23 00 00. HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

*[**Commentary:** Note: Division 23 applies to piping and valves, etc., within buildings. For piping and valves external to buildings (campus district heating, district cooling, natural gas, etc.,) Division 33 applies. For buildings connecting to campus utilities, review with University Project Manager where Division 33 applicability stops and Division 23 starts.]*

23 00 01. SUSTAINABILITY

.1 AE shall reference Division 18 "Sustainability" where some of the requirements are related to this division and adopt applicable requirements into the design.

23 00 03. GENERAL PROVISIONS

.1 Specialized exhaust systems will need to be provided for offset printing and dark room operations. Refer to Appendices for laboratory ventilation and fume hood exhaust air systems.

.2 COHESIVE DOCUMENTS OF BUILDINGS, UTILITIES AND SYSTEMS: The A/E's design documents shall provide one-line diagrams of all utilities, organized in relation to the new construction plus the existing construction. Provide one-line diagrams of each system, organized in relation to the new construction plus the existing construction. The one-line diagrams and system documents must display the interrelationship of all systems with all attributes of the building (number of floors, future or shelled-out spaces, original buildings, added building areas, etc.). Archived project contract documents may be downloaded from SIMS. Consult OSU PM for access requirements. Existing OSUWMC one-line diagrams may be obtained from OSUWMC Facilities Engineering.

.2.1 All Mechanical floor plans shall include column lines, room names, room numbers, Key Plan, and a north arrow.

.3 All electrical equipment provided by the HVAC contractor shall be in accordance with the requirements of Division 26.

.4 All equipment provided by the HVAC contractor that is furnished with fuses shall be provided with spare fuses in accordance with Division 26.

.5 ROTATING EQUIPMENT

.5.1 GENERAL PROVISIONS: Where possible, specify rotating equipment with antifriction sealed spherical ball or roller bearings, split pillow blocks, and lubrication of bearings in accordance with manufacturer's recommendations before start-up. Bearing life (on equipment 5 hp and larger) per Anti-Friction Bearing Manufacturers Association rating procedures shall be 90 percent expectancy of reaching at least 150,000

hours under design conditions. Caution the contractor to exercise extreme care in cleaning and lubrication of bearings after equipment has been subject to prolonged periods of storage before operation. The contractor shall be made responsible for continued lubrication of equipment until acceptance of his work.

Wexner Medical Center: Provide ceramic bearings on fans controlled by a VFD for protection against eddy current bearing failures. Bearing life per Anti-Friction Bearing Manufacturers Association rating procedures shall be 90 percent expectancy of reaching at least 150,000 hours under design conditions.

.5.2 NOTIFICATION OF START-UP: The A/E shall notify the University Project Manager of the schedule for start-up of all equipment.

.5.3 REPORT REQUIRED: The A/E shall specify that the Contractor, at the time of acceptance, shall provide the University Project Manager with a report listing the following:

.5.3.1 Dates equipment arrived at job site.

.5.3.2 Installation completion date.

.5.3.3 Dates of maintenance at start-up and periodic inspections.

.5.3.4 Dates of lubrication, specific brand names, manufacturer and type(s) of lubricant.

.5.3.5 Dates of maintenance inspections and scope of maintenance services performed.

Wexner Medical Center: OSUWMC Facilities Operations shall be provided with the above-mentioned report.

.6 EQUIPMENT IDENTIFICATION: Specify that fans, controls, switches, ventilators, pumps, and other items of equipment, which have had the manufacturer's data plate removed or rendered illegible, be equipped with new name plate by the installer. Plate shall be brass on which operational data plus information regarding areas or other equipment served is stamped. Permanently attach name plate to the equipment in locations where they can easily be read.

Wexner Medical Center: See table below for OSUWMC equipment tagging conventions.

GENERAL NAMING CONVENTION

BUILDING- FLOOR.QUADRANT - EQUIPMENT TAG - EQUIPMEMT SUB-IDENTIFIER - NUMBER	
BUILDING	4-DIGIT OSU BUILDING NUMBER WHERE EQUIPMENT IS LOCATED
FLOOR	FLOOR NUMBER WHERE EQUIPMENT IS LOCATED. INCLUDE .QUADRANT FOR FLOOR LEVEL EQUIPMENT ONLY
EQUIPMENT TAG	EQUIPMENT TYPE ABBREVIATION (FOR EXAMPLE, AHU FOR AIR HANDLING UNIT, P FOR PUMP)
EQUIPMENT SUB-IDENTIFIER	ONLY USED IF NEEDED TO IDENTIFY ASSOCIATED SYSTEM. FOR EXAMPLE: AHU-**SP** COULD BE USED TO IDENTIFY STAIR PRESSURIZATION AHU, P-**CHW** TO IDENTIFY CHILLED WATER PUMP
NUMBER (CENTRAL EQUIPMENT)	CENTRAL EQUIPMENT (PUMPS, AHU'S, FANS, ETC.): START WITH NUMBER 01 AND CONTINUE SEQUENTIALLY FOR THE BUILDING. EACH PIECE OF CENTRAL EQUIPMENT SHALL HAVE A UNIQUE NUMBER REGARDLESS OF FLOOR OR SUB-IDENTIFIER. DO NOT RESTART AT 01 FOR CENTRAL EQUIPMENT LOCATED ON DIFFERENT FLOORS (FOR EXAMPLE, DO NOT USE **07**-AHU-**01 AND 25**-AHU-**01**. DO NOT RESTART AT 01 WHEN A DIFFERENT SUB-IDENTIFIER IS USED FOR. FOR EXAMPLE, THERE SHOULD NOT BE TWO PUMPS LABELED 01 WITH DIFFERENT SUB-IDENTIFIERS (THERE SHOULD NOT BE A **P**-CHW-**01** AND **P**-HHW-**01,** THE BUILDING SHOULD ONLY HAVE ONE PUMP 01, **P**-xxx-**01).**
NUMBER (FLOOR EQUIPMENT)	FLOOR-LEVEL EQUIPMENT (DAMPERS, VALVES, VAV'S, FCU'S, ETC) SHOULD RESTART WITH NUMBER 01 ON EACH FLOOR. (DO NOT START AT NUMBER 01 FOR EACH QUADRANT ON THE SAME FLOOR).

INSTRUCTIONS TO DESIGN ENGINEERING TEAM:

1. PROJECT TEAM TO SUBMIT PROPOSED STANDARD EQUIPMENT TAGS TO OSUWMC FOR APPROVAL. FOR EXAMPLE, AHU FOR AIR HANLDING UNIT, P FOR PUMP, ETC.
2. QUADRANT SHOULD MATCH NAMING CONVENTION OF SHEET NUMBERING, IF USED. FOR EXAMPLE, IF FIRST FLOOR MECHANICAL DRAWINGS ARE SPLIT INTO M2.1A AND M2.1B, A VAV BOX SHOWN ON SHEET M2.1A SHALL USE DESIGNATION XXX-01.A-VAV-XX. A VAV BOX LOCATED ON M2.1B SHALL USE DESIGNATION XXX-01.B-VAV-XX.
3. SELECT EQUIPMENT MAY REQUIRE TWO SUB EQUIPMENT IDENTIFIERS. FOR EXAMPLE, THERE MAY BE A STAIR PRESSURIZATION AHU, TAGGED 870-07-AHU-SP-41. THE VFD FOR THIS PIECE OF EQUIPMENT SHOULD BE LABELED TO BE ASSOCIATED WITH THE UNIT TAG, MAKING IT 870-07-VFD-AHU-SP-41
4. FLOOR PLAN DRAWINGS MAY REMOVE THE BUILDING ID FROM THE TAG TO SAVE SPACE, BUT BUILDING TAG MUST REMAIN ON EQUIPMENT SCHEDULE. FOR EXAMPLE, VAV BOX TAG ON SCHEDULE COULD BE 870-22-VAV-01. TAG ON FLOOR PLAN MAY BE SHORTENED TO 22-VAV-01

CENTRAL EQUIPMENT EXAMPLES

870-07-AHU-01	BUILDING 870, LEVEL 7, AIR HANDLER 1	
870-25-AHU-02	BUILDING 870, LEVEL 25, AIR HANDLER 2. (THERE WOULD NOT BE A UNIT LABELED 870-25-AHU-01)	
870-07-EX-01A	BUILDING 870, LEVEL 7, EXHAUST FAN 1A	NOTE THAT EX FAN NUMBERS START AT 1 AND GO UP REGARDLESS OF FLOOR LOCATION
870-R-EX-05A	BUILDING 870, LOCATED ON ROOF, EXHAUST FAN 5A	
870-07R-EX-35A	BUILDING 870, LOCATED ON L7 ROOF, EXHAUST FAN 35A	
870-07-P-SCH-01	BUILDING 870, LEVEL 07, PUMP (SECONDARY CHILLED WATER) 1	
870-07-P-PCH-04	BUILDING 870 LEVEL 7, PUMP (PROCESS CHILLED WATER). (THERE WOULD NOT BE A P-PCH-01)	
870-07-VFD-P-PCH-04	BUILDING 870 LEVEL 7, VARIABLE FREQUENCY DRIVE FOR P-PCH-04	

FLOOR EQUIPMENT EXAMPLES

870-15.A-FSD-01	BUILDING 870, LEVEL 15 QUADRANT A, FIRE SMOKE DAMPER 1
870-16.A-FSD-01	BUILDING 870, LEVEL 16 QUADRANT A, FIRE SMOKE DAMPER 1
870-04.A-VAV-01	BUILDING 870, LEVEL 04 QUADRANT A, VARIABLE AIR VOLUME BOX 01
870-04.C-VAV-15	BUILDING 870, LEVEL 04 QUADRANT C, VARIABLE AIR VOLUME BOX 15
870-05.A-VAV-01	BUILDING 870, LEVEL 05 QUADRANT A, VARIABLE AIR VOLUME BOX 01
870-04.A-FCU-01	BUILDING 870, LEVEL 04 QUADRANT A, FAN COIL UNIT 01

LIST OF EQUIPMENT IDENTIFIERS

AHU	AIR HANDLING UNITS
AHU-SP	AIR HANDLING UNIT – STAIR PRESSURIZATION
EX	EXHAUST FAN
P	PUMP
FCU	FAN COIL UNIT
VAV	VARIABLE AIR VOLUME TERMINAL UNIT
VFD	VARIABLE FREQUENCY DRIVE
CP	CONDENSATE PUMP
HX	HEAT EXCHANGER
FD	FIRE DAMPER
SD	SMOKE DAMPER
FSD	COMBINATION FIRE/SMOKE DAMPER
V	VALVE

WATER SYSTEM SUB-IDENTIFIERS

HHW	HEATING HOT WATER
CH	CHILLED WATER
PCH	PROCESS CHILLED WATER
GHW	GLYCOL HEATING WATER
S/T	SECONDARY/TERTIARY DESIGNATION
SCH	SECONDARY CHILLED WATER
TCH	TERTIARY CHILLED WATER

.7 SPRINKLER PIPING IN CEILING SPACE OF VESTIBULES and similar locations shall be protected from freezing.

.8 All installed equipment requiring maintenance shall be designed to enable proper access.

Wexner Medical Center:

.8.1 Systems serving patient care areas and systems serving clinical buildings as a whole shall be designed with N+1 redundancy such that the areas and building can still fully function with the largest piece of equipment out of service.

.8.2 The use of duct liner is strictly prohibited.

.9 SLEEVES:

.9.1 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.

.9.2 CLEARANCE: Provide not less than 1/4 inch clearance on all sides for both insulated and non-insulated pipes which penetrate walls and slabs.

9.3 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.

.9.3.1 SLEEVES THROUGH WATERPROOFED FLOORS shall project a minimum of 4-inches above the floor.

.9.3.2 SLEEVES IN HVAC AND PLUMBING EQUIPMENT ROOMS shall extend no less than 1-1/4 inches above the curbs.

.9.3.3 SLEEVES IN ALL OTHER FLOORS shall extend 3/4 inch above the finish material on the floor.

.9.3.4 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.

.9.4 FIRE-STOPPING: Specify and show fire stopping at all penetrations of fire-rated assemblies.

.9.5 Sleeves for copper pipe shall be fabricated of copper pipe for up to 4 inches in diameter.

.10 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 A/E 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.

.10.1 WIRING: Specifications shall clearly point out the responsibility for wiring related to Plumbing, HVAC, Fire Suppression and Fire Alarm equipment. In general, it is required that power wiring is provided by the Electrical Contractor and control wiring is provided by the Plumbing, HVAC and Fire Suppression Contractor. Also see Communications Wiring Standard in Appendix.

.10.2 STARTERS: Specifications shall require that motor starters be provided by the Electrical Contractor. Exceptions to this requirement will require the approval of the A/E and his review is necessary to ascertain that standards stipulated in the electrical specifications are

followed. Variable Frequency Drives (VFD's) shall be specified by the A/E.

.10.3 MOTORS shall be sized in accordance with applicable NEMA standards for the operating conditions of each specific items of equipment with a 1.15 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; motors larger than ½ horsepower 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. Definite purpose inverter fed motors shall be specified for use with VFD's.

.11 POWER AND CONTROL DRAWINGS: Electrical power and control drawings for large, complex electrical equipment shall be supplied in a legible format on site.

.12 DIAGRAMS AND OPERATING INSTRUCTIONS: Complete diagrams and operating instructions for all control systems shall be posted near the related equipment. Provide framed glass or clear acrylic 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 and shall be included in the O & M manuals submitted as part of the project closeout.

.13 Domestic water shall not be used for condenser heat rejection. No single pass cooling water may be used on mechanical equipment in new construction or retrofits, except in the case of emergency.

.14 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.

.14.1 GENERAL REQUIREMENTS

.14.1.1 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 A/E 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. Energy Conservation is dependent on all elements of a total building structure. Compliance with Division 18 is mandatory. If, in

Schematic or Design Development submittals, it is determined that the project does not meet or exceed the requirements of Division 18, a conference with The University Engineer and FOD's Senior Director of Sustainability 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. Refer to Division 00 PROCESSING THE WORK of the BDS for the required design documentation submittals to show compliance with Division 18.

.14.1.2 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, server rooms, communications rooms, IDFs, MDFs, 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. HVAC systems that require chilled water below 50 F outside air temperature require prior approval by the University Engineer or Wexner Medical Center Facilities Engineering.

.14.1.3 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.

.14.1.4 The Ohio Building Code allows the use of either the International Energy Conservation Code (IECC) or ASHRAE 90.1 for energy code compliance. The University requires the use of ASHRAE 90.1 as adopted by Division 18. Use of IECC requires University Engineer approval.

.15 BUILDING SYSTEMS - DESIGN REQUIREMENTS

.15.1 HVAC systems, lighting systems, building envelopes and other building energy consuming systems shall be designed to conserve energy. Replacement of air handling units, lighting systems, or other systems utilizing energy, directly or indirectly, shall be treated as new systems and not as repair or maintenance. New systems must comply with Division 18. New buildings and renovations of the complete heating water systems shall use a design heating water supply temperature no hotter than 140 deg F and the heating water return temperature should be 110 deg F, but shall not be hotter than 120 deg F.

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

Summer:	Outside conditions,	92/74 degrees F DB/WB
	Inside conditions,	75/64 degrees F DB/WB

Winter for space conditioning:

Winter:	Outside conditions,	+1 degrees F DB
	Inside conditions,	72 degrees F DB

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

Winter:	Outside conditions,	(minus) -22 degrees F DB
	Coil Leaving Air conditions,	+55 degrees F DB

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 A/E by the University Engineer.

Wexner Medical Center: Medical Center spaces shall adhere to ASHRAE 170-latest edition. Environmental requirements shall be obtained from OSUWMC Facilities Engineering.

