

**PART FOUR - DOCUMENTS FOR PLUMBING, FIRE PROTECTION, HVAC, AND ELECTRICAL CONSTRUCTION**

**FACILITY SERVICES - REQUIREMENTS FOR PLUMBING, FIRE PROTECTION, HVAC, AND ELECTRIC DOCUMENTS**

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**FS-1. SEPARATE DOCUMENTS REQUIRED**

- .1 THE LAW AND THE CSI FORMAT: Section 153.02 and 153.03 of the Revised Code of the State of Ohio requires that completely separate drawings and specifications be prepared for each of the following prime contracts:

General Construction Contract  
Plumbing (and Fire Protection) Contract  
Heating, Ventilating, and Air Conditioning Contract  
Electrical Contract

Include all work related to Fire Protection within the scope of the Plumbing Contract. The new CSI format now makes provision for the separation of Plumbing and HVAC specifications.

- .2 SEPARATION OF PLUMBING; AND HEATING, VENTILATING AND AIR CONDITIONING: The University requires that the complete separation of documents for these Divisions of The Work be made evident by prohibiting use of the word "MECHANICAL" when writing specifications for these Divisions and when making references to the contracts and contractors for any of these parts of The Work. In preparation of specifications, numbering of sections for Plumbing shall be preceded by "22"; and Heating, Ventilating and Air Conditioning by "23". Any system of numbering (either an alphanumeric system or a decimal system) may be used for the sections, articles, and paragraphs comprising these Divisions, at the Associate's option.

On drawings avoid using "mechanical" to describe pipe or duct chases, HVAC or electric equipment rooms, etc.

**FS-2. DESIGN CONSIDERATIONS**

- .1 DIRECT DIGITAL CONTROL (DDC) SYSTEM: To achieve precise control of all HVAC systems and to provide the means to integrate standard control functions with energy saving strategies, it is intended that all newly constructed and remodeled buildings on the Columbus campus be controlled using stand alone microprocessor based Direct Digital Control (DDC) computer systems. All hardware, software, and miscellaneous equipment required to insure that the DDC system can be managed from within the building and from a remote control center shall be provided as a part of the project. Control centers now in existence or planned for the future are:

Main Campus  
Medical Academic  
Midwest Campus  
University Hospitals and James Cancer Hospital  
West Campus  
Dormitory and Residence Areas

Each Associate shall submit schemes for connecting new facilities to the control center(s). All DDC systems shall be connected to the appropriate control center(s) using the University's fiber optic network, a hard-wired communication trunk, or a telephone communications trunk,

## FS-2. DESIGN CONSIDERATIONS (Cont'd)

as dictated by the capabilities of the system selected and by the location of the building being controlled.

Control centers in the Midwest campus, University Hospitals and the Dormitory / Residence areas have Central Processing Computers (CPU's) that are compatible with Direct Digital Control. Any expansion in any building within these three networks must maintain the integrity of the existing system and allow the new equipment to be controlled by the existing CPU. These three locations are to be treated as exceptions and cannot be addressed in the same fashion as an expansion in an area where no CPU exists. The Associate will coordinate this requirement through the University Architect.

- .1.1 An interconnecting conduit system shall be installed between all DDC panels within a given building. The interconnecting conduit system shall be extended to the appropriate building exit point to provide the link to the remote communications network. All communications cables required to provide the communications link between the DDC controllers and the external communications network shall be installed as a part of the project. The remote communications network shall be installed as a part of the project. The remote communications link shall be established and remote capabilities shall be verified by the contractor prior to final acceptance of the DDC system.
- .1.2 Schemes shall include necessary provisions in the Plumbing, HVAC, Fire Protection and Electrical construction documents for making system connections. Provisions for DDC Systems are described thoroughly in Appendix A. Also see Communication Wiring Standards in Appendix M and Electrical in Division 26.
- .1.3 Due to the highly technical nature of Direct Digital Control System selection as to its performance, compatibility with existing systems and other requirements the Associate and Facilities Operations and Development through the University Architect will mutually designate one manufacturer to be specified as base bid. Equals will be developed for bidding two other systems.
- .2 AESTHETICS: Requirements for aesthetic design and for coordination of design between the Associate and each of his consultants are stipulated in PART ONE, paragraph 00021, and 00023. These requirements are repeated here for emphasis.
  - .2.1 EXTERIOR INSTALLATIONS: Design for proper functions and consider in the aesthetics of building design. Large and unsightly installations shall be hidden from public view or shall be appropriately screened. If due consideration of aesthetics is not observed, the University Architect will require complete redesign of systems and of structure elevations until a pleasing, well integrated design is achieved. Elevations, site, and roof plans must show all equipment, such as fans, cooling towers, etc.
    - .2.1.1 TRANSFORMER STATIONS: Wherever feasible, as determined by the location of the service entrance and the space available on the site, transformer station shall be located inside the building along the exterior wall of the building at grade level. Exterior installation shall be approved by the University Architect.
  - .2.2 INTERIOR INSTALLATIONS: The Associate shall allow sufficient room for an orderly arrangement of equipment, piping, and conduit and shall continually monitor the work of consultants to see that pleasing arrangements are achieved. Special consideration shall be given to dimensions of floor to ceiling spaces to allow for concealment of systems, as much as practicable.

