BSRV - BUILDING SERVICES

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BSRV.1 GENERAL

BSRV.1.1 INTRODUCTION

Heating ventilation and air conditioning (hvac) equipment, electrical systems, elevator systems, and building equipment, such as kitchen equipment, associated with new and renovation construction are energy consumption costs throughout the lifespan of a building. Unless demonstrated to not be cost effective in terms of initial cost and recovery of cost in reducing energy consumption, EPA energy star equipment is to be provided, including hvac equipment, electrical transformers and motors, refrigeration and food service equipment, and other energy consuming equipment operating continuously or for an extended time.

BSRV.1.2 CONNECTIONS TO MECHANICAL, ELECTRICAL AND CIVIL UTILITIES

All utilities to a proposed building site are to be furnished from University central distribution systems, unless either unavailable or demonstrated to be impractical in terms of design or cost. Facilities Management may determine that systems designs shall accommodate development of new or future central distribution systems subject to available funds or potential supplemental funds. Utilities not available or impractical from central distribution systems must be generated at the proposed building.

All heating water, steam, and condensate mains shall be run in tunnels. Tunnels shall be 5’ x 6’ if pipes are run only on one side or 6’ x 6’ if pipes are run on both sides. Tunnel structure shall be designed for HS 20 traffic. Consult Facilities Management Utilities Department for access requirements. Only hot water branches to individual buildings may be direct buried, with documented approval by the Chief Facilities Officer and, when determined applicable, the Director of Engineering and Buildings as coordinated through the Project Manager.

Specifications shall include requirements that alterations or connections to any University domestic water, steam, hot water, chilled water, sanitary, storm, electrical, plumbing, fire protection, gas, compressed air, vacuum, medical gases, energy management systems, and exterior utilities, both distribution and internal, shall be coordinated with Facilities Management Utilities Department through the Project Manager.

For systems serving a building area greater than a renovation project area, or affecting other occupied facilities, specifications shall require that Facilities Operations (Health System Physical Plant for the University of Virginia Health Systems) be notified through the Construction Manager not less than ten working days before such systems may be affected. See GENERAL REQUIREMENTS, **GR.10.11** Utility and Building System Outages.

BSRV.1.2 (continued)
Domestic and hydronic pipe shall not be installed in or under concrete slabs on grade, except where necessitated by building entrances or under sidewalks.

Shut off valves are required at the main service entrance into buildings and on each floor at take-offs from all vertical risers.

Spaces designated as unfinished in new construction shall have plumbing, HVAC and electrical utilities stubbed into them so that when they are finished in the future no demolition is required in the space and outside of it to provide utilities.

BSRV.1.3 METERING UTILITIES

All utilities shall be metered and should be connected to building automation systems to be monitored and totaled at the Systems Control Center.

All buildings shall be metered individually. Where remote totaling by Systems Control Center is not feasible, a separate local BTU meter shall be installed. The A/E shall specify flow meters used to calculate BTU's, or other utility consumption, for the particular installation after consulting with the Facilities Management Utilities Department as coordinated by the Project Manager.

a Revenue chilled water flow meters shall be combination wide beam transit-time ultrasonic and Doppler, thermal energy meter package. Meters shall have energy function and shall have the following outputs which are compatible with the University DDC system; two temperature, flow, instantaneous BTU/hr, and pulse cumulative BTU. These meters shall have 10 unobstructed pipe diameters of straight pipe up stream and 5 pipe diameters down stream.

b Heating Hot water flow meters shall be the same as used for chilled water.

c Steam flow meters shall be inline variable area orifice type. These meters shall have 10 unobstructed pipe diameters of straight pipe up stream and 5 pipe diameters down stream.

d Where Utilities Department requires a condensate flow meter, a turbine type shall be used. Condensate meters shall be located so that there will be no air or uncondensed steam will pass through.

e All revenue meters shall have diagnostics.

f The outputs from all revenue meters shall be included on the DDC points list.

g Revenue meters shall be installed by a manufacturer's trained and authorized representative.