.15.3 Occupied-unoccupied programming of systems should be initiated to shut-off ventilation air, exhaust air, fan systems, pumps, etc., wherever possible. Variable air volume systems with DDC controls at the zone level should use setbacks of space temperature to allow the VAV air handler to run at reduced speeds during unoccupied periods. 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 A/E's consultants may be required to determine the feasibility of energy recovery systems before the University Engineer will render a decision of their acceptability. This analysis shall be furnished by the A/E to the University Engineer.

.15.4 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.

.15.5 All air conditioning systems shall have controlled economizer cycles where required by the energy code. Air conditioning systems smaller than this 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.

.15.6 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.

Wexner Medical Center: OSU Wexner Medical Center is exempt.

.15.7 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.

.15.7.1 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.

.15.8 The following criteria shall be employed in the selection of equipment (each project to be reviewed on an individual basis):

.15.8.1 FANS selected for operation above 6-1/2" total static pressure must be approved by the University Engineer.

.15.8.2 COMPRESSORS for electricity-driven chillers and refrigeration units, Electrical power consumption shall be in compliance with Division 18. Absorption water chillers should not be used unless waste heat is available. The University's central steam distribution system is NOT considered waste heat.

.15.8.3 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 A/E and Facilities Operations and Development through the University Engineer will mutually designate one manufacturer to be specified as

base bid. Equals will be developed for bidding two other units.

.15.8.4 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.

.15.8.5 Water-cooled condensers or condensing units (e.g., WSHPs or VRF condensers) shall not reject heat to city water or to chilled water systems. Exception: small laboratory chillers may reject heat to their building's process chilled water return with the approval of the University Engineer.

.15.9 Variable Frequency Drives, elevator controllers and other electronic equipment are to be located within a separate temperature controlled area of building maintenance rooms to avoid the harmful effects of heat produced by steam stations, heating hot water pumps or other building systems producing local environments which exceed safe operating conditions for electronic equipment.

.15.10 The use of active chilled beams in building HVAC design shall require the prior approval of the University Engineer.

.15.11 **Wexner Medical Center: Equipment Schedules**

When designing equipment for current and future conditions, equipment schedules shall show connected heating/cooling flow rates expected for Day 1 design loads, as well as heating/cooling flow rates at "future" load. Quantity of components required to operate at each load condition shall also be identified with schedule of equipment.

Existing equipment to be retrofit for renovation projects shall identify existing performance criteria in addition to proposed performance criteria in equipment schedules.

15.12 **Wexner Medical Center:** Humidifier selections within air handling units shall be evaluated at both the minimum expected heating airflow and peak design airflow. Tunnel air velocity and dispersion panel design shall be validated at both conditions. Velocity through humidifier shall exceed 250 ft/min in worst case conditions. Where necessary, provide tunnel blank off panels and isolated portions of the dispersion tube that can be modified if future airflow is increased.

15.13 HVAC systems connected to campus chilled water plants shall be designed utilizing the Chilled Water Plants - Building Connection Basis of Design, Operations and Maintenance document. (Access is restricted - finding BDS files in SIMS)

15.14 Provide redundant inline filters where water filtration is recommended by manufacturer's installation instructions for sophisticated equipment (e.g., MRIs, CTs, LINACs, etc.).

23 00 05. SUBMITTALS:

.1 FOR DESIGN CONSIDERATION:

.1.1 Refer to Division 00 PROCESSING THE WORK – of the Building Design Standards.

.2 FOR PROJECT CLOSEOUT:

.2.1 Refer to Division 00 PROCESSING THE WORK - of the Building Design Standards.

23 00 07. TESTING

.1 TESTING PROCEDURES

.1.1 Testing Procedures: Specify that all tools, instruments, and equipment required for performing tests be furnished and that required temporary connections be made. Defects that develop under tests shall be repaired promptly and the tests shall be repeated. No caulking of screwed joints, cracks, or holes will be permitted. Leaks shall be repaired by tightening joints or by replacing pipe, fittings, or equipment with new materials. Minor leaks in welded joints may be chipped out and rewelded.

.1.1.1 Do not insulate ducts prior to duct leakage testing.

.1.1.2 Hydrostatic and air tests shall be made before piping is concealed or covered. Specify that systems be completely drained after

hydrostatic tests are performed and that damages caused by freezing, prior to acceptance of the completed installation, be repaired at no cost to the University.

.1.1.3 Preparation for Testing: Prior to testing, obtain satisfactory operation and uniform temperatures; perform air and water balancing and adjustment of pressure reducing stations and HVAC equipment. Pressure reducing valves, relief valves, air vents, and motor-operated valves shall be checked for proper operation. Pumps shall have operating heads adjusted in accordance with the performance curves; test reports shall include amperage readings.

.1.1.4 Water Chiller and Boiler Check Out: Specify that a factory-trained serviceman employed by the manufacturer perform adjustments, start-up, tests, and provide syllabus-of-training plus instructions to designated University operating personnel. Training by the manufacturer shall be coordinated with the University Project Manager and Wexner Medical Center Facilities Services (for Med Center Projects)

.1.1.5 Refrigeration piping shall be isolated from the refrigeration system and tested in accordance with ASHRAE 15. Perform tests at an ambient temperature above 50 degrees F.

.1.1.6 Testing of service lines shall follow recommended code practices. When lines are tested with water pressure, care must be taken to remove all air to avoid false pressure readings.

.1.1.7 Refrigerant piping shall be tested independent of existing piping systems and existing or new equipment.

.1.1.8 Underground and buried lines testing: See Division 33.

.1.1.9 Conduit for underground thermal lines testing: See Division 33.

.1.1.10 Pressure and Duration of Tests: Exposed lines shall be tested with the test fluid at pressures indicated for a period of not less than 6 hours and shall show no drop in pressure. Follow ASME B31.1 and B31.9 for pressure testing and the below pressures are min pressures.

Line	Test Fluid	Pressure Not Less Than
Steam - 200 lbs.	Water	300 lbs.
Steam - 100 lbs.	Water	200 lbs.
Steam - 15 lbs.	Water	125 lbs.
HWHS & HWHR	Water	125 lbs.

Chilled Water	Water	125 lbs.
Condensate	Water	125 lbs.
Condenser Water	Water	125 lbs.
Air	Air	150 lbs.

.2 BALANCING: Specifications shall make recommendations for balancing of air and water systems and shall stipulate that the Balancing Contractor shall be a company certified by the Associated Air Balance Council (AABC), National Environmental Balancing Bureau, Inc. (NEBB), or other nationally recognized authority to perform tests, and shall be certified in the disciplines specific to the project applications and needs. The balancing contractor shall be hired by the A/E, except for Design-Build projects, where the balancing contractor shall be hired by the Criteria A/E. The balancing contractor may be hired by the A/E [Engineer of Record], HVAC contractor, or Design-Build Contractor for small, simple projects with prior approval by the University Engineer.

Commentary: *The University desires that Testing, Adjusting, and Balancing results be verified independently of the HVAC Contractor and of the A/E for Design-Build. The TAB contractor may be hired by the HVAC Contractor, Construction Manager, A/E, or Criteria A/E for any project with TAB verification by an independent Commissioning Authority under contract with the University.*

Wexner Medical Center: The balancing contractor shall be hired by the A/E or Commissioning Agent. Pre-Design Air and Water Balance: Before design begins, the Engineer of Record shall hire an approved balancing contractor to verify existing airflows and hydronic flow limitations. The Engineer of Record shall bring all deficiencies to the attention of the OSUWMC project team.

.2.1 Pre-balance Meeting: At a date determined by the University Project Manager, a pre-balance meeting will be scheduled with the balancing company, designated University personnel, the A/E, and his engineering consultants, and contractor to review the system or systems involved. During the meeting, it shall be determined whether the system or systems will be balanced for full cooling, full heating, or modulated as applicable to both design and weather conditions. In preparation for this meeting, the company selected to perform the system balance shall be required to review the project drawings and, within 30 days, submit to the A/E a summary of proposed methods of test procedure for each system and indicate if any changes are required to permit balancing. Proposed tests shall include, but not be limited to, the following:

.2.1.1 Testing of hot and cold mixing dampers.

.2.1.2 Testing and setting of balancing dampers.

.2.1.3 Testing total C.F.M., S.P., R.P.M., O.V., and B.H.P. of all fans.

.2.1.4 Testing air and water velocities and flow at coils. Describe test conditions and procedures.

.2.1.5 All new supply air handling equipment shall be leak tested.

.2.1.6 Testing ducts and air shafts for leakage. Duct leakage testing shall be per ASHRAE 90.1 as adopted by Division 18. Student Life requires that equipment also be leak tested.

.2.1.7 Testing and adjusting of variable air volume systems and the tracking of supply air fans with return air fans at the following normal extremes of system operation:

.2.1.7.1 Maximum volumes, i.e., maximum summertime cooling design volumes, with constant volume toilet exhaust in operation.

.2.1.7.2 Minimum volumes, i.e., minimum wintertime heating design volumes, with constant volume toilet exhaust in operation.

.2.1.8 Prior to any hydronic balancing, the following must first occur. The hydronic systems shall have been circulated and shall be determined to be internally clean and leak-free. The hydronic system contractor shall open all hydronic strainers, remove the strainer from the strainer fitting, throw away the start-up strainer, run the system with the new permanent strainer, then remove, clean and re-insert the permanent strainer, and remove all air from the water system. The balancing contractor may then perform the hydronic balance.

.2.2 Conducting the balance: The balancing company will coordinate with the Contractor to adjust equipment or to arrange for personnel of equipment suppliers to be available for the necessary adjustment at the time of balance. Any discrepancies or items not in accord with contract documents, which may affect the total system or systems balance, shall be reported in writing to the A/E and University Project Manager. Air and water balance must be repeated following corrections to confirm that corrections were made.

.2.3 FUME HOOD BALANCING shall be in accordance with procedures outlined in Appendix W. Coordinate balancing with OHIO STATE Environmental Health and Safety through the University Project Manager.

.2.4 REPORTS: One copy of the preliminary air and water balance report is required. One hard copy and one electronic copy of the final balance reports indicating specified and actual tested conditions, including verification of equipment performance, as well as explanation for variation from specified conditions shall be submitted following OHIO STATE's Closeout Standard.

*[**Commentary:** The A/E should determine the level of effort desired based on individual project needs when specifying verification of performance (e.g., will testing and demonstration of design capacity for chillers, cooling towers, boilers, etc., be required?).]*

.3 COMMISSIONING: Refer to Owner's Project Requirements (OPR) for systems to be commissioned. Reference ASHRAE Standard 202, Commissioning.

23 05 05. HVAC SPECIALTIES

23 05 14. VARIABLE FREQUENCY MOTOR CONTROLLERS

.1 Refer to Appendix A for controls compatibility requirements of VFDs.

.2 Contractor must submit a harmonic distortion study to show that harmonics are within NEC code compliance.

23 05 19. METERS, GAUGES AND THERMOMETERS

.1 METERS: Refer to Division 33

Wexner Medical Center: Utility metering shall support connection to the OSUWMC Building Automation Delta Controls front-end through a BACNet compliant system to monitor for the purpose of improving operational efficiency of the building systems.

.2 GAUGES:

.2.1 Gauges other than draft gauges shall be 4-1/2 inches diameter single spring type with recalibration adjustment in the dial face and with ball valve shut-off. Tailor the range to the application. Gauges shall not be positioned over 6-feet above the floor; install remote sensing gauges as required to conform to this restriction. Gauges shall be applied on all pumps, strainers, air handler coils, and pressure reducing stations. Provide separate gauges on inlet and discharge. Do not use a single gauge with a valved manifold. Gauges shall include snubbers and/or siphons. Gauges in applications with possible dirty strainers shall include compound-ranges.

Wexner Medical Center: Gauges shall be installed with ball valve shut-off and manifold to allow single gauge use. Gauges should also be installed upstream and downstream of pressure reducing stations. Gauge range shall be applicable to the installation.

.2.2 Magnehelic type gauges shall be installed across all pre-filter/intermediate filter systems, across after-filters and across low efficiency filters.

.2.3 Pressure gauges, at refrigeration compressors of over 100 Ton capacity, indicating high side, low side and oil pressure shall be provided if they are not included as a part of the compressor package.

.2.4 A steam gauge with syphon after regulators (within sight of the regulator but at a suitable distance downstream from the regulator to assure good pressure readings) shall be provided to enable operating personnel to properly adjust the regulator.

.2.5 Other piped systems: Locate vacuum or pressure gauges as required to properly identify pressure within each system.

.3 THERMOMETERS:

.3.1 Thermometers shall be mercury-free blue or red-reading-in-glass type with 9-inch magnified column, Fahrenheit scale, recalibration feature, adjustable head and brass separable socket. Tailor the range to the application. Thermometers shall not be positioned over 6-feet above the floor; install remote head type of thermometers as required to conform to this restriction.

Wexner Medical Center: Thermometer scale range shall be applicable to the installation.

.3.2 Where appropriate to the application, consider using light-powered, digital thermometers with Fahrenheit scale, recalibration feature, adjustable head, brass separable socket, LCD with minimum 3/8-inch characters, high-impact ABS or cast aluminum case, and glass-passivated thermistor. Minimum range shall be minus 40 to plus 300 degrees F. Minimum ambient operating range shall be minus 30 to plus 140 degrees F. Thermometer shall have a lux rating of 10 lux (1 footcandle) and require no batteries.

Wexner Medical Center: Required applications include hot water converters, domestic water heaters, water tempering stations, air handling unit heating coils, air handler cooling coils, pressure reducing stations, chiller and condenser water systems.

.3.3 Piped systems and storage tanks: Locate thermometers as required on all systems or tanks where temperature should be identifiable for operation and maintenance. Suggested applications include hot water converters, domestic water heaters, water tempering stations, air handler heating coils, air handler cooling coils, chiller and condenser water systems, etc.

.3.4 For each temperature sensor well location, also install a thermometer well and thermometer to allow verification of the sensor reading.

23 05 25. VALVES

Commentary: *For steam and steam condensate valves, the A/E shall review the type of connections (welded, flanged, or screwed) and the type of isolation valves (gate or high-performance butterfly) desired with the University Project Manager and University Mechanical & Electrical Systems, Student Life Building and Mechanical Services, and OSUWMC Facilities Engineering, as appropriate.*

.1 PROPRIETARY BRANDS: All valve-types furnished on a project shall be products of one manufacturer for each type of valve specified. List 3 (minimum) manufacturers of equal products from which the contractor will make a selection.

.2 TYPES: Specify the following valve-types for installations indicated:

.3 VALVES IN STEAM LINES (150 psig and above):

.3.1 Gate valves 2 inches and smaller: Use Division 33 valve 3GT10W, with socket weld or threaded ends.

.3.2 Gate valves 2-1/2 inches and larger: Use Division 33 valve 3GT20W, with butt weld or flanged ends.

.3.3 High-Performance Butterfly valves: use cast steel, Class 300, flanged rotary valves, suitable for bi-directional shutoff, dead-end steam service at 250 PSIG and 650 degrees F. Specify metal-seated, quarter- turn, triple-offset type valve with the following construction and characteristics:

.3.3.1 Suitable for installation above ground or in steam vaults.

.3.3.2 Body: WCB carbon steel; double-flanged body construction, ASME/ANSI B16.5 class 300 flanges.

3.3.3 Seat: Stellite or similar hard surfaced material.

.3.3.4 Resilient, non-flexing laminate metal seal composite of stainless steel and graphite retained such that centering movement is permitted.

.3.3.5 Retainer screws, disk, and plate shall be stainless steel.

.3.3.6 Shaft shall be single piece construction.

.3.3.7 Per ANSI B 16.5, 31, 34 construction for body components B31.1, 31.3 ASME section VII, IX.

.3.3.7 Valves shall meet API 607 Rev.4 standards.

.3.3.8 Hardened bearing with bearing seal shall be retained in body.