## FS-2. DESIGN CONSIDERATIONS (Cont'd)

- .3 FUEL OIL TANKS AND SYSTEMS: Provide heat and insulation for tanks, pumps, lines, etc. to assure cold weather operation of the equipment and systems dependent upon the fuel supply where possible locate tanks above ground in order to respond to an unexpected or accidental leak.
- .4 METERING: Separate and permanent meters for all utilities (gas, electric, water, chilled water, and steam) shall be provided for each building. Some buildings and systems will require additional sub-metering to facilitate adjustment of charges for water supply and sewage discharged. Also see Sewer Auxiliary Metering Systems in Appendix. See Index for other references.
- .5 ALARM SYSTEMS: All Fire Alarm Systems, all HVAC systems, and all Critical Environments Systems must be provided with dry-contact relay outputs connected to the University's existing campus-wide Access Control and Alarm Monitoring System (ACAMS), see Section 28 10 00. for all requirements.

Each individual field device must be capable of individually identifying itself when in an alarm or trouble condition. All alarm and fire suppression systems must be capable of self monitoring for all appropriate status changes such as, but not limited to, system trouble, water flow, improper water or air pressure, power loss, tamper, etc.

Any status change from any alarm system must be reported via the dry-contact relay output to the campus-wide Access Control and Alarm Monitoring System (ACAMS). All alarm systems are required to have backup power supplies including 24-hours or greater of monitoring, plus 4-hours or greater of local alarming, or longer if specified differently by building code, fire code, or higher authority.

The University has standardized on a campus-wide Access Control and Alarm Monitoring System (ACAMS) based upon Lenel Systems, International, Inc., Corporate Headquarters, 1212 Pittsford-Victor Rd., Pittsford, NY 14534-3820. See Section 28 10 00 for all requirements. All Columbus Campus alarm installations which require 24-hour remote reporting and monitoring must utilize this system.

Any new card access systems will require the use of Lenel systems and Lenel-compatible card readers, all to be consistent with Division 28, Section 28 10 00., unless written authorization is received from the Associate Vice President, Facilities Operations and Development, and the Assistant Vice President, Department of Public Safety, of the Office of Business and Finance to use an alternate.

Similarly, no card access system for exterior University building doors may be purchased or installed without specific approval from the Associate Vice President, Facilities Operations and Development, and the Assistant Vice President, Department of Public Safety, of the Office of Business and Finance.

## FS-3. COORDINATION OF CONTRACT DOCUMENTS

- .1 CROSS REFERENCES: Refer to PART ONE, for Associate's responsibilities regarding documents prepared by consultants. Documents for each Division of the work shall be compared with each other, not only to eliminate discrepancies between documents, but also to avoid repetition of requirements that are common to two or more divisions of the work. The requirement that separate documents be prepared for each division of the work does not preclude the incorporation of provisions contained in other divisions of the specifications by reference to the particular provisions.

Specifying by reference to other divisions and sections is no different from making references to ASTM designations, Federal Specifications or manufacturer's specifications. This method

### FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)

of specifying certain requirements will not only reduce the volume of the specifications but will also help assure complete coordination of the documents; in addition, forcing contractors to refer to other divisions of the specifications will serve as a reminder that their parts of the work must be integrated with other parts. Procedural, administrative, temporary facility and similar information belongs in Division 1. Do not duplicate such information in Division 21, 22, 23 or 26. Simply refer to Division 1 for such information. Examples of provisions that should be specified follow; this list is not all-inclusive.

- .2 CUTTING AND PATCHING: Division 1 should contain the article covering this item of work; however, mention should be made of special items of work that are not adequately covered in the General Conditions. Clearly indicate that responsibility and cost is to be borne by the contractor for the particular division.
- .3 TEMPORARY FACILITIES: Make reference to applicable portions of Division 1 (Section 01 50 00. to 01 60 00.) and Special Conditions. See State Architect's Handbook.
- .4 UTILITY CONNECTIONS: Include the following instructions in the specifications:

"Procedure for making connections to existing utilities shall be planned at least two weeks in advance of the work and the work shall be executed in a manner to provide reasonably continuous service throughout the construction period. **Connections shall be made only at times approved by the University.** For interruption of service in major utility systems, the Contractor must submit to the Associate a step-by-step sequence of operations planned to accomplish the work. Outline must show tentative dates and times of day for shut-off and restoration of services."