BSRV.1.3 (continued)

Provide adequate straight pipe, without tees or any other fittings, up and down stream of flow meter.

Taps shall be provided to measure flow rate (GPM) at each pump and at each heat exchanger, however, circuit setters shall not be used on variable volume systems. Wells for thermometers shall be provided before and after each heat exchanger.

All meters shall be installed and operational prior to connection to utilities. Accuracy of meters shall be verified, and corrected, if necessary, within 10 working days of connection to utilities.

See BUILDING SERVICES **BSRV.20.1.2**, Domestic Water Metering.
See BUILDING SERVICES **BSRV.50.2.4**, Electric Metering.

BSRV.1.4 AESTHETIC CONCERNS

All mechanical and electrical equipment and utilities shall be concealed, both on the interior and exterior of buildings, except in mechanical rooms and in laboratories that do not have suspended ceilings.

BSRV.1.5 IDENTIFICATION

All piping and equipment in mechanical equipment rooms and central plants shall be completely painted according to the "**Scheme for the Identification of Piping Systems**", ANSI A13.1 and the "**Safety Code Color for Marking Physical Hazards**", ANSI Z53.1, latest revisions.

All piping in buildings shall be identified by means of alphabetical stencils and color codes, showing contents of the piping and the direction of flow. Piping shall be identified at 30' intervals, on both sides of penetrations through walls and floors, and at each directional change.

All valves shall also be identified with stamped brass tags or discs secured with non-ferrous beaded chain. Value numbers shall be engraved or stamped as large as possible on tags (1 inch by 2 inches) or discs (1.25 inch diameter) attached to the valves by 10-gauge brass "s" hooks. Provided a framed valve schedule in mechanical rooms.

All motor driven equipment, HVAC components, and major electrical boxes shall be individually numbered on the drawings by the Architect/Engineer and have corresponding number plates on the equipment. (Example: For unit heaters, use UH-1, UH-2, etc., even though both units are of the same size and type.) All designations shall be integrated with and distinguished from existing designations.

BSRV.1.5 (continued)
The construction documents shall require the Contractor to color identify all equipment using the numbering system shown on the drawings with a color that contrasts with the equipment finish. In finished areas, identification shall be located on the inside surfaces of access doors; in unfinished areas, on outside surfaces. Tags may be used where preferred, and permanently attached.

Sprinkler control valves located above suspended ceilings shall be marked with a red thumbtack on the ceiling panel.

See BUILDING SERVICES **BSRV.50.2.1**, for additional electrical identification requirements.

BSRV.1.6 HAZARDOUS MATERIALS AND FUME HOODS

See GENERAL REQUIREMENTS **GR.3.18**.

BSRV.1.7 SOUND PRESSURE LEVEL REQUIREMENTS

Sound pressure levels around exterior mechanical and electrical equipment shall not exceed the limits set forth in the City of Charlottesville Noise Ordinance, or the dbA/time limitations set forth in the **Occupational Noise Exposure/Hearing Conservation Amendment** latest edition. The Project Manager shall direct questions regarding the Occupational Noise Exposure/Hearing Conservation Amendment to the University's Office of Environmental Health and Safety.

When placing noise-generating equipment, the Architect/Engineer shall consider uses of surrounding spaces that may dictate sound levels lower than those specified above.

BSRV.1.8 VIBRATION AND SOUND ISOLATION REQUIREMENTS

Mechanical and electrical equipment, associated piping and ductwork shall be mounted on vibration isolators to minimize transmission of vibration and noise to the building structure or spaces. All motors over five horsepower must be solidly attached to a base common with the driven unit to minimize alignment problems. Solid sheaves and band belts shall be used to minimize vibration in multiple V-belt driven equipment.