.3.3.9 Shaft seal shall be graphite with multiple stud packing gland follower for adjustability utilizing Belleville style washers.

.3.3.10 Right angle gear with 2 in. AWWA nut, with loose steel hand wheel or chain wheel attachment, for remote "tee" handle operation (identify

.3.3.11 Rotary valves for services requiring insulation shall be equipped with stem housings of suitable length to clear insulation.

.3.3.12 INSTALLATION: Do not use gaskets for resilient seated valves unless instructed by the manufacturer.

.3.4 Above 15 psig, for steam lines 6 inches and larger, provide a small globe valve bypass around isolation valve for warmup.

.4 VALVES IN STEAM LINES (above 15 to below 150 psig): Use cast steel, Class 150, bolted flange yoke bonnet, outside screw, rising stem, butt welding or flanged ends 2 inches and larger. Use forged steel, socket welding or threaded ends 1-1/2 inches and smaller. Bodies shall be cast carbon steel conforming to ASTM A216, Grade WDB. Bonnet shall be one-piece cast carbon steel conforming to ASTM A216, Grade WCB. Gasket shall be compressed in the body-bonnet. Valves shall be repackable under pressure. Seat rings shall be threaded.

.4.1 Gate Valves: Stem and solid wedge shall be stainless steel #P-140 conforming to ASTM A182, Grade F-6. Seat rings shall be stainless steel #P-140 –15, conforming to ASTM A182, Grade F-6, surface hardened. Stuffing boxes shall have high temperature packing. Condensation chamber shall be provided immediately below packing.

.4.2 Globe Valves: Disc shall be stainless steel P-140-15 conforming to ASTM A182, Grade F-6, surface hardened. The seat shall be stainless steel P-140 conforming to ASTM A182, Grade F-6. The type "S" seat and disc shall have spindle on underside of the disc guided through a bridge cast integral with the seat. Seat ring shall be threaded.

.4.3 Check Valves: Swing disc and seat ring shall be stainless steel P-140 conforming to ASTM A182, Grade F-6.

.5 VALVES IN STEAM LINES (15 psig and below): Use bronze or cast iron, 150 lbs. SWP at 500 degrees F, bolted flange yoke bonnet, outside screw rising stem, flange ends 2-1/2 inches and larger; screwed ends 2 inches and smaller. Gate and globe valves shall have Teflon packing. Other construction as specified in paragraph 23 05 25.4.2.

.6 VALVES IN HYDRONIC SYSTEMS:

.6.1 Gate valves: Prohibited for isolation.

.6.2 Globe valves (2 inches and smaller): Use all bronze, threaded, union bonnet, rising stem, 200 lbs. SWP, repackable under pressure. Control valves shall have pilot positioners.

.6.3 Globe valves (2-1/2 inches and larger): Make the same as for 0 to 15 psig steam lines. Control valves shall have pilot positioners.

.6.4 Check valves: Make the same as 0 to 15 pounds steam lines.

.6.5 Ball Valves: 3 inch and smaller, two or three piece bronze body, screwed ends, stainless steel ball, steel stern, reinforced TFE packing and seat ring with appropriate pressure and temperature rating for specific application.

.6.6 Butterfly Valves: 2.5-inch and larger, lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange; ASTM A 126, cast iron or ASTM A 536, ductile iron, NBR seat, SS stem, SS or aluminum bronze disc, 150 psig CWP rating. Butterfly valves 6 inch and larger shall have gear actuators.

.6.7 Isolation shut-off valves with ball-type drain valves shall be provided in major branch lines serving multiple terminal units, risers and branch lines serving each floor that are connected to these risers, and at air handling unit coils.

.6.8 Lock-shield balancing valves shall be provided at all terminal units and should also be considered for return branch lines connected to multistory risers.

.6.9 Blow down valves shall be provided for all strainers.

.6.10 Manual air vent valves shall be provided on all convectors, radiators and terminal unit coils.

.7 BALANCING VALVES: Special types of balancing valves may be approved if submitted with detailed information in advance to the University Engineer.

.7.1 Valves (2 inches and smaller): Use 150 lbs. SWP, all bronze, renewable composition disc, union bonnet, lockshield stem, repackable under pressure, or 175 lbs WOG, threaded brass body, wrench operated ball centric valve suitable for 250 degrees F continuous operating temperature, adjustable stop.

.7.2 Valves (2-1/2 inches and larger): make the same as for globe valves in 0 pounds to 15 pounds steam lines; hand-wheel shall be removed and tagged with number of turns that valve is open, or 175 lbs. WOG, flanged iron body, wrench operated ball centric valve suitable for 250 degrees F continuous operating temperature, adjustable stop.

.7.3 The University requires separate balance and shutoff valves. In that way, the setting of the balance valve is more likely to be retained without tamper when any shutoff valve is closed. Consider the cost versus benefit of pressure-independent balancing valves. Triple-duty valves are prohibited. Balance valves shall be installed along with check and shutoff valves rather than triple-duty valves.

.7.4 For accuracy of balance readings, the design and the installation must include the manufacturer's recommended upstream and downstream unobstructed distances to obtain reliable flow readings.

.8 VALVES IN STEAM CONDENSATE LINES: A union shall be provided downstream of (and within 12 inches of) each valve.

.8.1 Steam Condensate valves shall be as specified for valves in steam lines. Class of service shall be based on class of steam upstream (inlet side) of steam trap. For stainless steel condensate return systems, specify Division 33 valve 10GT20F for valves 2-1/2 inches and larger and valve 10BL11W (socket weld or threaded ends) for valves 2 inches and smaller.

.8.2 Drain valves shall be ¾ inch gate valves, as specified for valves in water lines, and shall have ¾ inch hose nipple switch caps.

.8.2.1 Nipples shall be of same weight and material as pipe with which they are used, except all close and shoulder nipples shall be extra heavy.

.8.3 Swing check/silent check valves shall be flanged, 250 pounds, semi-steel (ASTM A-126 – Grade B cast iron) body, bronze trim, 1/16 inch raised face.

.9 VALVES IN HOT WATER HEATING BOILER SYSTEMS: Attention is directed to "Ohio Boiler Inspection Laws and Rules," relative to valves at boiler connections and in blowdown lines.

.10 VALVE TAGS: Each valve in each piping system shall be tagged with a brass tag numbered consecutively for each system and attached to a stationary part of the valve with a brass chain. Valve tags shall have stamped abbreviations of the system in addition to the valve number. Valve tags shall be tagged with OHIO STATE nomenclature as: service- supply/return/recirc-valve number. For example, heating hot water supply valves in a building would be tagged HWH-S-1, HWH-S-2, HWH-S-3, etc..

Wexner Medical Center: Each valve in each piping system shall be tagged with a stamped brass tag - see 23 00 03.6 General Naming Convention for more details.

.11 Isolation Shut-off valves with ball drain valves shall be provided in branches and risers.

23 07 00. HVAC INSULATION

.1 GENERAL PROVISIONS FOR FIRE AND SMOKE HAZARD RATINGS: All insulation shall have a system fire and smoke hazard rating as tested by procedure ASTM-E-84, NFPA 255, and U.L. 723 not exceeding: Flame Spread 25 and Smoke Developed 50. The system rating shall be based on insulation, jacket, adhesives, coatings, fittings, and cements. Any treatment of jackets or facings to impede flame and/or smoke shall be permanent. The use of water-soluble treatments is prohibited. ASBESTOS IN ANY FORM OR MIXTURE(S) IS PROHIBITED.

23 07 13. DUCT INSULATION:

.1 THERMAL INSULATION: Thickness of supply air duct and plenum insulation shall be selected to prevent condensation on the surface of insulation when the ambient relative humidity is 90 percent at the maximum difference between the ambient air temperature and the supply air temperature. Insulation shall be continuous through all openings but shall be interrupted at fire dampers. The thermal insulation used to cover the ducts shall meet or exceed the R-value in ASHRAE Standard 90.1 as adopted by Division 18 for energy conservation and be asbestos free.

.1.1 Exposed rectangular air conditioning supply and return ducts in non-air conditioned space shall be insulated with rigid or semi rigid fiberglass insulation board having a density not less than 3 pounds/cubic feet and with field or factory applied fire retardant glass cloth jacket with vapor barrier. When factory applied facing is used, all insulation joints will be sealed with pressure sensitive joint sealing tape to match the insulation facing.

.1.2 Concealed air conditioning supply air ducts in ceiling space above an air conditioned room shall be insulated with fiberglass duct wrap insulation of 3/4 pounds/cubic feet density with factory applied vapor barrier and fire retardant jacket. When insulation is necessary on return air ducts, ducts shall be insulated in the same manner.

.1.3 All exposed round air conditioning supply air and return air ducts shall be insulated externally using either a closed-cell elastomeric sheet or roll insulation, with antimicrobial protection, adhered directly to the duct or a rigid preformed fiberglass insulation with All Service Jacket. Double wall insulated ductwork is acceptable. Exposed return air duct in conditioned spaces does not require insulation.

.1.4 Outside air intake ducts and air plenums shall be insulated the same as specified for exposed rectangular air conditioning supply air ducts.

Commentary: The insulation described above is for "indoor" applications. Installation of "outdoor" ductwork that requires insulation is not a preferred location for the University and requires prior approval by the University Engineer.

.2 ACOUSTIC LINING: INSTALLATION OF INTERIOR DUCT INSULATION (DUCT LINER) IS PROHIBITED. Exceptions: Lined ductwork is permitted for: transfer ducts connecting adjacent rooms; return air ducts from a room to a return air plenum; supply and return air ducts for ceiling mounted heat pumps and fan coils; other applications with prior approval of the University Engineer. Duct liner shall be fiber-free and anti-microbial. Sound attenuation for each individual project must be reviewed and is subject to approval by the University Engineer before design is completed.

.3 Noise Criteria

Type of Room or Area	Range of A-Sound Levels in Decibels	Range of NC Criteria Curves
AUDITORIUMS Concert and Music Halls Lecture Halls and Auditorium Multi-Purpose Halls and Theaters	 25-35 35-45 30-40	 20-25 30-35 25-30
CIRCULATION Corridors, Lobbies, and Waiting Rooms Wash Rooms and Toilets	 40-50 45-55	 35-45 40-45
CLASS ROOM AND STUDY AREAS Class Rooms Conference Rooms, Seminar Rooms	 35-45 30-40	 30-40 25-35
DINING AREAS Cafeterias Dining Rooms Restaurants	 45-55 35-45 40-50	 40-50 30-40 35-45
LABORATORIES Laboratory Class Rooms Processing Laboratories Research Laboratories	 40-50 40-50 40-50	 35-45 35-45 35-45
LIBRARIES	35-45	30-40
OFFICES Executive Offices General Office and Reception Rooms Open Offices and Drafting Rooms	 35-45 35-50 40-55	 30-40 30-45 35-50

Type of Room or Area	Range of A-Sound Levels in Decibels	Range of NC Criteria Curves
RECREATION Gymnasiums, Bowling Alleys, Squash and Hand Ball Courts Recreation Halls and Rooms Sports Arenas Swimming Pools	 40-50 40-55 35-45 45-60	 35-45 35-50 30-40 40-55
STUDY AREAS Auto Tutorial Study Carrel Rooms, Closed Study Carrels, and Study Rooms and Lounges	35-45	30-40
STUDIOS Sound Reproduction Studios Television Studios	 30-40 35-45	 25-30 30-35
MISCELLANEOUS Computer Machine Rooms Dormitory Sleeping Rooms Kitchens and Laundries Museums, Court Rooms Museums, Court Rooms	 45-65 35-45 45-55 35-45	 40-60 30-40 40-50 30-40

23 07 16. EQUIPMENT INSULATION

.1 All pieces of equipment with surface temperatures over 130 degrees F or with temperatures causing condensation at ambient relative humidity of 90 percent shall be insulated. Type and thickness of insulation shall be as specified for piping.

.2 INSULATION NOT REQUIRED: Steam traps, hot water, and condensate return pumps, and hot water expansion tanks shall not be insulated.

.3 Chilled water pumps are required to be insulated. Insulation may be closed-cell elastomeric, equivalent to Armacell AP/ Armaflex.

Wexner Medical Center: Chilled water pumps should be insulated with removable, reusable blanket insulation.

.4 BOILER BREECHING shall be insulated with manufacturer-provided, pre-fabricated, factory-insulated breeching. Follow specification to determine the specific operating temperature. Apply appropriate finish jacketing range.

.5 Provide removable, reusable blanket insulation for applications needing routine maintenance, including but not limited to, pumps, chillers, etc.

23 07 19. PIPING INSULATION:

.1 REQUIRED INSTALLATION: The following piping shall be insulated:
Steam and Steam Condensate lines
Domestic cold and hot water lines
Exposed Geothermal/Ground Source Heat Pump lines
Cooling Coil Condensate Drain Lines
Chilled water lines
Heating hot water lines
Refrigerant lines, where necessary
Fuel oil lines, where necessary or exposed to low temperatures.

.2 SPECIFICATIONS: Maximum temperature limit of the insulation must be above the maximum operating temperature of piping. Surface temperature of insulation for heated piping in still ambient air at 80 degrees F shall not be above 110 degrees F at the pipe operating temperature below 400 degrees F. The minimum thickness of insulation shall be one inch. Thickness of insulation for cold piping shall be selected to prevent condensation on the surface of insulation and ambient temperature is 50 degrees F above the pipe temperature. Specify that insulation be installed with a continuous unbroken and unpunctured factory applied vapor barrier. A/E shall evaluate whether environmental conditions dictate requirements for corrosion inhibiting coating. Insulation shall meet or exceed the current version adopted by Division 18 of ASHRAE Standard 90.1 -- Energy Standard for Buildings Except Low-Rise Residential Buildings for energy conservation.

.2.1 Piping with an operating temperature of 300 degrees F and above shall be insulated with calcium silicate insulation molded in sections with a minimum of .016 Aluminum jacket having a factory applied 3 mil polysurlyn inner layer moisture barrier. As an alternative to insulation being entirely calcium silicate, the first 3 inches (closest to the pipe) of insulation shall be calcium silicate, with the remaining thickness required by the energy code being fiberglass. Additionally, ceramic insulation may be specified that meets energy code and surface temperature remains at or below 110F

.2.2 Piping with an operating temperature under 300 degrees F shall be insulated with molded pipe covering composed of fiberglass, resin bonded and factory applied all service jackets. Compression strength at 25 percent deformation shall be 500 pounds per square foot.

.2.3 Fittings, flanges, unions, and valves, except valves in hot water lines, shall be insulated. Insulation shall be beveled down to unions with all exposed end sealed with CP.10 or equivalent. Insulation covers shall be either prefabricated or fabricated of pipe insulation. Insulation efficiency shall not be less than that of the adjoining piping. Specify that insulation vapor barrier be installed continuous and unbroken.

.2.4 Hangers, supports, anchors, secured directly to cold surfaces, must be adequately insulated and vapor sealed to prevent condensation.

.2.5 Rigid insulation inserts of proper length shall be installed between pipe and insulation protection shield to prevent sagging of pipe covering at hanger points. Compressive strength of insulation inserts shall be not less than 350 psf at 10 percent deformation. Specify that inserts be installed as pipe is erected.

.2.6 Insulated piping lines running outdoors shall have corrugated or plain 0.016 inches aluminum jacket complete with integral longitudinal laps with 2" overlap and butt joint laps with 3" overlap installed in order to shed water. In addition to the vapor barrier, this jacket is required on cold lines.

.2.7 In service tunnels, pipe insulation shall be covered with PVC jacket secured in place with aluminum straps on 18 inches centers. Sections exposed to heavy mechanical abuse shall have 0.010 inches stainless steel jacket secured in place with stainless steel straps. The lap shall be at least 2 inches on side shedding water and 3 inches overlap on the end.