The Associate will review the information given with the University Architect, who, upon approval of the planned operations, will make arrangements with appropriate University personnel for interruption of services. See 01 51 00. and 00029.9.

If University assistance is anticipated for utility connections/disconnections consult with the Utilities Division Director, Facilities Operations and Development to obtain current construction outage charges. Charges for University assistance for building systems outages may be obtained by consulting with the Maintenance Division Director, Facilities Operations and Development.

**Caution to Bidders: Bidders are cautioned that the University will probably schedule interruption of services at times other than the contractors' normal working hours and that only designated University personnel are authorized to interrupt services.** Frequently, outages are scheduled between quarters to reduce disruption of classes.

- .5 USE OF PREMISES: Make reference to the applicable portions of Division 1. If routing of trucks hauling materials to and from the site cannot be adequately described in the specifications, show routes on the Location Plan.
  - .5.1 While The Ohio State University is a publicly owned institution, its facilities are dedicated to serve specific functions, operations, and programs. Therefore, contractors' personnel may be barred from using existing toilets, food service, or other facilities.
  - .5.2 Show on plans the staging areas, material storage areas, office trailer locations, ingress routes, site limitations, etc., as required to convey opportunities and restrictions to the contractors.
- .6 PERMANENT UTILITY CONNECTIONS: On projects where connections to existing utilities (i.e., steam, condensate return, hot water heating, hot water return, chilled water, chilled

### FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)

- water return, domestic hot water, gas, cold water, alarm systems, emergency electric, electric, etc.) are proposed, the Associate shall contact Facilities Operations and Development (through the University Architect) to ascertain the actual operating conditions and limitations of such systems to confirm that ample capacity, both present and future, will be available for project loads. This is mandatory in order to obtain approval for connection and/or extension of any utilities. Instructions in the specifications (similar to those defined in Paragraph FS-3.4. above) must be provided to insure proper bidding, planning, coordination and minimal utility outages. Also see Division 33, Utilities.
- .7 UNDERGROUND PIPING: Where practicable, underground piping (particularly steam lines), shall be routed to pass underneath walks or other paved areas in order to protect planted areas from the heat transmitted by such piping.
- .7.1 Underground steam lines shall not parallel or cross within five feet of an electrical duct in any direction.
- .8 MANHOLES: Refer to City of Columbus, Ohio, Standard Construction Drawings. See Appendix for Standard Detail.
- .9 EXCAVATION AND BACKFILL: Specifications shall clearly define responsibilities of each contractor involved. Materials and compaction of backfill materials must be coordinated with requirements stated in Division 2 of these guides. **Note that the use of grits for backfill is prohibited.**
- .10 CONCRETE PADS, BASES, AND CURBS: In Division 21, 22, 23, and 26, call attention to the fact that concrete pads, bases, and curbs are provided in Division 3; however, the Plumbing, HVAC, Fire Protection, and Electrical Contractors shall furnish and install sleeves, anchors, and other items which require embedment in concrete. These installations must be coordinated with the work specified to be performed by the General Contractor.
- .10.1 CURBS: Duct spaces, pipe shafts, and similar openings in slabs shall be curbed in HVAC equipment rooms, pump rooms, kitchens, and other areas which are subject to flooding. Curbs shall be not less than 4 inches high. The General Contract drawings shall show required curbs.
- .11 PENETRATION OF FLOORS AND OF FIRE RATED WALLS by pipes, ducts, cabinets, etc. is prohibited, unless openings are appropriately fire-stopped by fire dampers, or sealing of voids with fireproof materials. Fire-rated walls or floors must not have the rating reduced by penetrations or reduction of thickness. Precautions must be used by contractors when coring or making penetrations to ensure that the cored material does not drop to the floor below and cause an accident or injury.
- .12 SLEEVES for copper pipe shall be fabricated of copper pipe for up to 4 inches in diameter.
- .12.1 PROTECTION FOR INSULATED PIPES: When insulated pipes penetrate floors that will be covered with finish flooring, specify that a sheet metal protective covering be installed around the insulation jacket. Sheet metal jacket shall extend through and above the pipe sleeve far enough to protect the insulation from bumping by floor polishing machines and vacuum sweepers. Space between the pipe sleeve and the sheet metal must be sealed. Where insulated pipes pass through wall sleeves, cover insulation with sheet metal and seal both ends of the space between the sleeve and sheet metal with non-combustible packing.
- .12.2 CLEARANCE: Provide not less than 1/4 inch clearance on all sides for both insulated and non-insulated pipes which penetrate walls and slabs.

### FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)

- .12.3 LENGTHS: Except where greater lengths are required for penetrations through floors, sleeves shall be fabricated to a length equal to the thickness of construction through which they pass. See below.
  - .12.3.1 SLEEVES THROUGH WATERPROOFED FLOORS shall project a minimum of 4-inches above the floor.
  - .12.3.2 SLEEVES IN HVAC AND PLUMBING EQUIPMENT ROOMS shall extend no less than 1-1/4 inches above the curbs.
  - .12.3.3 SLEEVES IN ALL OTHER FLOORS shall extend 3/4 inch above the finish material on the floor.
  - .12.3.4 SEALS: Special wall sleeve fittings with soft rubber seals shall be specified for water service piping. In other installations, the void between pipe and sleeve shall be sealed with mineral wool or other non-combustible material to prevent passage of flame and smoke. In locations exposed to public view, the packing materials shall be concealed with sheet metal cover plates or split type, chromium plated brass escutcheons.
- .12.4 FIRE-STOPPING: Specify and show fire stopping at all penetrations of fire-rated assemblies.
- .13 MASONRY STRUCTURES: If these structures are not provided in the General Contract, materials and installation should be specified by reference to applicable portions of Division 4. If installation details differ from installation specified in Division 4, specify the special requirements.
- .14 STRUCTURAL SYSTEMS: Lintels for openings to accommodate plumbing, HVAC, fire protection, and electrical installations should be provided in Division 5. Refer to paragraph 05 50 00. Any other structural steel required for support of equipment can be specified by making reference to applicable portions of Division 5.
- .15 ANCHORAGES AND SUSPENSION SYSTEMS: Ceiling grid systems shall not be supported from ductwork, electrical conduit, heating or plumbing lines, and vice versa. Each utility system and the ceiling grid system shall be a separate installation and each shall be independently supported from the building structure. Where interference occurs, provide trapeze type hangers or other suitable supports for each system. Locate hangers and supports where they will not interfere with access to mixing boxes, fire dampers, valves, and other appurtenances requiring servicing. Attention to this prohibition must be included in every section when there is the possibility that other than the independent suspensions systems would be used, together with prohibitions against use of perforated steel strap, power actuated anchors and plug anchorage (using wood, lead or plastic).
- .16 ROOF MOUNTED EQUIPMENT, FLASHING AND ROOF PENETRATIONS: Specifications should alert the Plumbing, HVAC, Fire Protection and Electric Contractors that installation must be coordinated with work specified to be performed by the roofer. Refer to paragraphs 07 50 10.3 and 07 60 10.4. All roof mounted equipment (i.e., heating, air conditioning, exhaust fans, intakes, etc.) shall be provided with pre-fabricated mounting curbs at least 12-inches high. Curb shall be fabricated of double dipped galvanized steel, copper or stainless steel. Any installation design must facilitate roof repair and maintenance. Protrusions through roof (ducts, pipe clusters, etc.) shall be located so as not to disrupt flow of water to roof drain. Maintain a minimum clearance of 6-feet from parapet walls or change in elevation and from roof sumps or drains. Note that pitch pans or pitch pockets are prohibited. Additionally, establish architectural acceptability with no ugly projections.

**FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)**

.17 PAINTING: Cleaning and painting of Plumbing, HVAC, Fire Protection, and Electrical items and equipment exposed to view should be specified in Division 9. If concealed installations require painting before being concealed, list the installations and specify that materials and application be as specified in Division 9. Do not specify painting of the same surface under more than one Division except shop prime coats, where protection is needed, color banding and flow arrows. See 09 91 23.1.

USE OF INK MARKING PENS ON ANY SURFACE IS PROHIBITED. Marks bleed through paint or other finishes.

.17.1 COLOR CODING OF PIPING: Specify that, after piping has been finish painted, the installer of the piping identify the type of service lines with applied color bands and stenciled letters and indicate direction of flow with stenciled arrows. Color bands shall be 1-inch wide, finished in gloss enamel; lettering and arrows shall be same color as the bands. Specify that indicators be applied at connections to pumps, chillers, and other equipment; at entrances to spaces; adjacent to valves; near access doors to pipe spaces; and at 30-foot maximum intervals on long pipe runs. Specify that letters be positioned to be easily read from a normal standing position.