All rotating equipment shall be balanced, both statically and dynamically. The structure supporting the equipment shall not have any natural frequencies within plus or minus 20 percent of the normal operating speeds.

BSRV1.8 (continued)
The equipment, while operating, shall not exceed a self-excited radial vibration velocity of 0.10 inch per second, or an axial vibration velocity of 0.05 inch per second, when measured with a vibration meter.

Vibration test pickups shall be placed on bearing caps in the horizontal, vertical and axial directions, or on equipment mounting feet if the bearing caps are concealed.

Walls and floors enclosing mechanical rooms adjoining occupied spaces shall have a sound transmission factor of 10 decibels, or greater, above the determined or probable airborne noise level of operating equipment. In no such applications shall the rating be less than a 55-decibel STC.

BSRV.1.9 CUSTODIAL ROOMS

Valves, electric panels or equipment, thermostats, terminal boards for telephone, data or other low voltage equipment, etc. shall not be placed in custodial rooms.

See GENERAL REQUIREMENTS **GR.5.6**, Custodial Rooms for other requirements.

BSRV.1.10 OPERATIONS AND MAINTENANCE MANUALS

See GENERAL REQUIREMENTS **GR.11.4**, Operating and Maintenance Manuals

BSRV.1.11 COMMISSIONING

All mechanical, plumbing, electrical and fire protection systems shall be commissioned per the below requirements. Facilities Management shall be the Commissioning Authority. The Architect/Engineer shall include in the specifications the commissioning procedures, requirements and schedules for the construction-phase through the end of the project. The procedures shall have a level of detail appropriate for the size and complexity of the building systems.

BSRV.1.11.1 Design Phase:

During predesign or schematic design and preliminary design, develop mechanical and electrical systems design criteria in consultation with Facilities Management personnel responsible for the operation and maintenance of buildings systems. Such personnel include representatives of Utilities/Systems Control, Operations (Health Systems Physical Plant for University of Virginia Health Systems), and corresponding Facilities Management Review Unit professional disciplines.

BSRV.1.11.1 (continued)
Unless established on a project basis, there are no special commissioning requirements beyond the design and review requirements of Chapter 8 of the Higher Education Capital Outlay Manual or Chapter 8 of the Commonwealth of Virginia Construction and Professional Services Manual.

Specify airflow measuring requirements where applicable under **BSRV.1.11.2**.

BSRV.1.11.2 Submittal Review and Construction Phases

A pre-installation meeting shall be held to review coordination drawings and submittals. Mechanical pre-installation meeting shall include all Division 15 and Division 17 trades. See GENERAL REQUIREMENTS, **GR.10.16** Preinstallation Conferences.

For renovation projects where ductwork is modified, the Architect/Engineer shall identify and location(s) for the contractor to measure airflow(s) prior to any demolition. The contractor shall be required to report the identified airflow(s) before commencing any HVAC demolition. The intent of this requirement is to identify existing capacities that may be critical to achieve design and/or code requirements.

Verify that submittals for all cooling coils specify a return water temperature of at least 62 degrees F. During construction special attention shall be given to items that cannot be easily corrected after construction completion. This includes but is not limited to locations of plumbing cleanouts, adequate maintenance access for equipment, adequate straight pipe up and down stream of flow meters, proper connection to supply and return piping, and code required clearances above and around electrical panels. There are no other special commissioning requirements in this phase.

BSRV.1.11.3 Startup and Close Out Phase

All specified tests will be witnessed by representatives of the appropriate (sub)contractor, equipment manufacturer's representative, Consulting Engineer; and Facilities Management (including designated personnel from Facilities Planning and Construction, Operations or Health Systems Physical Plant, Utilities, and the Facilities Management Review Unit.

The Architect/Engineer (A/E) through the Project Manager shall schedule all commissioning activities no less than two (2) weeks in advance. The Architect/Engineer shall certify and document that all commissioning tests and activities have been successfully completed, and that the HVAC systems are functioning in accordance with the contract documents.