.2.8 Provide removable, reusable blanket insulation for applications needing routine maintenance, including but not limited to, steam pressure reducing stations, strainers, etc.

23 09 00. INSTRUMENTATION AND CONTROL FOR HVAC:

.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 standalone microprocessor based Direct Digital Control (DDC) computer systems. All hardware, software, and miscellaneous equipment required to ensure that the DDC system can be managed from the building and from a remote control center shall be provided as a part of the project. Appendix A includes additional and detailed requirements for BAS and DDC systems. Separate versions of Appendix A exist for FOD, OSUWMC, and Student Life. Comply with the version of Appendix A appropriate for the project. Control centers now in existence are:

Columbus Campus - Academics and Research –FOD [See Appendix A – FOD]
Columbus Campus - University Medical Center [See Appendix A – WMC]
Columbus Campuses - Student Life [See Appendix A – SL]
Regional Campus - [Review requirements with University Project Manager.]

The A/E 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, as dictated by the capabilities of the system selected and by the location of the building being controlled. Telephone and cellular communications shall not be utilized for the Wexner Medical Center BAS network nor FOD Buildings.

The control centers in the Columbus Campus (FOD), Wexner Medical Center, Student Life, Lima Campus, Mansfield Campus and Wooster Campus have Central Processing Computers (CPU's) that are compatible with Direct Digital Control. Any expansion in any building within these networks must maintain the integrity of the existing system and allow the new equipment to be controlled by the existing CPU. These 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 A/E will coordinate this requirement through the University Project Manager.

Wexner Medical Center: All newly constructed and remodeled buildings/projects are to be controlled using BACnet compliant Direct Digital Controls. All controls shall tie into the existing building automation front end. See OSUWMC design standard for Building Automation Systems (Appendix A – WMC).

.1.1 An interconnecting conduit system shall be installed between all DDC panels within a given building. This conduit system shall be extended to the appropriate building exit point to provide the link to the remote communications network. All communications cables and equipment 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 link shall be established and remote capabilities shall be verified by the contractor prior to final acceptance of the DDC system.

Wexner Medical Center: Medical Center DDC panels shall connect to existing IT network and comply with their requirements. OSUWMC will require one BACnet Broadcast Management Device for every floor of every building. The OSUWMC network will be segmented so that each floor will be a separate subnet from all others.

.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.

23 09 05. HVAC BUILDING SYSTEMS CONTROL:

.1 Before design is begun, consult with the OHIO STATE Building Automation Shop (FOD, OSUWMC, Student Life, or Lima, Mansfield, or Wooster Campus, or other, as appropriate) to determine exact requirements for connection to control centers. In addition to requirements for Direct Digital Control Systems described in

Appendix A, the following must be considered in design and installation of equipment.

.2 AUTOMATIC DAMPERS: Automatic dampers which are under proportioning control should be accurately sized in accordance with temperature control manufacturer's recommendations to provide proper mixing and control.

No damper shall have a dimension exceeding four feet or be over 12 square feet in area. Each damper section shall have an individual operator. No linkages shall be installed between dampers to transfer operator power. Manufacturer's catalog information shall be de-rated 50 percent for application to provide positioning of the dampers. Damper operators shall not be of the swing mounting type. They should be mounted outside the air stream where possible, especially in outside air applications. Pneumatic control lines, where they penetrate outside air ducts, shall include dehydrator units. Outside air and return or relief dampers that are automatically controlled shall be of the minimum leakage type.

Quality of dampers shall be specified, including air leakage at 1-inch static pressure when the damper is in the closed position. Provide neoprene edge seals on blades.

Above automatic damper requirements do not apply to FOD projects. See Appendix A - FOD Building Automation System for automatic damper requirements for FOD projects.

.3 AIR COMPRESSORS: Air compressors, when required, shall be provided in the main equipment room for each building. Two vertical compressors shall be provided with the sizes calculated on 50 percent operating time of one compressor to meet the building's compressed air needs. The units' control will include automatic lead/lag control with a manual lead/lag control switch. HVAC air compressor systems shall not be cross-connected with other building air compressors.
Automated timer drains with a bypass shall be provided to drain compressor tanks of condensate. Condensate will be piped the nearest floor drain.
All temperature control air compressors shall be provided with an air dryer. Provide redundant coalescing and 5-micron air filters on the outlet of the air dryer. A bypass with service valves shall be provided so the air dryer can be repaired without taking the air system offline. Air dryer and coalescing filter drains shall be piped to the nearest floor drain. Utilize Zeks Air Dryers or approved equal.

Insure all condensate drain piping is secured to the floor.

Provide a ¼" quick connect compressed air hose coupling upstream of the air dryer for an emergency compressor connection.

Provide air pressure gauges both up and down stream of the pressure reducing valve.

Provide dry contacts for alarms for the air compressors and the air dryer to the Building Automation System. Provide an analog pressure transmitter to monitor air pressure downstream of the pressure reducing valve to the Building Automation System.

23 20 00. HVAC PIPING AND PUMPS

23 20 03. PIPING

.1 GENERAL PROVISIONS:

.1.1 Submittals for Approval by the University Engineer or his/her designee: Provide three copies each of the following and obtain approval before preparation of final documents.

.1.1.1 Calculations of stresses in steam, hot water, and condensate lines.

.1.1.2 Request for permission to use expansion joints in piping in lieu of bends and/or loops.

.1.1.3 Request for permission to use special materials for condensate piping in lieu of steel pipe with welded fittings. Provide pressure and temperature characteristics.

.1.1.4 Operating pressures and temperatures for grooved pipe mechanical coupling systems if permitted to be used.

.1.1.5 Detailed information on special types of balancing valves.

.1.2 Valve Tags: Specify that each valve be tagged with a brass tag numbered consecutively and attached to the valve with a brass chain. Valve tags shall have stamped abbreviations of the system in addition to the valve number. Valve tags shall be tagged with OHIO STATE nomenclature. As: service-building ID (2 letter designation)-floor-valve number. For example, a heating hot water supply valve on the 2nd floor of Rhodes would be tagged HWHS-RH-2-34.

.1.3 Valve Chart: A typewritten directory of valve numbers (by system, describing location) shall be furnished, framed, placed under glass, and installed in equipment rooms, where indicated by the A/E. A copy of the valve directory shall be included in each O-&-M manual, along with an electronic copy (PDF), and separate copies of the valve directory, bound in hard fiber binders, shall be delivered to the University Project Manager. Electronic copy to have the file naming convention [OSU Project Number - building number-H-valve chart.pdf] example: OSU-123456-xxxx-H-valve chart.pdf

Student Life: The A/E shall provide an additional electronic copy of the valve chart to Student Life's Office of Facility Management & Logistics for the project.

Wexner Medical Center: Valve number directory shall be noted on the as-builts.

.2 DESIGN OF PIPING SYSTEMS:

.2.1 Prohibited Installations:

.2.1.1 Condensate drip traps above 15 psig shall not be designed to discharge directly into condensate return mains or condensate pump receivers, but shall be designed to discharge into a flash tank (vented into the low pressures side of the system, if possible), and to drip through a low pressure F. & T. trap to a condensate return main or receiver. Where discharge to a flash tank unavailable/uneconomical, use a condensate mixer/sprayer to connect drip trap to pumped condensate return line.

.2.1.2 Bullhead connections in any piping service are prohibited.

.2.1.3 Cast iron, brass and ASTM A120 pipe shall not be used on lines with pressures higher than 49 psig or temperatures higher than 292 degrees F.

.2.1.4 Drain, steam, and condensate lines, and any wet lines (including pipes, fittings, valves, or other), shall not be installed or designed for installation over electrical switchgear, motor control centers, transformers, nor in elevator shafts and equipment rooms.

.2.2 Provisions for Expansion and Contraction: Steam lines shall be engineered with adequate provisions for expansion and the removal of condensate. The campus steam is distributed at nominal 200 psig. Steam systems shall be designed for a maximum steam pressure of 250 psig and 680 degrees F.

Generally, for all campus distribution steam piping outside the buildings, bends or loops shall be used to absorb the pipe expansion and contraction. Particular attention shall be given to proper design of guides and anchors in lines with expansion loops. Expansion joints are not recommended. Approval by FOD Operations is required prior to use of expansion joints.

OARDC: Steam distribution system is operated at 140 psig and 375 degrees F.

.2.3 Pipe anchors to control movement of piping shall be shown on drawing. Anchors shall be welded to the pipe, but anchor connection must be

mechanically attached to the building or other structure and details/analysis provided by structural engineer. Provide structural support and lateral structural support for all kinetic forces.

.2.4 Designs shall include provisions to accommodate both horizontal and vertical movement.

.2.5 Unions shall be provided on piping at the following locations:

.2.5.1 Adjacent to valves on the downstream side.

.2.5.2 At the final connections to items of equipment.

.2.5.3 On each side of traps.

.2.5.4 Where required for construction and assembling purposes.

.2.6 Supports: Spacing for the horizontal pipe supports and hanger rod sizes must be specified.

.2.7 Hangers: Where piping is subject to expansion and contraction caused by changes in temperature of carried fluid, adjustable roller hangers or adjustable pipe roll stands shall be provided. A thermal expansion stress analysis is required to determine where vertical spring supports are necessary. Hangers for copper piping shall be copper plated or shall have a suitable lining to prevent electrolysis. Hangers for cold insulated pipe and all roller hangers shall be only outside of the insulation with appropriate banded support plates to prevent crushing of insulation and to avoid condensation.

.2.8 Pipe Guides shall be detailed and locations shall be shown. Guide shall consist of a guide spider clamped to the pipe for which movement is to be controlled and a guide casing bolted to a suitable support. Casing shall be of two pieces bolted together by 4 bolts for sizes 3 inches and larger and by 2 bolts for sizes 2-1/2 inches and smaller. The inside diameter of casing shall be larger than the outside diameter of the insulated pipe.

.2.9 Discharge Piping from all refrigeration system pressure relief devices shall extend, in an approved manner, to the building exterior.

.2.10 Glycol: If glycol is necessary on a new installation, specify propylene glycol. Consider: whether freeze or burst protection is appropriate; need for formulation compatible with aluminum; and automatic makeup system. Use of ethylene glycol requires University Engineer approval. When using domestic water for temporary fill of an ethylene glycol system, the contractor shall use a temporary reduced pressure principle backflow preventer. The domestic water shall be disconnected from the ethylene glycol system after filling.

23 20 05. PIPING MATERIALS:

.1 STEAM PIPING (15 psig and below):

.1.1 Schedule 40, ASTM A-53, Type E or S, Grade B black steel pipe shall be used. Schedule 40 butt welding seamless forged steel fittings shall be used with NPS 2-1/2 and larger pipe. Elbows shall be long radius; flanges shall be 150 pounds class forged steel, welding neck, or slip-on, welded inside and outside. For 2 inches or smaller pipe125 psig class black cast iron screwed fittings may be used.

.2 STEAM PIPING (above 15 psig to 200 psig, temperature less than 600 degrees F):

.2.1 Schedule 40, ASTM A-53, Type E or S, Grade B Black steel pipe shall be used. Schedule 40 butt welding seamless forged steel fittings shall be used with NPS 2-1/2 and larger pipe. Flanges shall be 300 pounds class. For 2 inches or smaller pipe, fittings shall be socket weld forged steel, 3000 lbs. (minimum) class.

.2.1.1 Bolting Materials: Bolting shall consist of a bolt head which requires one nut on the opposite side on the threaded end in accordance with ANSI B 1.1, Class 2A. Material shall conform to ASTM A 193, Grade B7. Nuts shall be heat-treated, heavy, hexagonal nuts, semi-finished, and in accordance with ANSI B 18.2.2 and B1.1, Class 2B. Material shall conform to ASTM A 194, Grade 2H.

.2.1.2 Gaskets: Gaskets shall be spirally wound, Type 304 Stainless Steel with non-asbestos filler material and carbon steel outer ring. Gasket shall be 1/16-inch thick and conform to the flange face on which they are used. Acceptable products from acceptable manufacturers include: Flexitallic Style CGI with Flexicar Filler and 316L winding, manufactured by Flexitallic Inc., or approved equal.

.2.2 Steam piping above 15 psig within University buildings shall be designed, fabricated, and installed to comply with ASME B31.1. Such piping shall be inspected, examined, and tested per the requirements of Chapter VI, Article 136, of ASME B31.1. Inspection services per ASME B31.1 shall be provided by the A/E (Criteria A/E for design-build). Qualifications of inspector(s) shall be submitted and are subject to approval by the University.

.3 CONDENSATE PIPING: Schedule 40S seamless stainless steel, conforming to ASTM A312 Type TP316L, or Schedule 80 black steel pipe, ASTM A-53, Type E, Grade B shall be used with Schedule 80 butt welding fittings of seamless steel or forged steel socket weld fittings 2000 pounds WOG. Special materials might be

approved, upon request, if pressure and temperature characteristics are submitted in advance of design to the University Engineer.

.3.1 Underground and Tunnel Applications condensate distribution piping requirements: Refer to Division 33.

.4 HOT WATER HEATING (HHW) PIPING: Shall be ASTM A53, Gr B, Type E except that lines 4-inch diameter and smaller may be hard copper type L with wrought copper fittings. All copper pipe fittings, regardless of size, shall be brazed.

.4.1 Fittings 2-1/2 inches and larger: Schedule 40, butt welding seamless forged steel. Elbows: long radius; flanges: 150 pounds SWP, forged steel, welding neck, or slip-on, welded inside and outside, or wrought copper for use with type L copper piping.

.4.2 Fittings 2 inches and smaller: 125 pounds SWP black threaded cast iron or forged steel welded fittings, or wrought copper for use with type L copper piping.

.4.3 Press fittings for copper pipe HHW systems (up to 4-inch diameter) may be used with the approval of the University Engineer. Press fittings made of bronze or copper conforming to ASME B16.18 or ASME B16.22 and performance requirements of IAPMO PS 117. Press fittings shall have factory installed EPDM sealing element and an identification feature on the fitting that provides a visual indication of fittings that have NOT been pressed. Installers of the press fittings shall be certified by the manufacturer.

Wexner Medical Center: Press fittings for copper pipe HHW systems require prior approval by OSUWMC Facilities.

.4.4 Press fittings for black steel pipe HHW systems (up to 2-inch diameter), up to Schedule 40 pipe, may be used with the approval of the University Engineer. Press fittings conforming to ASME A420 or ASME B16.3 and performance requirements of IAPMO PS 117. Press fittings shall have factory installed EPDM sealing element and an identification feature on the fitting that provides a visual indication of fittings that have NOT been pressed. Installers of the press fittings shall be certified by the manufacturer.

.4.5 The use of press fittings for copper or steel pipe systems shall be limited to accessible locations only (not in chases or above inaccessible ceilings).

Commentary: *In lieu of University Engineer approval, FOD Operations personnel who have received appropriate training may use press fittings with the approval of the Senior Director of Facilities Support or their designee.*

.4.3 Grooved Piping Systems: Grooved piping is prohibited on hot water systems.

.5 CHILLED WATER SUPPLY AND RETURN: Same as specified for Hot Water Heating Piping except do NOT use press fittings for chilled water systems that are connected or that may be connected in the future to a central campus chilled water plant.

.5.1 Underground chilled water distribution piping requirements: See Division 33.

.5.2 Grooved Piping Systems: For chilled water systems, an engineered system of rolled-grooved piping with couplings and gaskets designed for the application may be used with the approval of the University Engineer. Cut-grooved piping shall be specifically prohibited.

Wexner Medical Center: Grooved Piping Systems for chilled water require prior approval by OSUWMC Facilities and OSEP.

.6 CONDENSER WATER SUPPLY AND RETURN: Same as specified for Hot Water Heating Piping.