.17.1.1 Use the following band colors and letter designations:

Type of Service	Color	Designation
PLUMBING PIPING (Show direction of flow)		
Compressed Air	White	CA
Drain	Room Color	
Natural Gas	Yellow	Gas
Hydrogen	Red	HYD
Nitrogen	Black	NIT
Oxygen	Green	OXY
Vacuum	Room Color	VAC
Domestic Cold Water	Light Blue	DCWS
Domestic Hot Water	Dark Blue	DHWS
Domestic Hot Water Return	Dark Blue	DHWR
Deionized Water	Room Color	DZDW
Distilled Water	Room Color	DSTLW
Soft Water	Medium Blue	SFTW
Oil, Fuel, or Hydraulic	Orange	Oil
HEATING AND COOLING PIPING (Show direction of flow)		
High Pressure Steam 125PSI	Aluminum/Orange Band	HPS
Med. Pressure Steam 50PSI	Aluminum	MPS
Low Pressure Steam 15PSI	Aluminum	LPS
Boiler Feed Water	Green	BLR F
Chilled Water Supply	Black	CWS
Chilled Water Return	Black	CWR
Condensate Water	Aluminum	COND
Condenser Water	Purple	CDSR
Hot Water Heating Supply	Lime Green	HWHS
Hot Water Heating Return	Lime Green	HWHR
FIRE PROTECTION PIPING		
Fire Line	Red	FL

**FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)**

- .18 LOUVERS for air distribution systems shall be specified in Division 23, door louvers in Division 8, all others in Division 10.
- .19 PIPING: Since the Plumbing (and Fire Protection) contract is required to be separate from the HVAC contract, provide independent and complete documents for each contract. The documents shall clearly indicate the scope of work included in each contract and shall call attention to areas of work that require coordination between contractors. For those common areas where the two contractors meet, on each document state which contractor is responsible for which work. For instance, on gas-pipe connections to boiler, state and show the 'Plumbing contractor' responsible for providing the gas piping up to the shutoff and union before the boiler, and state and show the 'Plumbing contractor' is responsible for providing the gas piping beyond the shutoff and union up to the boiler. Do not use the words 'Not in Contract', and do not use the acronym 'N.I.C.' If either contractor is required to do related work, then show and state the contractor by Division (i.e., Plumbing, or HVAC, etc.).

To avoid duplicate costs for identical work, these notations are necessary. Be sure to indicate the extent of related work and which contractor makes the interconnection.

- .19.1 PIPING DETAILS, which are applicable to any or all of these three Divisions of the work, follow; details, which are applicable only to particular divisions, are stipulated in the guides for the particular division.
- .19.2 SUPPORTING DEVICES: Specify copper-plated devices for copper pipe and splitting type for galvanized pipe. Use wrought clevis type for soil and vent piping. Perforated strap hangers are prohibited.
  - .19.2.1 HANGERS: Trapeze hangers and roller hangers are acceptable. Hanger rod sizes shall be:

Size in Inches	For Pipe Size
3/8	2-inch and smaller
1/2	2-1/2 and 3-inch
5/8	4 and 5 inch
3/4	6-inch
7/8	8 to 12-inch
1	14-inch and larger

MAXIMUM SPACING BETWEEN SUPPORTS for water, soil, vent, air, and gas pipe shall be:

Nominal Pipe Size	Maximum Span
Inches	Feet
<b>Steel</b>	
3/4 to 1	7
1-1/4 to 1-1/2	9
2	10
2-1/2	11
3	12
3-1/2	13
4	14
5	16
6	17
8	19
10	22
12	23

### FS-3. COORDINATION OF CONTRACT DOCUMENTS (Cont'd)

#### Copper

1/2	6
3/4 to 1	7
1-1/4 to 2	9
2-1/2 to 5	11
6 to 8	14

FOR CAST IRON, BELL, AND SPIGOT PIPING, space supports at 5 ft. o.c., maximum.

SOIL PIPE shall be supported at each floor on (vertical stacks), and at each 5 ft. increment, joint, and elsewhere as required for adequate support.