BSRV.1.11.3 (continued)
Specifications shall stipulate that until commissioning is satisfactorily completed:

- No heating, ventilation and air conditioning system will be accepted.
- No warranty period starting date on equipment will be established.

All heating, ventilation and air conditioning systems shall be commissioned per the following requirements prior to training owner's operations and maintenance personnel:

- Point-To-Point (PTP) tests will be performed on all sensors and outputs prior to testing and balancing and Functional Performance Tests. All damper linkages will be run through their full travel as part of PTP testing. All remote duct and hydronic sensors shall be located and tested. All PTP tests on zone controls shall be done before ceiling tiles are installed. Graphics, alarms, trends, etc. on the University Systems Control computers shall be verified.
- All motors shall be checked for proper lubrication, drive rotation and belt tension.
- Functional Performance Tests shall be done on all freezestat controls with fan switch in automatic, hand, and bypass position. Functional Performance Testing shall be as stated in section 8.16 of the Higher Education Capital Outlay Manual (HECOM) or section 816.0 of the Commonwealth of Virginia Construction and Professional Services Manual (CPSM).
- In vivarium, laboratories with high safety levels, and other spaces as specified, differential airflows and proper pressurization shall be verified.
- Witness tests shall be performed on all devices that require maintenance including but not limited to, filters, dampers and motors, control valves and motors, reheat coils, and condensate drain pans and traps.
- Furred in or enclosed equipment shall be inspected before being concealed. All information required for record documents and O&M manuals shall be verified.
- Cooling coil condensate drain pans and traps shall be checked for proper drainage. In all air handling units and all fan coil units above ceilings pour a sufficient quantity of water into the drain pan to verify proper drainage.
- Sound levels of all exterior fans shall be measured.

Plumbing systems shall be commissioned as follows:

- Back flow preventers shall be checked for code compliance and a certification report shall be submitted to the University Project manager. Plumbing cleanouts shall be checked for required maintenance access.

Fire Protection systems shall be commissioned as follows:

- Functional operation will be demonstrated in the presence of responsible State and Facilities Management fire safety personnel for accessibility to fire dampers, fire dampers, automatic fire suppression systems and alarm systems.

BSRV.1.11.3 (continued)
The following shall be completed during the first year of systems operation:

- Capacities of HVAC equipment shall be verified during extreme summer and winter conditions.
- Total energy consumption of the first year of operation shall be compared to scheduled values and any discrepancies resolved.
- Revenue meters shall be setup, programmed, and calibrated by a manufacturer's trained and authorized representative and witnessed by University Utilities Department.
- Revenue meters shall be recalculated by a manufacturer's trained and authorized representative 6 and 12 months after initial balancing.

BSRV.1.12 TRAINING AND DEMONSTRATION OF SYSTEMS

After commissioning is complete, but prior to beneficial occupancy or substantial completion, the Contractor shall provide field training for designated Facilities Management personnel who are responsible for the operation and maintenance of HVAC, electrical and fire protection/detection equipment and systems. Classroom training can be held prior to commissioning. Field training shall include a demonstration of all required maintenance activities and proper operation of all control sequences. The Architect/Engineer shall schedule all training and demonstration activities no less than two (2) weeks in advance.

BSRV.1.13 CLOSE -OUT

See GENERAL REQUIREMENTS, GR.11 Project Close-out Requirements and Procedures.

BSRV.10 VERTICAL TRANSPORTATION

BSRV.10.1 ACCESSIBILITY FOR THE DISABLED

In addition to the requirements of **ADAAG 407**, passenger elevators shall provide:

- Hall call and cab shall be flush, not raised.
- 6" x 8" cutout for emergency telephone, located between 24" and 48" above the cab floor. University to provide and install telephone. Conduit, wiring and all other requirements shall be provided in design and by the Contractor to accommodate a Talk-A-Phone ETP-100.