.6.1 Grooved Piping Systems: For condenser water systems, an engineered system of rolled-grooved piping with couplings and gaskets designed for the application may be used with the approval of the University Engineer. Cut-grooved piping shall be specifically prohibited.

Wexner Medical Center: Grooved Piping Systems for condenser water require prior approval by OSUWMC Facilities.

.6.2 For condenser water systems, Schedule 80 PVC piping and fittings may be applied. The PVC shall include UV-protectants and shall be rated for exterior applications.

Wexner Medical Center: PVC piping shall not be used.

.7 DRIP PIPING FROM PUMPS: Schedule 40 galvanized steel pipe with 150 pounds galvanized banded malleable iron fittings, minimum size ¾ inch. Run drip piping to floor drain. Hard copper, type L, minimum size ¾-in., may be used if protected and clamped in place.

.8 COOLING COIL CONDENSATE DRAIN PIPING FROM AIR HANDLING UNITS: Type “L” hard copper, minimum size 1 inch. Specify that wrought copper fittings with sweat joints of 95-5 solder be used. Trap drain lines and run to suitable drains. Provide cleanouts at traps and in the piping system where pipe changes direction.

.9 REFRIGERANT PIPING: Dry Seal Type “L” or ACR (Air Conditioning & Refrigeration) nitrogen-charged hard copper. Wrought copper fittings with joints brazed with a 6 percent or higher silver alloy with a 1000 degrees F solidus

minimum and comparable to J.W. Harris Co., Inc. "Dynaflow". Copper-steel joints shall be brazed with 55 percent silver alloy brazing materials. Zoomlock pressure seal fittings are also acceptable. Fittings for 5 inches or larger lines shall be tinned cast brass.

Prefabricated line sets of annealed, refrigeration grade copper tubing, ACR type, meeting ASTM B280 may be used with split systems 5 tons or under when the inside and outside units are not separated by more than 100 lineal ft of pipe, the pipe is protected from damage, the pipe is not exposed through interior spaces, and it does not run in mechanical rooms.

.10 Piping, fittings, and piping accessories manufactured, fabricated, or assembled in China, including Taiwan, are prohibited.

23 20 07. UNDERGROUND CONDUIT

.1 Underground distribution piping: See Division 33.

23 20 09. PIPING SPECIALTIES

.1 GASKETS: Where flanges must be used, gaskets shall be of materials suitable for use at temperatures and under conditions encountered in the system. Gaskets on steam lines, with pressures of 50 psi gauge or over, shall be wound stainless steel and appropriate composition gaskets.

.2 AIR VENTS:

.2.1 AUTOMATIC AIR VENTS with isolation valves shall be installed at the high points of all hydronic piping, and at all points where horizontal flow goes to vertical down flow. Vents with visual drain shall be specified. The discharge drain shall be extended to a suitable floor drain.

.2.1.1 Specify automatic air vents for hydronic systems employing a bladder-type expansion tank (i.e., a tank having air and water surfaces separated by a flexible membrane).

.2.2 AN AIR CHAMBER with manual vent shall be provided at high points on lines above finished ceilings and in areas where a safe and suitable drain point is not readily available. Provide a flexible drain line.

.2.3 Specify manual air vents where existing hydronic systems have compression tanks (direct air-water interface).

.3 STEAM TRAPS: Traps shall be installed at least 24 inches below steam heating devices to assure adequate draining of the coils. Valves, strainers, check valves and unions or flanges shall be provided at traps stations (Armstrong TVS-4000

trap station preferred). Provide check valve downstream of trap where any portion of the condensate discharge line is flooded and/or where condensate is lifted.

.3.1 INVERTED BUCKET TRAPS: On saturated drips, regardless of steam pressure, inverted bucket traps (IBT's) may be used.
Wexner Medical Center: Inverted Bucket Traps are prohibited.

.3.2 BIMETALLIC TRAPS: On superheated drips, use bimetallic traps (BMT's). Suggested for consideration are Armstrong SH-300 or Bestobell DM25.

.3.3 **Wexner Medical Center:** Thermodynamic traps shall be used on any drip traps in steam systems greater than 30 psi.

.3.4 FLOAT AND THERMOSTATIC TRAPS: On any modulating application such as hot water converters, steam heating coils, steam humidifiers, or any other modulating application, use float and thermostatic traps (F&T's). Pay special attention to temperature rating.

Wexner Medical Center: Float and thermostatic traps shall be used on drip traps in steam systems less than 30 psi.

.3.5 Steam traps shall be stainless steel for stainless steel piping and cast steel for black steel piping, except for black steel piping at 15 PSIG and lower traps may be cast iron.

.4 VACUUM BREAKERS AND AUTOMATIC AIR VENTS shall be provided on all steam heating coils with modulating valves or automatic on-off valves.

.5 EXPANSION TANKS: Specify replaceable bladder- type expansion tanks. Do not specify compression tanks having direct contact between air and water surfaces or expansion tanks not having a replaceable bladder.

23 20 11. PIPING INSTALLATION:

.1. INSTRUCTIONS TO BE INCLUDED IN THE SPECIFICATIONS: The following instructions to the contractor should be included in the applicable paragraphs. These instructions must be edited to suit the work.

.2 DIELECTRIC CONNECTIONS: In water lines where dissimilar metal pipes connect to one another, use dielectric nipples or flanges with dielectric gaskets to counteract electrolysis. All piping and piping accessories shall be suitable for the working pressures and temperatures of the lines in which they are installed. Do not install dielectric unions.

.3 WELDED CONNECTIONS:

.3.1 Stamped Welds: Welders on pressure piping shall be certified and shall carry their certification and stamp with them. Welds on lines with pressures above 125 psig shall be stamped.

.3.2 Items Requiring Welded Connections: Weld steel piping 2-1/2 inches and larger. Weld steel piping installed above finished plaster ceilings and in pipe chases. Weld steam condensate pipe except at 2 inch and smaller threaded connections to equipment and traps.

.3.3 Welded Fittings (see piping specifications 23 20 05 for specifications of fittings)

.4 BRANCHES: "T" or "Y" forged branch connections or reducing tees are acceptable for branch connections to mains 2 inches diameter or larger. Design all other branch connections with main size tees and eccentric reducers or reducing tees. Branch piping shall not be welded directly to mains. Drip legs in steam lines shall be made with steam line size tees. Eccentric reducers shall be used for pipe size changes with bottom of steam line level, bottom of condensate return lines level, and top of hydronic waterlines level.

.5 VIBRATION ISOLATION shall be provided on chilled and condenser water supply and return piping at all compressors.

23 20 13. PUMPS:

.1 GENERAL PROVISIONS:

.1.1 COUPLING ALIGNMENT: The University requires that the final coupling alignment be documented and the results furnished in writing to the University Project Manager. Field check all alignments and report the maximum angular and eccentric misalignments to the nearest 0.001 inch.

.1.1.1 Align coupling flanges for concentricity to assure that the face and curved edges are concentric within the manufacturer's recommendations.

.1.1.2 Align coupling for angular alignment to tolerances recommended by the manufacturer.

.1.1.3 Align coupling for parallel alignment. On large equipment, subject to heat conditions, alignment must be done in the hot condition.

.1.2 SHOP DRAWINGS AND PUMP PERFORMANCE CURVES: Reference should be made to Division 1 for instructions for submittals of shop drawings. Submit performance curves with shop drawings.

.2 PUMPING SYSTEMS DESIGN:

.2.1 A PRIMARY-SECONDARY PUMPING SYSTEM is preferred where practicable.

.2.2 DESIGN PUMPING SYSTEMS so that the engineer-designed net positive suction head available (NPSHA) at the pump intake will be larger than the (manufacturer-required) net positive suction head required (NPSHR) at the highest possible water temperature at the pump intake.

.2.3 THE PUMP CURVE REPRESENTING FLOW-HEAD RELATIONSHIP shall intersect the system curve at design operating point. Pumps shall be selected to operate at an efficiency of not less than 90 percent of the maximum efficiency. Maximum total pump head at the no flow condition shall be specified.

.2.4 FRICTION HEAD CALCULATIONS FOR CHILLED WATER SYSTEMS shall be based on the friction loss standards of the Hydraulic Institute in new pipe. For steam condensate (pumped and gravity) and hot water heating systems, base on friction losses in 15 years old pipe. The A/E may submit for approval by the University of use other sizing standards, such as ASHRAE, Cameron, or Bell & Gossett.

.2.5 PUMP MOTOR shall be selected and specified as non-overloading over the entire pump curve shown by the manufacturer.

.2.6 ALL PUMPS shall be installed with system size isolation valves on both sides.

Commentary: *System size refers to the pipe size of the building system: NOT the pipe size of the suction and discharge size of the pump.*

.2.7 Motor and impeller speeds shall be 1750 RPM or 1150 RPM. 3600 RPM selections are prohibited unless approved by the University Engineer.

.2.8 Refer to Owner's Project Requirements (OPR), of the project, for pump redundancy requirements.

.3 CONDENSATE RETURNS: Electric condensate return systems are preferred. Steam-powered condensate return systems require prior approval by the University Engineer. When pumps must be used, specify packaged duplex units, shipped assembled as a complete factory unit with cast iron receiver.

Wexner Medical Center: Steam powered condensate return systems shall be supplied with sight glass.

.3.1 LEAD-LAG ALTERNATOR for pumps shall be automatic with a manual override. Electrical float switch shall bring on the second pump if the flow is too great for one pump. Audible alarm shall be activated when either pump fails.

.3.2 Condensate return pumps shall be limited to no greater than 1800 rpm.

Wexner Medical Center: Combination pump-trap assemblies shall be utilized on systems with modulating steam valves to prevent condensate backup. Unless approved otherwise by Medical Center Facilities Engineering

.4 PUMP TYPES

.4.1 IN-LINE PUMPS: In-line pumps shall be connected directly to the piping. Motor shall not be separately supported except for large pumps specifically designed for such support. Pumps shall not be mounted with motor shaft vertical unless special thrust bearings are provided. Provide gauge valves at in-line pump suction and discharge. Locations for installation of in-line pumps shall not be obstructed by overhead or beneath equipment or services, such that the pump can be easily maintained and/or removed. Provide split- or flexible-coupled, in-line, horizontal or vertical pumps. Exceptions for FOD and Student Life buildings only (not for OSUWMC): Pumps 5 HP and under may be close-coupled.

.4.2 BASE-MOUNTED WATER PUMPS: For primary pumping application, split case (double suction) centrifugal pumps are preferred over the end suction pumps.

.4.2.1 MECHANICAL SEALS are preferred and should be used where adaptable. Complete flushing arrangement shall be provided for mechanical seals and packing.

.4.2.1.1 Horizontal split case pump ball bearings shall be double row on outboard. Pump casings shall have vent and drain plugs and pressure gauge tapping.

.4.2.2 PUMP AND MOTOR shall be installed on a common steel or cast iron base, isolated from the building structure so that the unit will not transmit vibration to the building (concrete inertia base, CIB). Pump coupling to motor shall be flexible. Coupling shall be equipped with a guard.

.4.2.3 PIPING CONNECTIONS to pump shall be flexible to reduce vibration transmission. Braided over corrugated flexible connections are preferred. The flexible connection shall not be used to correct for piping misalignment. Provide separate valved pressure gauges, mounted at the same elevation, for pump suction and discharge.

.4.3 TURBINE PUMPS: Regenerative turbine pumps may be utilized on clean liquid applications. Pump shall have both inboard and outboard bearings. The motor shall be 1750 RPM and shall be sized to prevent overloading at the highest head conditions when the flow of liquid is shut off. Impeller shall

be hydraulically self centering. On larger turbine pumps 5 hp and over, a relief valve may be used on the pump to avoid overloading the motor at shut off conditions.

23 25 13. WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

.1 Cleaning, Flushing and Water Treatment guidelines can be found in BDS Appendix G-1.

Commentary: *The Guideline is intended to provide the A/E with general procedural information. The wording in the Guideline is not mandatory; however, the procedure is mandatory for all Closed-Loop Hydronic Systems.*

23 30 00. HVAC AIR DISTRIBUTION

.1 GENERAL DESIGN CONSIDERATIONS:

.1.1 LEAK DETECTION requirements shall be discussed with the University Project Manager. Take into account such factors as upper floor mechanical rooms, coils that see freezing entering air conditions, and cost of damage to building and its contents. For air handling units installed above occupied spaces, consider providing a cooling coil condensate overflow detector to lock out cooling in the event the primary drain line is blocked. Alarms shall be connected into the Building's Automation System and annunciate at the BAS shop.

23 30 05. AIR HANDLING UNITS WITH AND WITHOUT COILS:

.1 CONSTRUCTION: Central station air handler units shall be of sectionalized construction, consisting of fan section, coil section, and drain pan to catch all condensate. All condensate drain pans shall be aluminum or stainless steel. Galvanized steel, plastic or fiberglass pans are not permitted.

.2 MULTI-FAN UNITS: Selection of a multiple-fan wheel housing assembly in a common fan section (multiple fan wheels on a common shaft or multiple fans operating in parallel) is subject to the approval of the University Engineer. Note: University Engineer approval is not required for a "fan wall" assembly (array of modular, direct-drive, plenum fans). Automatic backdraft dampers are required at each fan in a fan wall. The use of manual blank off plates is prohibited.

Wexner Medical Center: MULTIPLE FAN UNITS: Multiple fan units shall be provided for patient care areas, including but not limited to patient room units, operating room units, radiology area units, emergency department units, procedural area units.

.3 FAN WHEELS AND HOUSINGS shall be AMCA Class II construction; except, high velocity systems requiring total fan static pressure over 4 inches shall use Class III fans. Medium and high velocity draw-through and built-up systems shall have duct discharge sections designed per accepted good practices to minimize losses and for velocity energy recovery. Minimum length of transition shall be equivalent to one wheel diameter.

.4 CONDENSATE LINES from drain pan must have deep traps to prevent either draw or blow through conditions.

Wexner Medical Center: Floor of all AHU's shall be designed to have all sections sloped to drain to the exterior of the AHU through a drain hole to allow all cleaning fluids to be drained out of the AHU floor. Drain hole shall be capped when not in use.

.5 INTERIOR SURFACES, as well as the division panel separating the hot and cold deck, shall be insulated with not less than 1 inch thick fiberglass blanket. The drain pan shall be insulated preferably on the exterior; however, interior insulation, if provided, shall be of a type that will resist mechanical damage and deterioration by water. All condensate drain pans shall be aluminum or stainless steel. Galvanized steel, plastic, or fiberglass pans are not permitted.

Wexner Medical Center: INTERIOR SURFACES: All interior panels shall be solid metal covering insulation. No perforated panels are allowed.

.6 FACE AND BY-PASS DAMPERS AND ZONE DAMPERS shall have bronze or nylon bearings with non-slip spline and rib connections between damper blades and mounting rods. Zone dampers shall have neoprene gaskets for blades to seal against entire stop.

.7 MISCELLANEOUS DETAILS:

.7.1 Solid shafts shall be specified. All shafts will be provided with machine centers.

.7.2 Wheels shall be of heavy gauge riveted or welded design.

Wexner Medical Center: Wheels shall be of heavy gauge welded design.

.7.3 Wheel hubs shall be machine bored with full line contact on solid shaft.

Wexner Medical Center: Air handling units serving patient care areas shall be on emergency power.

23 33 00. AIR DUCT ACCESSORIES

.1 FIRE AND SMOKE DAMPERS:

.1.1 INSTALLATION: All fire and smoke dampers shall be provided with access panels for routine inspection and maintenance. Specify that, after dampers are installed, the contractor shall operate each damper through all positions to assure free operation and witnessed by FOD project manager.

Specify that, after dampers are installed, the contractor shall operate each damper through all positions during air handling unit operation to assure free damper operation and witnessed by University or OSUWMC (where applicable) representative.