- .19.3 THREADING cast iron or ductile iron pipe is prohibited. Call attention to this in applicable specification sections.
- .20 MOTORIZED EQUIPMENT: Basic requirements for electrical work and equipment are covered in Division 26 of these standards. The requirements included herein cover specific items that have been troublesome in the past and require that the specifications incorporate adequate provisions for electrical work and equipment furnished by the Plumbing, HVAC, and Fire Protection Contractors. The Associate shall specify motors, drives, and equipment to meet all operating requirements for the installation. Consideration for motors should be for voltage, phase, frequency, frame size, temperature rise, and sufficient starting torque to start loads with high inertia. Performance requirements should include capability to make multiple starts per day to meet energy conservation control requirements. Where necessary, non-recycling shall be specified to protect the equipment from short time recycling.
- .20.1 WIRING: Specifications shall clearly point out the responsibility for wiring related to Plumbing, HVAC and Fire Protection equipment. In general, it is required that power wiring be provided by the Electrical Contractor and control wiring be provided by the Plumbing, HVAC and Fire Protection Contractor. Also see Communications Wiring Standard in Appendix.
- .20.2 STARTERS: Specifications shall require that motor starters be provided by the Electrical Contractor. Exceptions to this requirement will require the approval of the Associate and his review is necessary to ascertain that standards stipulated in the electrical specifications are followed.
- .20.3 MOTORS shall be sized in accordance with applicable NEMA standards for the operating conditions of each specific items of equipment with a 1.5 service factor. Motors must be selected to operate within nameplate Hp and shall not operate on the service factor. Short shaft motors shall not be used for belt drives. In general, motors one-half horsepower or smaller shall be single phase; larger motors shall be three phase. Motors shall be provided with electrical overload protection to prevent burn-out under operating conditions. Large motors shall have adequate internal overload and thermal protection in addition to the overload elements in the motor starter.

### FS-4. SUBMITTALS

- .1 GENERAL: Refer to Division 1 for the list of submittals required to insure quality control of materials and workmanship. Submittals required for specific items may be stipulated in articles in which the items are specified (as is done in these guides), or may be listed under this heading. The Associate shall stipulate additional submittals that he deems necessary for the prosecution of the work.

#### **FS-4. SUBMITTALS (Cont'd)**

- .2 SAMPLES AND SHOP DRAWINGS: Reference should be made to Division 1 for instructions for making these submittals. In Divisions 21, 22, 23, 26, 27, and 28, only a listing, of items for which samples and drawings are required, will suffice.
  - .2.1 Submittals shall be specified to be provided within 90-days of Notification to Proceed.
  - .2.2 PERFORMANCE CURVES: Specify that these be submitted with shop drawings.
- .3 RECORD DRAWINGS: The Associate is directly responsible for the accuracy of these records. In addition to notes made in the field by the Associate's representative, Article 11 of the General Conditions requires Division Contractors to accurately record all deviations from Contract Documents during construction and to furnish this information to the Associate. When writing specifications, avoid wording that might suggest to contractors that changes can be made without prior approval. See 01 78 39.2.
- .4 WARRANTIES, OPERATION AND MAINTENANCE MANUALS: At the time of Beneficial Occupancy of the project, four approved copies of warranties, instruction sheets, catalogue data, and final shop drawings secured in binders shall be forwarded to the University Architect's Office. Also see 01 78 23. Provide full information (trim sheets and log sheets) defining all conditions, quantities of refrigerant, pressures, temperatures, etc. during the testing operations of each piece of equipment.
- .5 POWER AND CONTROL DRAWINGS: Electrical power and control drawings for large, complex electrical equipment shall be supplied and posted at, on, or near the equipment. Provide framed glass or plastic protection.
- .6 DIAGRAMS AND OPERATING INSTRUCTIONS: Complete diagrams and operating instructions for all control systems shall be posted near the related equipment. Provide framed glass or plastic protection. When multiple equipment rooms exist in a building, these diagrams will be required at each piece of equipment. Additionally, a complete set of diagrams will be posted or made available in the main equipment room.

#### **FS-5. SAFETY REQUIREMENTS**

- .1 OSHA REQUIREMENTS: Belt guards, coupling guards, rails, and other protective devices shall be provided to meet OSHA requirements and Ohio Industrial Commission.
- .2 Contractor shall be required to comply with all requirements for Material Safety Data Sheets (MSDS's), lockout and tagout procedures, confined space entry requirements, hot work permits, construction site fire protection, fall protection for all contractor and subcontractor employees, hazardous materials abatement procedures, prohibition of mercury-containing materials, etc.

#### **FS-6. A REVIEW OF ENERGY CONSERVATION REQUIREMENTS**

The subject of energy conservation is discussed in various sections of these BUILDING DESIGN STANDARDS. This review is made for the purpose of consolidating all requirements for this important part of design under one heading for easy reference.

##### **.1 GENERAL REQUIREMENTS**

- .1.1 The University is dedicated to the principle of conserving energy and will scrutinize proposed construction for means of reducing not only initial cost, but also long-range operating costs. The Associate must work in close cooperation with his consultants to design new buildings and remodel existing buildings making the most efficient use of building materials and energy sources available. Compliance with The State of Ohio

## FS-6. A REVIEW OF ENERGY CONSERVATION REQUIREMENTS (Cont'd)

Energy Efficiency code, which is based on the most current edition of ASHRAE Standard 90.1 -- Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved), is the minimum requirement. ASHRAE standards might be exceeded by requirements specified in these OSU Building Design Standards. If, in preliminary or basic submittals, it is determined that the BTU allotment or maximum allowable energy load will exceed the ASHRAE standards, a conference with The Ohio State University will be required to determine the course of action. Redesign of problematic portions of the building will be required with all professionals working in close cooperation to design energy efficient buildings. The Energy Conservation Engineering Data Report shall be submitted prior to the final review. See 00034.

