design intent document for specific spaces, such as animal rooms, and for kitchen hood exhaust methods.

g. Submit a design intent document for air distribution zoning.

h. Submit a design intent document for motion sensors to prove occupancy.

i. Submit a design intent document for pump selections. Provide Yale University with the following documentation:
   - Total GPM complete with GPM by equipment type, such as air handlers, unit heaters, fan coil units, all coils, and fin tube radiation.
   - Certified pump curves to indicate that pumps are non-overloading in parallel or individual operation, and operate within 25 percent of the mid-point of the published maximum efficiency curve. Plot the pump and system operating point. Include the NPSH curve when applicable.
   - Electrical data: voltage, required horsepower, full-load amps, electric phases used.

6. Sequence of Operation

a. Submit a sequence of operation of the DDC system for all controlled equipment, including:
   - The position of failed equipment, including provisions for freeze protection, normally closed, and normally open
   - The method of maintaining minimum ventilation by code, for occupied spaces
   - The anticipated close off pressures for both supply and return, including differential pressure, for chilled water systems

b. Provide a separate sequence of operations for the occupied, unoccupied, and warm-up cycle for each season of the year.

c. Describe the life safety operating modes for:
   - Atrium systems
   - Smoke pressurization systems
   - Fire pumps
   - Smoke detectors and automatic shut-off of supply and return air fans
   - Smoke dampers and automatic shut-off of supply and return air fans

d. Provide a plan to integrate control of existing HVAC systems with new HVAC systems.

e. State whether pre-heat coils for 100% air make-up units are to be steam or glycol hot water.

f. Describe humidification methods and show psychometric calculations.

7. Control Points List

Important! Provide a points list with Yale university acronyms. Coordinate new numbers with existing equipment. Obtain approval for acronyms before starting drawings.

D. Mechanical Design Requirements

Design criteria and assumptions should include the following design conditions for each space:

- Indoor dry bulb temperature
- Indoor relative humidity
- Outdoor dry bulb temperature
- Outdoor wet bulb temperature
- Occupancy, hours, and degree of activity
- Lighting and miscellaneous power
- Ventilation – recirculation and outside air
- Internal loads
- Special loads
- R-values for roof, wall, glass, and other insulating materials
- Percentage of glass – fenestration
- Type of glass, including coatings and solar coefficient
- Building pressurization and infiltration
- Zone control
- Air changes
- Smoke control
- Air movement
- Control responses of the ATS
- Freeze protection of steam, hot water, and chilled water coils
- IAQ
- Noise

E. Electrical Design Requirements

Where wiring interfaces with equipment or systems of other divisions, clear distinction shall be made between work of division 16 and work of other divisions; Do not make references by subcontractor or trade.

1. Provide separate floor plans or removals and demolition, and for power, lighting, and fire alarm systems.
    a. Equipment locations for other systems, such as intrusion detection and telecommunications systems, may be included on power plans, unless the other systems are extensive enough to warrant separate floor plans.
    b. Include relevant building information, such as ceiling heights and slopes, exposed joists, beam and girder locations, and fan CFMs, on fire alarm system floor plans.
2. Provide one-line diagrams for power distribution systems.
    a. Indicate on the diagram the short-circuit energy available at each bus or tabulate it on the drawing.
    b. Indicate grounding methods and locations for all separately-derived systems. Where extensive or complex grounding arrangements are required (including ground-fault protection systems), provide separate grounding diagrams.
3. Provide riser diagrams for such systems as fire alarm, intrusion detection, and telecommunications. Include the locations of vertical chases.
4. Equipment schedules for feeders, switchboards, panelboards, and lighting fixtures must be in accordance with standard details shown in the relevant standards.
5. Provide design and engineering criteria, as well as space and ambient conditions. Specify the system under the designed intent to perform.

6. Calculate demands for the following loads:
   - Loads operating at 120 volts
   - Lighting loads
   - All other normal loads
   - Emergency loads, excluding fire pumps (include itemized list)
   - Fire pump, with horsepower rating
   - Standby loads (include itemized list)
   - Maximum coincident demand expected on the normal source and the alternate source
7. Where multiple buildings are fed from a load center, list the following information for each building:
   - The expected power factor prior to power factor improvement measures
   - Duty cycles for each category of equipment
   - Sizing calculations for switches over 100 amperes
   - Calculations for selection and sizing of all transformers, including connected load, future loads, harmonics, and temperature considerations
   - Calculations for sizing bus ducts
   - Lighting fixtures catalog cuts
   - Lighting calculations or isofootcandle layouts demonstrating that required illumination levels will be achieved throughout all egress routes

8. The building electrical service and distribution should be based on following criteria or conditions:
   - Service entrance configuration
   - Connected load estimate: receptacles, lighting, motors, special loads
   - Demand load estimate
   - Provision for future load growth
   - Level of redundancy or reliability requirement
   - Basis for equipment sizing: connected or demand load, load factor, non-linear load, future load growth, overload criteria
   - Automatic scheme and interlock
   - Over-current protection criteria and degree of selectivity at each voltage level
   - Required metering and accuracy
   - Provision for testing and maintenance
   - Grounding system requirement: safety, instrumentation, lightning protection
   - Special protection requirement: transient voltage surge suppression, under-voltage or loss of phase protection, EMI or RFI
9. The emergency power system should be based on following criteria or conditions:
   - Connected load estimate: receptacles, lighting, motors, special loads
   - Demand load estimate
   - Provision for future load growth
   - Motor starting capability
   - Non-linear loads
   - Transient performance, block load, and unload criteria
   - Generator auxiliary systems: starting, fuel supply and storage, cooling, combustion air supply, exhaust, sound attenuation, fire protection
   - Configuration and mode of operation
   - Required metering and accuracy
   - Provision for testing and maintenance
   - Over-current protection criteria and degree of selectivity
   - Provision for monitoring, supervisory and alarm
   - Interaction with other systems: fire protection, elevator, energy management, security, lighting control

10. The fire alarm system should be based on following criteria or conditions:
    - System configuration and equipment
    - Type of detection and signaling to be provided in each space
    - Type of system, initiating device circuit, and signaling circuit per NFPA 72
    - Standby power supply
    - Interaction with other systems: fire protection, elevator, HVAC, security, fire door and fire curtain, lighting control and egress lighting
    - Provision for signaling, monitoring, supervisory and alarm annunciation
11. The communication and paging system should be based on following criteria or conditions:
    - System configuration and equipment
    - Zone listing
    - Audibility criteria
    - Instrument type and functionality
    - Reliability and redundancy
    - Interaction with other systems: fire alarm, security
    - Power supply: UPS, emergency power, DC battery

End of Section