.1.2 LABELING: All fire and smoke dampers shall be labeled in accordance with OHIO STATE requirements. Dampers shall be labeled with either FD for fire damper, SD for smoke damper or FSD for combination fire/smoke damper, building abbreviation, floor and number. For example, a smoke damper on the 5th floor of Rhodes Hall shall be labeled SD-RH-5-19. Any modifications, deletions or additions within existing buildings shall have the number coordination performed with OHIO STATE Operations. A color coded dot shall be placed on the ceiling tile grid at the location of the access panel for ease of maintenance.

.1.3 INSPECTION: Specify that, at final acceptance inspection, approximately 10 percent of all fire and smoke dampers, as randomly selected by the University Project Manager, must be demonstrated by the contractor to be in proper position and in operational order. Failure of any one of the demonstrated dampers shall require the contractor to check and demonstrate all dampers.

.1.4 CERTIFICATION: Specify that the contractor must certify in writing that all fire and smoke dampers were checked by operation at installation and that all are in proper position and functional order.

Wexner Medical Center:

.1.5 Provide means of notifying the building automation system when a smoke damper or fire smoke damper has closed.

.1.6 Smoke dampers shall be electrically operated.

.1.7 Closure temperature for fire dampers and combination fire/smoke dampers shall comply with Ohio Building Code and NFPA 90A

23 34 00. HVAC FANS

.1 GENERAL REQUIREMENTS: Centrifugal fans are preferred for supply and return air requirements. Tubular centrifugal, axial and propeller fans may not be used unless written authorization is obtained from the University Engineer.

Wexner Medical Center :

GENERAL REQUIREMENTS: Centrifugal fans are preferred for supply and return air requirements. Air handling units shall be designed as draw-through units. Tubular centrifugal, axial and propeller fans may not be used unless written authorization is obtained from OSUWMC Facilities.

.2. SUPPLY AND RETURN AIR FANS:

.2.1 HIGH PRESSURE FANS: Fans selected for operations above 6-1/2 inches static pressure are subject to approval by the University Engineer or his/her designee.

.3 EXHAUST FANS:

.3.1 EXHAUST FOR HAZARDOUS AIRBORNE CONTAMINANTS: Exhaust fans handling dangerous or obnoxious agents of a contagious disease shall discharge vertically from an outlet and extend at least eight feet above the roof of the building at velocities in excess of 3,000 feet per minute. Extreme care must be exercised to avoid locating exhaust fans and ducts close to high roof lines, other systems, radioactive systems, operable windows, doors, or fresh air intakes.

.3.1.1 Finishes for Exhaust Systems: Consideration should be given to the use of special metal in preference to special paint when designing exhaust fan systems for use with dangerous, corrosive, or noxious fumes.

23 36 05. AIR TEMPERING SYSTEMS:

.1 GENERAL DESIGN CONSIDERATIONS:

.1.1 Outside air, in lieu of machine cooling, shall be utilized on air conditioning systems serving spaces with cooling loads when outside temperatures of 56 degrees F or below are prevalent and when the cost for additional work and equipment involved can be justified.

Commentary: *The University typically resets mixed-air temperatures higher (to approximately 65 F) in heating season to save energy. Consider higher cooling supply air temperatures in heating season when sizing zone airflows for systems using airside economizers. Medical Center Information – this is not always an option in critical and patient care areas*

Outside air shall be controlled via two separate dampers. – a two-position minimum outside air damper and a modulating economizer damper – on all systems.

.1.2 Variable volume air distribution systems should be used to vary the air quantities with the loads rather than falsely loading the system with reheat or mixing at the terminal units. Space-air outlets should be aspirating types to prevent dumping of unmixed air into occupied spaces.

.1.3 Interior spaces requiring cooling the year around should be handled independently from perimeter areas requiring heating during winter and cooling during summer. Interior areas should be supplied from a variable volume cooling system utilizing a controlled economizer cycle. The perimeter systems should utilize controlled economizer cycles when cooling is required and minimum ventilation rates when heating is required.

.1.4 Heat recovery systems should be considered for use when shutdown of systems cannot be accomplished during hours when building is unoccupied. Each application should be examined independently to determine any special sources for obtaining a recovery of energy.

.1.5 Local cooling for limited areas or rooms may be provided by window air conditioners with approval by the University Engineer. Window Air Conditioner Policy:

.1.5.1 Evaluate the circumstances for suitability and consider the use of window air conditioning units only as a last resort. Obtain approval from the University Architect and the University Engineer prior to any window unit installation.

.1.5.2 Unit shall not protrude beyond the exterior surface of the building. Unit shall be installed in a manner to assure proper condensate drainage and without using the building façade as a surface path (staining potential) to grade level or creating a nuisance or hazard to pedestrians. Installations, whenever possible, should permit winter closing of windows (double hung and single hung type) past the exterior surface of the unit. This will both conserve energy and somewhat discourage improper turn-on at temperatures below 50 degrees F.

.1.5.3 Install only in lower sash to provide better access for maintenance.

.1.5.4 Provide a separate electrical circuit for each unit (typically 208 volt). The 208 volt characteristic results in somewhat more efficient use of energy and also acts as a deterrent to theft for use in residential applications.

.1.5.5 Purchase and install only units which do not have side vents for condenser air exchange (rear vent units are capable of internal mounting so that window can close past them in winter).

.1.5.6 Insofar as feasible, standardize with a single manufacturer's units to minimize problems with stocking parts and familiarization of maintenance personnel.

.1.5.7 Use of combination heat/cool units is prohibited.

.1.5.8 Purchasing and/or installing a window unit in a University building without proper review and authorization is prohibited.

.1.5.9 Window air conditioners, when permitted, shall have a 240 volt DPST timer; 0- 4 hour for offices; and 0-12 hour for computer rooms and laboratories. Timers are not required for residential applications.

.1.5.10 All new window air conditioning units shall be capable of bringing in outside air to the space.

.2 EQUIPMENT:

.2.1 General: Equipment shall be of adequate size to handle air quantities and static pressure in accordance with design. Air quantities and distribution pattern shall be shown on the pattern drawings. Provisions for controlling air flow to or from outlets shall be included in the specifications, as well as indicated on the drawings. Air velocities in branch runs shall be kept low enough to maintain acceptable noise levels at air grilles.

Wexner Medical Center: General: Equipment shall be of adequate size to handle air quantities and static pressure in accordance with the design plus 20%. Air handling units shall be sized for the full connected load with no diversity consideration. Air velocities in branch runs shall be kept low enough to maintain noise levels of NC 25 or less in the room.

.2.2 Fans and Air Handling Units:

.2.2.1 Fans: Specify each type of fan separately. All fans shall be statically and dynamically machine balanced and fan motors shall operate within nameplate values.

.2.2.1.1 Fan ratings shall be based upon test performance in strict accordance with the AMCA Standard 210-67 Test Code for air moving devices. Specify that each fan bear the seal authorized by AMCA indicating that ratings are certified and that fans not bearing this seal will not be accepted.

.2.2.1.2 Centrifugal fans with motors 5 hp or over shall have bearings of the split pillow block, double row roller or ball, grease-lubricated type, with pedestal-type supports. Bearing life per Anti-Friction Bearing Manufacturers Association rating procedures shall be 90 percent expectancy of reaching at least 150,000 ~~87,360~~ hours under design conditions.

Wexner Medical Center: Provide ceramic bearings on fans controlled by a VFD. Bearing life per Anti-Friction Bearing Manufacturers Association rating procedures shall be 90 percent expectancy of reaching at least 150,000 hours under design conditions.

.2.2.1.3 Space Planning: Fans, motors, and drives shall be located so that safe and easy access for periodic inspections and maintenance is possible.

.2.3 Drives: The following guidelines must be considered in the selection of, and specifications for, belt drives:

.2.3.1 Single belt drives shall not be used on equipment with 1 hp motor and over.

.2.3.2 Drives shall always be installed with provisions for center distance adjustment. Motors shall be located on their respective motor bases allowing for 1/6 of the total motor base travel for installation of new belts with remaining 5/6 of the travel available for belt tightening.

.2.3.3 Arc of contact on the smaller sheave should not be less than 120 degrees.

.2.3.4 Ratios should not exceed 8 to 1.

.2.3.5 Belt speed should not exceed 5,000 feet per minute.

.2.3.6 A full and free circulation of air should be around the drive at all times.

.2.3.7 Drives operating in an explosive atmosphere should be well grounded and equipped with static-conducting belts.

.2.3.8 Variable drive pulleys used with 5 hp and larger motors are prohibited on final drive installations. Specify that original sheaves be changed when required to achieve proper rpm balancing.

.2.4 Ducts: Ducts shall not be run above electrical panelboards, switchboards, substations or within electric rooms except for the duct serving the electrical room.

.2.5 FRESH AIR SUPPLY:

.2.5.1 Intakes: Fresh air intakes shall be located in a vertical plane a minimum of 8 feet above grade and should not be located in close proximity to loading docks, driveways, loading zones, or any other contaminant source. Sufficient distance or a direction change of fresh air shall be provided between the outside air intake louver and the filters to eliminate snow and rain being carried to the air filters. Intake ducts ahead of filters must incorporate adequate and accessible drains. Duct must also be totally rust resistant.

.2.5.2 Masonry Structures: If masonry plenums or air shafts are used to handle air flow, they shall be coated with special materials or lined with sheet metal to make them airtight.

.2.6 Return Air: Include return air fans in ventilation systems. Provide controls to coordinate return air fans with supply fans and to use return air or outside air as needed for highest energy efficiency.

.2.6.1 Plenums: The use of return air plenums in lieu of ducted return air systems requires prior approval by the University Engineer.

Wexner Medical Center:

.2.7 Terminal Boxes: Terminal boxes shall be provided with fiberglass insulation with solid sheet metal interior, other alternatives need to be approved by OSUWMC Facilities Engineering. Terminal boxes shall be pressure independent with hot water reheat coils. Terminal boxes shall be located outside of patient rooms and other patient care procedural rooms for ease of maintenance and accessibility. Control boxes shall be installed where easily accessible. Terminal boxes shall be provided for each individual office, lab, exam room and patient care room unless approved otherwise by OSUWMC Facilities Operations.

.2.7.1 Labeling: All terminal boxes shall be labeled in accordance with OSUWMC requirements. Terminal boxes shall be labeled with TB, building abbreviation, floor and number. For example, a terminal box on the 5th floor of Rhodes Hall shall be labeled TB-RH-5-19. Any modifications, deletions or additions within existing buildings shall have the number coordination performed with OSUWMC Operations. A color coded dot shall be placed on the ceiling tile grid at the location of the access panel for ease of maintenance.

.2.7.2 VAV applications: minimum settings shall be carefully chosen so as not to create excessive negative pressurization and therefore infiltration.

.2.7.3 Modification: When modifying systems within existing buildings, confirm design conditions with OSUWMC Facilities.

23 40 00. HVAC AIR CLEANING DEVICES

.1 REQUIREMENT FOR FILTERS: All air supplied by a forced air type unit or system shall be filtered. Pre-filter in a single filter installation or a pre-filter intermediate filter combination shall be upstream from the coils. After-filter, where required, shall be on the discharge side of the fan and downstream from all coils. All HVAC equipment shall have new filters provided by the Contractor upon completion of construction and the Contractor shall provide new filters at the end of the 1 year warranty period.

Wexner Medical Center:

REQUIREMENT FOR FILTERS: All air supplied by a forced air type unit or system shall be filtered. Pre-filter and intermediate filter combinations shall be provided upstream from the coils. After-filters shall be on the discharge of the fan and downstream from all coils. Filter size shall be 24”x24” without approval from OSUWMC Operations.

Pre- Filter % Efficiency	Intermediate- Filter % Efficiency	After- Filter % Efficiency
30	60	80-95
30	60	95-99
30	60	HEPA

.2 SPACE REQUIREMENTS: Adequate clearances must be allowed for cleaning or changing filters.

.3 EFFICIENCIES: Filter efficiency shall be specified as minimum efficiency reporting value (MERV). Pre-filters shall be MERV 8 and final filters shall be MERV 13, or better.

.4 DRAFT GAUGES: See 23 05 19.2

.5 AIR FILTRATION FOR HOSPITALS: Air filtration shall comply with the FGI Guidelines for Design and Construction of Hospitals and Health Care Facilities.

Wexner Medical Center:

AIR FILTRATION FOR HOSPITALS: Air filtration shall comply with the FGI Guidelines for Design and Construction of Health Care Facilities, latest edition, unless noted differently above.

.6 PRE-FILTERS in a single filter installation shall be of the following types; filter size and thickness shall be specified.

.6.1 Throw-away type.

.6.2 Disposable media pad between permanent frames.

.6.3 Disposable media pad and frames.

.6.4 Disposable filtering media for roll-type filters. Roll-type filters shall not exceed 10 ft. in width for horizontal or vertical operation and shall be provided with dust covers and motor and drive covers. The filter media shall be provided with adequate support to keep it from being pulled out of place.

.7 INTERMEDIATE AND AFTER-FILTERS shall be of the following types:

.7.1 Dry-type throw away cartridges. Cartridge casings shall be fabricated from zinc-coated steel, with fully gasketed holding frames with compression fastening devices set in a zinc-coated sheet steel frame.

.7.2 Deep pockets of high performance filter media.

.7.3 Bag-type filter, fixed to a zinc-coated steel holding frame and equipped with wire supports to hold bags erect.

.8 ELECTRO-STATIC FILTERS may be incorporated in a project only with approval of the University Engineer.

Wexner Medical Center: ELECTRO-STATIC FILTERS shall be prohibited.

.9 HEPA FILTERS:

.9.1 Shall be on air handling units serving operating rooms, all cancer patient rooms, all intensive care rooms, and per FGI Guidelines.

.9.2 HEPA filter installations shall be tested and certified by a third party testing agent hired by the AE. Testing for certification shall include a smoke test for leakage and particle count verification. Any deficiencies for certification shall be repaired/replaced by the installing contractor. AE shall make provisions in the design for periodic testing.

23 50 00. CENTRAL HEATING EQUIPMENT WITHIN BUILDINGS

.1 GENERAL PROVISIONS: Refer to paragraph 01 78 23 (01730). In Division 01; specifications shall include provisions for:

.1.1 TRAINING OF University OPERATORS by specially qualified personnel furnished by the boiler manufacturer.

.1.2 OPERATING AND MAINTENANCE INSTRUCTIONS: electronic copies of operating and maintenance instructions and wiring diagrams shall be submitted to the University Project Manager.

.1.3 CAPACITY AND EFFICIENCY TESTS of each boiler, including the proper testing of other equipment in the boiler plant installation.

.1.4 TESTS: The specifications shall be written to require the contractor to prepare and perform all tests, to place the boiler in operation, and to demonstrate to designated University personnel that the safety valves and all other safety and control devices function properly.

.2 COORDINATION WITH BUILDING DESIGN:

.2.1 TWO SEPARATE MEANS OF EGRESS shall be provided, consistent with requirements of current Ohio Building Code, in boiler plants housing large boilers.

.2.2 LOCATION AND ARRANGEMENTS of the combustion air openings shall be such that any piping or equipment in the boiler room will not be subject to freezing.

.2.3 ACCESS for cleaning, replacement of tubes or sections, and maintenance is mandatory. Show manufacturer-specified clearances on plan views and elevation views for tube-pull areas, flanges, unions, etc., as needed to remove equipment heads as required for service.

.3 FUEL HANDLING EQUIPMENT:

.3.1 GENERAL: Fuel handling equipment and fuel burning equipment on boilers shall comply with FIA recommendations.

23 52 00. HEATING BOILERS:

.1 PREFERRED BOILER PLANTS: Where their use is practical, hot water boilers are preferred over steam boilers. Minimum 10 to 1 turndown.