- .1.2 In the design of the HVAC and Electrical systems, consideration must be given to building utilization by planning for conservation of energy during summer and winter vacations and for other periods of minimum occupancy. Research laboratories, spaces for animals, and other spaces which might require 24 hours/day operation must be serviced by systems separate from office systems which may require only 8 hours/day operation, and classrooms which may be shut down during summer and vacation periods.
- .1.3 The capability of using alternate sources of energy is of extreme importance. If gas-fired boilers are installed, the facilities must be provided with stand-by equipment for use of other fuels or sources of energy.
- .1.4 The Associate shall submit to the University a life-cycle cost analysis which has been prepared in cooperation with his HVAC and electrical consultants. The analysis shall be prepared pursuant to Sections 123.001, 153.01, 153.04, and 153.10 of the Revised Code of the State of Ohio and in accordance with rules adopted under Chapters 3781 and 4101. Submit with basic documents - three copies.
- .1.5 The Associate shall provide an energy budget to the University, prepared in cooperation with his HVAC, electrical consultants. The budget shall show the estimated use of energy for the structure calculated on a BTU per square foot per year basis. See Appendix - "Energy Conservation Report". Submit with design development documents.

## .2 BUILDING CONSTRUCTION REQUIREMENTS

- .2.1 The exterior envelope shall be given careful consideration. University maintenance, security, and utility costs indicate the need for restraint in the use of large areas of glass. If large areas of glass are required for aesthetics, careful orientation of these areas for reduction of heat loss and heat gain must be made.
- .2.2 WINDOWS, insofar as practicable, shall be provided with operable vent sections.
- .2.3 The overall R-Value of walls, including windows and doors, shall be consistent with, and more energy efficient than, the code requirements of the Ohio Building Code.
- .2.4 The overall ceiling and roof R-Value shall be consistent with, and more energy efficient than, the code requirements of the Ohio Building Code.
- .2.5 INFILTRATION shall be consistent with, and more energy efficient than, the code requirements of the Ohio Building Code. Compliance with the overall air leakage requirement should be determined by calculations using certified data furnished by the manufacturers or suppliers for doors, windows, and wall materials supplemented by calculations using the crack method given in the ASHRAE Handbook of

## FS-6. A REVIEW OF ENERGY CONSERVATION REQUIREMENTS (Cont'd)

Fundamentals at the appropriate prevailing design wind condition for the area of application.

### .3 SYSTEM DESIGN REQUIREMENTS

.3.1 Air conditioning systems shall be designed to conserve energy. Systems shall automatically adjust to the actual space load conditions to reduce energy consumption at partial space loads rather than falsely load and waste energy.

.3.2 Design temperatures for heating and air conditioning systems shall be as follows:

Summer: Outside conditions, 92 degrees FDB and 74 degrees FWB  
Inside conditions, 76 degrees FDB and 64 degrees FWB

Winter for space conditioning:

Winter: Outside conditions, +1 degrees FDB  
Inside conditions, 68 degrees FDB

Winter for preheat coil sizing on 100% outdoor air fan systems:

Winter: Outside conditions, \_\_\_\_\_ (minus) -22 degrees FDB  
Coil Leaving Air conditions, \_\_\_\_\_ +55 degrees FDB

Relative humidity should range between 40 and 70 percent in order to control the growth of molds, fungi, bacteria, etc.

Special areas, such as computer rooms, animal areas, etc., will have temperature and humidity requirements transmitted to the Associate Architect by the University Architect's Office.

.3.3 Occupied-unoccupied programming of systems should be initiated to shut-off ventilation air, exhaust air, fan systems, pumps, etc., wherever possible. Where shut-down of systems cannot be accomplished during unoccupied hours, heat recovery systems should be considered. Each application should be examined independently to determine any special sources for obtaining a recovery of usable energy. An economic analysis by the Associate's consultants may be required to determine the feasibility of energy recovery systems before the University will render a decision of their acceptability. Four copies of this analysis shall be furnished by the Associate to the University Architect.

.3.4 Fan coil units and radiation will be required in specific areas to facilitate shut-down of major fan units. Where necessary, the controls on these units shall be coordinated with the controls on the air handling units.

.3.5 All air conditioning systems, 5000 CFM and larger, shall have controlled economizer cycles. Air conditioning systems smaller than 5000 CFM shall have controlled economizer cycles where the cost for additional work and equipment involved can be justified. All systems that have economizer cycles shall be capable of running the cooling equipment independent of the economizer cycle controls. Furthermore, the economizer control shall not revert to the minimum outside air damper position for cooling season unless mechanical cooling is available.

.3.6 All air conditioning, heating, ventilating, and exhaust systems shall be closely matched to the minimum required performance. The use of variable volume supply and exhaust air systems is encouraged to compensate for diversities in loads and reduce equipment sizes. Space air outlets should be aspirating types to prevent "dumping" of air into occupied spaces.

## FS-6. A REVIEW OF ENERGY CONSERVATION REQUIREMENTS (Cont'd)

- .3.7 Interior spaces requiring cooling the year around should be handled independently from perimeter areas requiring heating during the winter and cooling during summer. Interior areas should be supplied from a variable volume cooling system utilizing controlled economizer cycle. The perimeter systems should utilize controlled economizer cycles when cooling is required and minimum ventilation rates when heating is required.
- .3.7.1 For any system based upon variable air volume, include a pre-heat coil as the first coil in the fresh air stream, sized to preheat the fixed-minimum ventilation air from design heating outdoor air temperature up to design mixed air temperature. This will help to maintain the required fixed minimum ventilation air, by preventing the mixed air temperature controller from closing the outside air damper.
- .3.7.2 Apply carbon dioxide (CO2) monitors in large occupancy rooms, such as auditoria, etc., to monitor and regulate the ventilation air as required to maintain the CO2 values below 1000 parts per million (ppm).
- .3.8 The following criteria shall be employed in the selection of equipment (each project to be reviewed on an individual basis):
- .3.8.1 FANS selected for operation above 6-1/2" total static pressure must be approved by the University Architect.
- .3.8.2 COMPRESSORS for electricity-driven chillers and refrigeration units, of over 100-ton type. Electrical power consumption shall not exceed 0.75 KW/ton between 30% and 90% of chiller capacity. Refer to ASHRAE 90A-1980, Section 6, for minimum Energy Efficiency Ratios (EER) allowable for all other compressors. Absorption water chillers should not be used unless waste heat is available. The University's central steam distribution system in NOT considered waste heat.
- .3.8.3 Due to the highly technical nature of chiller selection as to its performance characteristics, space requirements, isolation requirements with regard to noise and vibration, and other requirements, the Associate and Facilities Operations and Development through the University Architect will mutually designate one manufacturer to be specified as base bid. Equals will be developed for bidding two other units.
- .3.8.4 Water-cooled, air-cooled, or evaporative condensers are acceptable depending upon job requirements and necessities. Water-type cooling towers are preferred to conserve energy and shall generally be used on systems 80-tons and larger. On units below 80-tons, an economic evaluation, including cost of maintenance should be made to determine if the condensing unit will be air cooled or water cooled.
- Cooling tower fan motor loads shall not exceed 0.06 H.P./ ton of chiller capacity. Reduced condenser water temperatures should be utilized when possible to reduce the chiller electrical consumption. At design conditions air cooled condensers shall have not more than 115°F condensing temperature with 20°F temperature difference between air entering and leaving the condenser.
- .3.9 Variable Frequency Drives, elevator controllers and other electronic equipment are to be located within a separate temperature controller area of building maintenance rooms to avoid the harmful effects of heat produced by steam stations, heating hot

**FS-6. A REVIEW OF ENERGY CONSERVATION REQUIREMENTS (Cont'd)**

water pumps or other building systems producing local environment which exceed safe operating conditions for electronic equipment.

**.4 ELECTRIC LIGHTING REQUIREMENTS**

.4.1 LIGHTING SYSTEMS should be considered as a source of heat to supplement heating requirements and recovery systems shall be provided wherever practicable.

**FS-7. EQUIPMENT**

.1 FIXED EQUIPMENT required by the program will be furnished by the project unless written exception is given by the University Architect for the omission. Also, See Division 11.

**.2 RELOCATING EXISTING EQUIPMENT**

.2.1 Relocation of existing equipment must include disconnecting and moving to new location as well as restoration and capping utilities at the old location.

.2.2 Require the contractor to be responsible for recording existing wiring and piping to facilitate reinstallation.

.2.3 Require the contractors to replace unsalvageable piping and wiring and to furnish any new piping and wiring to complete proper reinstallation.

.3 RESTRICTED LOCATION: Operating equipment other than sump pumps shall not be located below the 730 foot elevation in buildings in the Olentangy River "flood plain".

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END OF FACILITY SERVICES