.2 SEPARATE PLANTS: Many buildings will be heated with separate boiler plants. It is the intent of the University that these plants be fully automatic and equipped with the latest and best safety devices.

.3 SIZES: Plants shall be designed with boiler sizes so selected as to not require an attendant licensed operator.

.4 ELECTRIC BOILERS: The A/E must submit for review and approval by the University before applying any electric boiler. Electric boilers shall use the highest voltage available. Electrode boilers are favored over resistance-element type boilers. Adequate provisions shall be made for boiler capacity control.

.5 STEAM BOILERS: Steam boilers shall have blow down flash tanks located below the boiler water level in compliance with the State of Ohio rules for the construction and installation of steam boiler blow off systems.

.6 VIBRATION CONTROL: Boilers located on floors above grade shall be installed on pre-compressed fiberglass vibration pads.

.7 ALUMINUM HEAT EXCHANGERS: Use of boilers having aluminum heat exchangers requires approval by the University Engineer.

23 52 10. BOILER ACCESSORIES:

.1 THE WATER COLUMN on steam boilers shall comply with the Ohio Boiler Code. Float controls are desired.

.2 CONTROLS: On multiple boiler plants, the controls shall be of the modulating selector type so that individual boilers can be made to lead or lag. These controls shall be located in view of the boilers themselves so that personnel can see the boilers as controls are being adjusted. Boiler controls shall be per Appendix A.

.2.1 Float chambers of level control devices shall have gate valve drains with pipes extended to discharge over a floor drain.

.2.2 Pressure Type Relay: Steam boiler plants having more than one boiler shall have a pressure type relay and non-return valve on each boiler to prevent steam pressure in lag boilers from dropping below header pressure. (The purpose of this control is to prevent header steam from condensing in the boiler and raising the water level above the high level point in the header).

.2.3 Aquastat Relay: On steam and hot water boilers, an aquastat relay shall be installed on each boiler to prevent the burner from reaching high fire rating before the water temperature in the boiler rises to within a few degrees of the normal operating temperature.

.2.4 Safety Valves: On both hot water and steam boilers, relief valves shall be installed and so vented that they may be blown down without danger to

personnel. Design will require adequately sized vent lines with appropriate drains to prevent steam and hot water from blowing back into the boiler room or other areas where they can endanger personnel.

.2.5 Vacuum Breakers: Each steam boiler shall have a vacuum breaker provided on a pipe connected to the top of the water column or float control for vacuum release.

.2.6 Cut-offs: Boilers shall have a low water cut-off on the burner.

.3 GAUGE GLASSES shall be automatic ball shut-off type.

23 53 00. HEATING BOILER FEEDWATER EQUIPMENT:

.1 WATER SOFTENER: Each boiler room shall be provided with a water softener for boiler feedwater makeup.

.2 THERMAL SHOCK PREVENTION: Each steam boiler plant shall have a factory assembled de-aerating feedwater heater with automatic controls. The heater shall be located at an elevation to provide net positive suction head for the boiler feedwater pumps. Hot water boilers shall have system piping and cold water makeup arranged to prevent cold water from entering a hot boiler.

.3 CHEMICAL TREATMENT: Boilers shall be provided with individual means for feeding chemicals into the boilers. Steam boilers having an output of 3,000,000 Btu or more and having at least 75 percent feedwater makeup requirement shall be provided with an automatic surface blow off arrangement. The device shall maintain a constant conductivity concentration by means of a boiler water probe and controller. Boilers having a high makeup requirement shall be provided with special chemical feed pumps for continuously feeding chemicals into the boiler.

.4 BACK FLOW PREVENTERS: Domestic “makeup” waterlines to boilers shall be provided with backflow preventers.

Wexner Medical Center:

23 57 00 HEAT EXCHANGERS

.1 SYSTEM DESIGN:

.1.1 The building shall be supplied with a fully redundant heating system, including heat exchangers and pumps. Heat exchangers shall be designed to supply 180-200 deg F heating hot water to the building.

.1.2 Heat exchangers shall be steam to hot water converters utilizing shell and tube configuration. The tubes shall be stainless steel. Flooded heat

exchangers require approval from Medical Center Facilities Engineering. Approval is contingent on control requirements being coordinated with Medical Center Facilities Engineering.

23 60 00. CENTRAL HVAC EQUIPMENT

23 60 05. COILS AND PIPING SYSTEMS:

.1 COILS: All coils shall be ARI certified. Direct expansion coils may be used on small systems and shall be piped and installed in accordance with factory recommendations, if the installation can be considered normal or average by the manufacturer. Additional design precautions shall be taken, or a field refinement procedure shall be included in the specifications, on those installations not covered by the manufacturer's guide.

.1.1 Water coils shall have copper tubes (0.035" thickness) with aluminum fins, permanently bonded. Steam coils that could see superheated steam shall have 316 stainless steel tubes. Water cooling coils shall be designed for full counter-flow of water and air with water inlet at the bottom of the supply header and outlet at the top of the return header.

Wexner Medical Center: Fins shall be spaced no more than 12 fins per inch

.1.2 Water Coils versus Steam Coils: Hot water coils are preferred over steam. Use of steam coils requires prior approval by the University Engineer.

.1.2.1 For VAV (variable air volume) HVAC systems, include a preheat coil of sufficient size to preheat the code-required minimum ventilation air up to 55 Deg F leaving air temperature. This will help to prevent nuisance low-temperature shutdowns, and will help to avoid negative pressurization of the building, during the heating season.

.1.2.2 For any hot water preheat coil provide either:

.1.2.2.1 integral face-&-bypass dampers and a control valve piped normally open to the coil; above 40 F position dampers full open to coil and modulate control valve; below 40 F position valve wide open to coil and modulate dampers, or

.1.2.2.2 a coil recirculation pump for continuous flow through the coil and a control valve piped normally open to the coil. The control valve shall modulate to maintain preheat discharge air temperature.

.1.2.2.3 the heating control valve shall remain in control when the fan is OFF, except upon alarm of the low-temperature detection thermostat.

.1.2.2.4 glycol may be used for preheat coil protection with University Engineer approval.

.1.2.3 Steam coils, if used, shall be positive drain type with vacuum breakers, air vents, and double parallel condensate traps to reduce the possibility of freeze-up. The steam coils shall be installed with suitable pitch such that condensate shall naturally drain from the coil. Steam coils shall have integral face & bypass dampers. Provide adequate differential pressure for steam traps. Do not lift condensate if modulating steam valves are used.

.1.3 Design Details:

.1.3.1 Condensate Removal: Whenever cooling coils are stacked one above the other in a plenum, drip troughs shall be installed on the downstream side of the top coil(s) to eliminate drip into the air stream of the bottom coil. Pay special attention to pitch of cooling coil housing, exterior piping, and traps to ensure adequate removal of condensate from the plenum.

.1.3.2 Access: Provide access per manufacturer's recommendations. Access on inlet, outlet, and both ends of coils is desired, if possible, for maintenance and/or replacement purposes. Provide coil pull space on the piping connection side. Student Life – access on both ends is required to permit repair of tube bends without removing coil.

.1.3.3 Freeze-up Protection: Specify that the volume of heating medium being supplied to a coil facing outside air shall not be modulated. Provide manual reset freeze-up protection, applied to the downstream side of the coil.

.2 PIPING: Piping for hot and chilled water systems shall include isolation valves, drain valves, air vent facilities, and pipe unions at each coil, as well as a lockshield balancing valve or balancing cock for those systems having more than one coil being served. Air vents (automatic, or manual, as appropriate) with a line extended to an adjacent floor drain shall be specified for installation wherever air is likely to be trapped. A strainer with isolation valves on the suction side of a pump and a pressure relief valve are required on all systems. Back-flow preventers shall be provided to prevent contamination of potable water systems.

Wexner Medical Center:

PIPING: Piping for hot and chilled water systems shall include isolation valves, drain valves, air vent facilities and pipe unions at each individual coil as well as its

own isolation, calibrated balance valves. Air vents (automatic or manual as appropriate) with a line extended to an adjacent floor drain shall be specified for installation wherever air is likely to be trapped. A strainer with isolation valves on the suction side of a pump and a pressure relief valve are required on all systems. Back-flow preventers shall be provided to prevent contamination of potable water systems. Unions shall be positioned to best facilitate removal of coils from AHUs for service.

.2.1 Refer to Appendix K Technical Provisions for Corrosion-Scale Inhibitors, Microbiocides and Water Analysis Services for Cooling Towers, including OSUWMC requirements.

.2.2 Refrigerant Piping: Accessory equipment in a refrigerant circuit shall include:

.2.2.1 A dryer of adequate size.

.2.2.2 Sight glass-moisture indicator installed in the liquid line at a convenient and accessible location.

.2.2.3 Liquid solenoid valve located near the expansion valve on systems using coil pump-down.

.2.2.4 Service hand valves shall be considered a convenience on small refrigerant systems and a necessity on extensive or large systems. They shall be located for component isolation purposes during normal maintenance.

.2.2.5 Liquid charging port and service valve installed in the liquid line for large systems.

23 61 05. REFRIGERANT COMPRESSORS

.1 COMPRESSORS OF 60 TO 100 TON CAPACITY: Screw or scroll type, equipped with full running protection as described for larger compressors, suction and discharge oil pressure gauges, crankcase heater(s) oil reservoir sight glass, replaceable refrigerant filter-dryers and 5-year warranties. Incorporated features shall include the following:

.1.1 Deleted.

.1.2 Positive unloaded start.

.1.3 An adequate discharge muffler.

.1.4 Internal vibration isolation to provide minimum vibration transmission.

.1.5 Closed transition starting switchgear, determined by the electrical specifications for the particular sizes of motors.

.1.6 Air cooled units shall be furnished with a receiver on the condenser and provisions for pumping the full refrigerant charge into the receiver.

.1.7 Power factor correction as described for large compressors.

.1.8 Provide low ambient accessory as required for the particular application.

.2 COMPRESSORS UNDER 60 BUT OVER 15 TON CAPACITIES shall be scroll type. Incorporated features shall be as specified in paragraph 23 61 05.1 plus inherent thermal overload protection for motors. Provide low ambient accessory as required for the particular application.

.2.1 Chiller control panels shall be equipped with energy management and metering features including current kW usage, kWh used, and water side differential pressure sensors. This data must be available via the BACnet connection.

.2.2 Control panels to provide hard wired inputs and outputs to the BAS system for control of the following: On/Off, System Alarm, running feedback, and supply temperature resets.

.2.3 Compressors to be mounted on spring type vibration isolators.

.3 COMPRESSORS BELOW 15 TONS OF CAPACITY SHALL be scroll. Unloaded start features are not required, but should be considered. Units shall have inherent thermal overload protection for motors. Provide low ambient accessory as required for the particular application.

.4 COMPRESSOR PRESSURE RELIEF DISCHARGE PIPING -See 23 20 03.

23 63 05. CONDENSING UNITS AND CONDENSERS:

.1 All condensing units under 100 tons shall come factory pre-charged with NON-CFC refrigerants and compressor manufacturers recommended lubricating oil. The unit shall be clearly marked as to the refrigerant and oil that it contains.

.2 SPECIFIC DESIGN REQUIREMENTS:

.2.1 CONDENSER CONSTRUCTION: Blow-through evaporative condensers are preferred to draw-through units. Where required for all season operations, air cooled systems shall be designed for condenser location within equipment rooms with discharge air to the outside. Where this is not possible, the condensers must be exterior mounted, the system shall be provided with adequate winter protection to prevent short cycling of the

system. Winter protection shall be in accordance with the manufacturer's recommendations and so warranted by the manufacturer.

***Commentary**: Consider hinged water boxes, polymer coating, and sacrificial anodes.*

.2.1.1 Air cooled condensers shall be selected in accordance with ASHRAE Standard 20-70 or ARI Standard 460-70 using 115 degrees F condensing temperature and 95 degrees dry bulb entering air temperature.

.2.1.2 Water-cooled condensers utilizing city water are prohibited. Exception: evaporative condensers.

.2.1.3 Modulating dampers used for controlling air quantities through towers or condensers shall have non-ferrous blades, linkages, and bearings. The operator motors and linkages shall be located outside the tower for convenient maintenance and operation.

.3 ARRANGEMENT OF EQUIPMENT:

.3.1 Condensers shall be located so that tubes can be rodded without hindrance from walls, piping, or equipment.

.3.2 Evaporative condensers shall be located near their compressors to reduce refrigerant piping to a minimum.

.4 CONDENSER PIPING: Piping of condensers shall have proper and adequate fittings and supports to facilitate removal of water box ends for maintenance. One set of flange fittings shall be located adjacent to the water box and a second set of flange fittings located away from the water box at such a distance that would permit the removal of the header and to provide maintenance space. This same provision for removal of headers in piping shall be made in the chilled water circuits at the chiller unit. Provisions shall be made for TDS-controlled blowdown per Appendix L. Dry sumps shall be utilized with interior storage when winter operation is required.

.4.1 Water treatment control of pH and solids shall be provided as outlined in Appendix L. Backflow prevention or an air gap shall be provided to prevent contamination of all potable water systems. Refer to Appendix L for condenser water treatment systems sample specification.

.4.2 Condenser water lines and city water make-up lines exposed to the weather shall have drain facilities properly located to allow drain down of the system to prevent freeze-up during the winter.

.4.3 Check valves shall be installed on condenser water pump discharge lines where a reverse flow could occur in event of pump shut down.

.4.4 A basket type strainer shall be installed ahead of the condenser water pump on all systems. Strainer shall be valved so that minimum amount of water will be lost when strainer is removed for cleaning. The pressure gauges on any condenser water strainer or condenser water pump shall be compound-range gauges, such that if the strainer becomes plugged, the gauge will read below zero (0) without damage to the gauge.

.4.5 Refrigerant piping to and from an air-cooled condenser shall be installed in accordance with the manufacturer's recommendations (re: pipe size, traps fittings, and receiver size).

.4.5.1 Installation of Refrigerant Piping: Specify that lines be fitted, installed, and pressurized with dry nitrogen before being brazed. Use 6 percent or higher silver alloy with a 1000 degrees F solidus minimum. Specify that lines be blown with dry nitrogen to eliminate brazing debris before starting evacuation and charging procedures.

.4.5.2 Elbows and fittings for refrigerant lines shall be long-radius to minimize capacity loss.

.5 HVAC WATER TREATMENT SYSTEMS:

.5.1 See BDS Appendix L.

23 64 05. CHILLERS:

.1 CHILLERS OF OVER 100 TON CAPACITY: Units will be centrifugal, screw or scroll type which utilize NON-CFC refrigerants with safety classification A-1 or B-1. (as defined per ASHRAE Standard 34- -- Designation and Safety Classification of Refrigerants) such as R-134a or R-123. The use of HCFC-22 is not permitted for use on campus. The primary considerations are high efficiency at part load, high efficiency at full load, low acoustic noise, ease of service, high reliability of operation, low operating costs, low service costs, fast response from local service representatives, and ease of data transfer using BACnet communications to the building automation system from chiller controller. Also specify:

Wexner Medical Center: Refrigerants shall be coordinated with OSUWMC Facilities. Screw Chillers shall not be used for OSUWMC Facilities.

.1.1 Motors: Dual winding, star-delta design, with matching two-step, closed transition, time-delay starting switchgear is preferred. An auxiliary timer in the starting circuit is required. Specify that timer be set to limit starts to a minimum of 60-minutes apart, or greater as recommended by the manufacturer.

.1.1.1 Alternate Starting Arrangements: An auto-transformer with reduced voltage start or solid state starter are acceptable alternates.

.1.1.2 Thermal Protection: All motors shall have heat sensors in the windings for thermal protection.

.1.1.3 Consider variable frequency control of chiller drive motor; justify with Life Cycle Cost Analysis.

.1.2 Power Factor Correction: The equipment manufacturer shall provide fused, switched, power factor correction capacitors to correct to 100 percent or greater. It is preferred that the units be connected after the contractor, before the overloads. Units shall meet all fire and environmental codes.

.1.3 Full-running Protection: Specify that compressors be equipped with high and low pressure safety cut out, external overload protection, and low oil pressure safety cutout. Safeties shall be manual reset type initiating an electrical lockout of the starting circuit when tripped, with an indication of which safety device has tripped.

.1.4 Gauges: See 23 05 19.2.

.1.5 Forced feed lubrication with filter, cooler and visual inspection port in the oil reservoir shall be provided.

.1.6 Capacity Control: A capacity control will be located in the machine control cabinet with an adjustable range of 20 to 100 percent. This will be a pneumatic-electric or a microprocessor based device suitable for remote reset.

.1.7 Heaters: Compressors shall be equipped with crankcase heaters wired on a separate electrical circuit. Units using low-pressure refrigerants shall be furnished with purge units to eliminate the non-condensable gases. Units shall be furnished with a pump-out unit and receiver large enough to hold the full refrigerant charge.

.1.8 Air-cooled units shall be furnished with a receiver on the condenser and provisions for pumping the full refrigerant charge into the receiver.

.1.9 Bidding Requirements: See Division Facility Services-6 for Base Bid requirements for CHILLERS over 100 ton capacity.

.1.10 Evaporator and condenser connections shall be specified to include marine boxes with hinges which will permit ease of service to tubes. Condenser shall include factory installed sacrificial anodes and polymer coating.

.1.11 Oil filtration system shall be specified to include isolation valves, to isolate the filter from the machine and avoiding removing the refrigerant charge when servicing the oil filter.

.1.12 Refrigerant circuit shall be specified to include refrigerant isolation valves, and sufficient volume in both evaporator and condenser to allow all of the refrigerant to be moved into one section of the circuit while servicing the other section, to avoid removing the refrigerant from the machine.

.1.13 Chiller control panels shall be equipped with energy management and metering features including current kW usage, kWh used, and water side differential pressure sensors. This data must be available via the BACnet connection.

.1.14 Control panels shall provide hard wired inputs and outputs to the BAS system for control of the following: On/Off, System Alarm, running feedback, and supply temperature resets.

Commentary*: Intent is to have direct communication between the chiller and BAS*

.1.14 Extended Warranty: Review including a 5-year parts and labor chiller warranty and a 5-year refrigerant warranty with University Project Manager.

.1.15 Chillers shall be mounted on ASHRAE Type 4 spring vibration isolators.

23 65 00. COOLING TOWERS:

.1 GENERAL DESIGN REQUIREMENTS: Cooling towers shall be of the induced draft design with propeller type fan. Fan drive shall be right angle gear type with electric motor mounted outside the air stream.

.1.1 Free-standing towers shall be provided with appropriate factory made service platforms, ladders and a safety railing to provide adequate access for servicing the equipment inside and on top of the tower.

.1.2 Cooling towers shall be sized based on 78 degree F wet bulb outside air temperature. Cooling tower capacity requirements shall be checked by the A/E throughout the full operating range of the chiller and outside air ambient conditions to ensure adequate tower capacity.

.1.3 Fan motors shall be inverter-rated, to permit warranted-use of the motors when controlled by variable frequency drives.

.1.4 The use of variable frequency drives for tower fans is strongly encouraged in order to provide the lowest suitable condenser water supply temperature to the chillers, such that the chillers can operate more efficiently at the lowest lift.

.1.5 Provide tower bypass control valves in order to allow friendly start-up to chillers and avoid nuisance shutdowns of chillers with too-cold tower water. It is encouraged to apply a two-way tower-bypass valve for modulating control with a line-size valve to the tower for positive shut off of flow to the

tower. Avoid using three-way valves. Consider having the chiller directly controlling the bypass valve in lieu of the Building Automation System.

.1.6 The tower condenser hot water distribution pans and cold water sumps shall be stainless steel

.1.7 For towers with indoor sumps, provide a 1”-size drain-equalizer at the indoor sump, interconnected between tower supply and tower return lines, such that both lines will automatically drain to the sump. The 1” drain-equalizer shall have zero (0) valves and shall be continually open to both lines.

Wexner Medical Center : Provide sump heaters on all cooling towers.

.1.7 Specify that cooling tower manufacturer shall furnish balancing valves for distribution pans. Do not specify butterfly valves with lever actuators for this purpose.

23 80 10. LIQUID HEAT TRANSFER:

.1. HOT WATER HEATING PIPING AND INSULATION: Refer to Sections 23 07 19, 23 20, and 23 20 09.

.2. STEAM HEATING PIPING AND INSULATION: Refer to Sections 23 07 19, 23 20 05, and 23 20 09.

.3. HEAT EXCHANGER PIPING AND INSULATION: Refer to Sections 23 07 19, 23 20 05, and 23 20 09.

4 **Wexner Medical Center**: Consideration shall be given to provide 50% propylene glycol in all systems requiring freeze protection.

23 80 15. DESUPERHEATER (DSH) STATION:

.1 De-superheat all superheated steam to within 20 F of saturation downstream of the main high pressure building pressure reducing station. Submit details for construction and installation during preliminary design for review and approval.

.2 Review with University Project Manager whether: 1) the DSH should be designed for N+1 (100% backup), or 2) all equipment downstream should be designed for superheated temperature, or 3) an automatic shutdown of the steam system upon failure of the DSH is desired. [One of these methods shall be provided.] Automatic shutdown valve shall be slow-closing (2 minutes, adjustable, from fully-open to fully-closed).

3. Each DSH shall have at least a 100:1 turndown ratio and be sized for the peak design steam load. DSH shall be Copes Vulcan VO II (variable orifice) or Schutte & Koerting Fig. 6910 (absorption). Other types of DSH (e.g., steam atomizing) are prohibited. Provide DSH control system per Appendix A.

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4. Steam condensate (not domestic water) shall be used for DSH cooling. Consider using coalescing dirt separator. If DSH is designed for N+1, the condensate cooling injection system shall also be designed for N+1.

23 80 17. DESIGN AND INSTALLATION OF STEAM PRESSURE REDUCING STATIONS:

.1 SOUND ATTENUATION: Provide either sound attenuating valve trim or a downstream in line silencer or both to maintain noise levels below 85 dB. Attenuator outer body and inner wall shall be of steel construction with pressure and temperature rating as required by the safety relief valve set point and stream conditions. Acoustical insulation shall be fiberglass for service below 300 degrees F and fiberglass with steel casing for service above 300 degrees F.

.2 MAIN HIGH PRESSURE BUILDING STATIONS: Steam stations processing campus high pressure steam at nominal 200 psig at 600 degrees F to produce building utilities such as heating hot water, domestic hot water and reduced pressure process steam shall be located immediately adjacent to an exterior wall. The Control Valves shall be selected to satisfy winter and summer steam usage, which in most cases has a turndown of 50:1 (Fisher model ET-667 preferred. Armstrong Python and Spirax-Sarco KEA 43 HW acceptable). Routing campus high pressure lines through interior building spaces is prohibited except in the case where the steam line is completely enclosed in a utility tunnel physically segregated from interior building space. The space shall be adequately ventilated /cooled (Ventilation of the space is preferred. Mechanical cooling of the space requires University Engineer approval. Exception: Use of mechanical cooling for OSEP HRC projects is permitted where it has been demonstrated to save energy.) to achieve an overall temperature not to exceed 95 degrees F at a distance of 4 feet from the station. Label all piping that is anticipated to carry superheated steam with the appropriate abbreviation listed in the Facility Services section and an additional 'S' plus steam pressure in parentheses. For example medium pressure superheated steam: MPSS (70 psig). High pressure stations, requiring close reduced pressure control and reliable operation, shall be designed to include:

Wexner Medical Center:

MAIN BUILDING STATIONS: Pressure reducing stations and desuperheaters shall be utilized to reduce the incoming campus steam from 200 psi/585 degF to 70psi/400 degF for utilization to produce heating hot water, domestic hot water, etc. Pressure reducing stations shall be located immediately adjacent to the exterior wall within the building walls, not in a vault.

.2.1 Valves shall be cast carbon steel body, Class 300 rating and flanges or threaded ends, Stellite-faced stainless steel plug, cage, and seat ring,

normally closed single port, cage guided, bonnet extension, with graphite packing and Belleville style washers.

.2.1.1 Diaphragm shall be molded type suitable for 300 degrees F operating temperature with a fabric insert, iron, steel, or aluminum diaphragm plate, silicone manganese-steel actuator spring, and stainless steel travel indicator scale.

.2.1.2 Pressure Controller: Specify that each valve be furnished with a proportional and reset action pressure controller with overload protection on the bourdon tube. For sensing line to bourdon tube, provide minimum 6-inch length of tubing for temperature reduction, steam syphon ("pigtail"), and three-valve manifold (all 316 stainless steel). Provide pneumatic pilot positioner (BLX positioners are prohibited). Provide supply and output pressure gauges at controller and valve positioner. See 23 05 19.2.

.2.1.2.1 A 1/4 inch filter regulator shall be installed in the air line ahead of each controller.

.2.1.2.2 The sensing line connecting the pressure controller to the steam pipe shall be #316 stainless steel pipe, minimum 3/8" NPT size, or larger as specified by the controller manufacturer. The sensor line shall be sloped down and away from the controller to the steam main.

.2.1.2.3 Valve manufacturers: Fisher, Spirax-Sarco, or Armstrong.

.2.2 The A/E shall provide a detailed steam system piping diagram on the Drawings to clarify the design intent indicated above, showing for example, steam pressures and temperatures, valve Cv ratings, relief valve settings, pressure gauges, and thermometers, etc.

***Commentary**: The steam system piping diagram will enhance the visual aid for the Operations staff for determining the status of the steam delivery system.*

.3 MEDIUM PRESSURE (LESS THAN 150 PSIG) HIGH VOLUME STATIONS: Medium pressure stations that can see superheated steam shall be same as for high pressure building stations. Medium pressure stations that can only see saturated steam and that require close reduced-pressure control shall be designed to include:

.3.1 Valves shall be Class 300 cast steel body, Class 300 flanges or threaded ends, with Stellite-faced stainless steel trim, normally closed single port, cage guided, with PTFE packing.

.3.1.1 Diaphragm, pressure controller, and filter regulator shall be the same as required for main building station.

.3.1.2 The Control Valves shall be selected to satisfy winter and summer steam usage, which in most cases has a turndown of 50:1.

.4 SMALL VOLUME STATIONS: Stations with small loads and that do not require close reduced-pressure control, shall be designed to include:

.4.1 Air loaded (no pilot) reducing valve with no stuffing box.

.4.2 High pressure and superheated steam valves shall have Class 300 screwed or flanged cast steel bodies, single port with top and bottom guided stainless steel valve plug, replaceable screwed-in Stellite-faced stainless steel seat, stainless steel main spring, and double stainless steel diaphragm. Medium pressure valves that can see only saturated steam shall be same except Class 150 cast steel body.

.5 OTHER CONDITIONS: The A/E may consider using valve materials and pressure/temperature ratings different than described above if the building steam system is a lower temperature or pressure application. Where a desuperheater is used, the A/E shall consider the consequences of a desuperheater failure on the equipment installed downstream. The design assumptions for these conditions shall be documented in the Basis of Design and submitted to the University Engineer or his/her designee for approval.

Commentary: *The A/E is encouraged to consider using valve materials and pressure/temperature ratings that meet the needs of the application without incurring unnecessary expense for the University. Some examples of such applications would be standalone boilers or systems using only desuperheated steam.*

.6 INSTALLATION DETAILS: Specify that:

.6.1 Valves with pneumatic controls shall be provided clean, dry air at up to 80 psig, as required.

.6.2 Steam gauges: See 23 05 19.2.

.6.3 Safety valve and safety valve vent shall be provided. Safety valves shall discharge to the outside. The pressure drop in the safety valve discharge piping shall be minimal so that it does not impede the safety valve operation. Where steam passes through regulators to a lower class of piping, safety valves shall be installed with enough capacity to prevent over-stressing the piping in the event of regulator failure.

.6.4 A drip-leg, full pipe size, and a trap be provided just ahead of each regulator to remove the moisture from the steam before it enters the regulator.

.6.5 A minimum of two regulators shall be provided on pressure reducing stations, both sized for full flow capacity with one being a standby. Regulators shall be installed with valves and unions or flanges so that any regulator can be removed without disturbing the others. Strainers (100 mesh) with blowdown valves shall be installed horizontal ahead of regulators. Where two valves are necessary to meet the summer-winter turndown (e.g. 1/3 – 2/3, or ¼ -- ¾), the standby valve shall be sized for the larger of the two valves. In lieu of a standby regulator, provide a full-flow globe valve bypass.

.6.6 Pressure reducing stations shall be of such design that regulators can be easily removed without straining the pipe.

.6.7 Gauges on steam lines should be compound-range gauges, such that gauges will not be damaged if steam systems draw a vacuum when shut-down.

.6.8 Provide removable/reusable insulation jackets on all devices, to reduce heat gain to the space, and allow for convenient service. Fiberglass insulation shall not be used on piping systems above 300 degrees F. (Exception: mats composed of 100% needle felted Type E fiberglass fibers may be used.)

.7 ZERO ENERGY POTENTIAL: Double block and bleed (DBB) techniques, as recommended by OSHA, shall be used to achieve ZEP (Zero Energy Potential) on all systems of 15 psig or higher. AE shall confirm whether a DBB arrangement exists in system, and shall consider DBB valving for inlet and outlet of major equipment (HX's, PRV's, DSH's) and main branches/risers.

Wexner Medical Center: Requires DBB valving for inlet and outlet of major equipment (HX's, PRV's, DSH's) and main branches/risers

23 82 10. COILS, RADIATORS, AND FAN COIL UNITS:

.1 USAGE:

.1.1 Forced Air Type Units: An adequate supply of heat shall be provided at building entrances and in air locks. Cabinet unit heater with thermostat control shall be used. Units shall be equipped with filters to minimize dirt collection on coils.

.1.2 Convectors shall be used where architectural features cause an increase in heating requirements. When used, convectors shall have ratings based upon test procedures as set up by the Hydronics Institute, Institute of Boiler and Radiator Manufacturers (I=B=R).

.1.3 Through-wall type heating/cooling units shall not be provided with any liquid service to avoid winter freeze-up problems.

.1.4 Energy Conservation: Fan coil units and radiation will be required in specific areas to facilitate shutdown of major fan units after hours to save energy. Where necessary, the controls on these units shall be coordinated with the controls on the air handling units.

.1.5 Coils: All coils, except fan coil units, shall have a tube wall thickness of 0.035 inches.

.1.6 Hot water or steam heat should be used wherever possible; avoid use of electric heat. Radiant ceiling panels are prohibited.

.2 DETAILS:

.2.1 Convectors shall be wall hung type with sloping top and knob dampers. Elements shall be tested at 150 psi.

.2.1.1 Fins shall be non-ferrous, spaced not closer than 72 fins per foot.

.2.1.2 Tubes shall be copper.

.2.1.3 Cabinet shall be sheet metal, no less than sixteen gauge on fronts and tops, and eighteen gauge on backs.

23 84 00 HUMIDIFIERS

Wexner Medical Center:

.1 USAGE: Humidification levels shall be maintained per the requirements of the AIA Guidelines for Design and Construction of Health Care Facilities, latest edition.

.2 DESIGN: Humidifiers shall be direct steam injection. Humidifiers shall be accessible for routine maintenance. Steam generators used for humidification shall be approved by OSUWMC Facilities Engineering.

23 90 00 MAKEUP WATER

All make up water systems (chilled water, HHW, cooling tower) shall be metered and connected to the BAS

END OF DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)