BSRV.10.2 ELEVATORS

In addition to the following, Architect/Engineers are encouraged to consult with the Elevator Maintenance Supervisor, Facilities Management Operations Department or Health Systems Physical Plant, by arrangement with the responsible Project Manager. Cab door heights over 8'-0" shall be prohibited unless approved by the appropriate elevator maintenance shop. Recommendations may include proven manufacturers to be included in specifications.

BSRV.10.2.1 Elevator Machine Rooms and Pits

Elevator equipment rooms shall not be used for access to roofs or other parts of the building unless elevator equipment is fenced or walled in.

Traction-type elevators shall have machinery located overhead. Written approval of the Chief Facilities Officer is required for an under-slung installation.

Underground hydraulic piping for elevators shall be schedule 80.

The electric fused disconnect switch for the elevator shall be adjacent to the door jamb of the main access door to the machine room.

Elevator pits shall have sump pits for use of a portable sump pump by Facilities Management personnel. Drainage from the elevator pit shall not be connected to any building drainage or sewer system. Sump pits shall be equipped with a float sensor connected to Facilities Management Systems Control.

Health Systems Physical Plant prefers permanent sump pumps, subject to environmental requirements for preventing contamination of sanitary or storm water drainage systems.

BSRV.10.2.2 Control Systems

Elevator controls shall be solid-state "Selective Collective Automatic Operation", as defined in ASME/ANSI A17.1. Controller shall be non-proprietary and shall not require a battery to maintain programming. Control system shall be microprocessor based for dispatch and motor control, capable of computer based monitoring with terminals for connection

BSRV.10.2.3 Diagnostic Requirements

For microprocessor control system, specifications shall require that diagnostic tools, hand held or built into the control systems, be functional for the lifetime of the equipment, without requiring recharging or reprogramming. The use of proprietary equipment shall be prohibited by the specifications.

BSRV.10.2.4 Warranty Service Requirements

The specifications shall be explicit regarding:

- Contractor shall provide four (4) sets of all electric schematic wiring diagrams, access codes or passwords required for all maintenance functions. including diagnostics, adjustments and parameter reprogramming. Tools may be hand held or built into the control systems, and shall function for the lifetime of the equipment. Tools that require recharging or reprogramming shall not be used. The successful contractor upon completion of the project shall provide any special tools, prints, and technical operation of equipment that cannot be obtained from multiple suppliers to the University. Specifications shall be explicit that all tools, adjusters, manuals and schematic wiring diagrams become the **property of the University** to be used at their discretion related to the installed elevator or elevators.
- Prior to the end of the warranty period, the Elevator Contractor shall readjust the elevator as required to meet all performance parameters specified. A written report shall be submitted by the Elevator Contractor to the University Service Contract Manager.

BSRV.10.3 OTHER VERTICAL TRANSPORTATION

BSRV.10.3.1 Dumbwaiters

Dumbwaiters require documented justification by the user and Architect/ Engineer, and subsequent approval by Facilities Planning and Construction.

If approved for use, a car safety gate shall be provided to prevent loads from falling while the car is in motion. Controls shall not allow movement unless the door is closed. A "door open" signal shall be provided.

If provided for three or more landings, "in-use" indicator lights shall be provided.

BSRV.20 PLUMBING

BSRV.20.1 DOMESTIC WATER

BSRV.20.1.1 Water Supply and Treatment

Domestic water is obtained from the University distribution system. New service lines shall be valved at the point of connection to the main and at entry to the building.

Pressure reducing valves shall be provided in all buildings at the domestic water entrance just downstream of the meter.

Provide a strainer with blow down valve upstream of the meter bypass loop.

Provide a backflow preventer (BFP) downstream of the meter bypass loop, with a bypass BFP of half the diameter of the service main unless a larger size is needed to meet peak demand.

Water line shall be disinfected and tested for bacteria.

See SITEWORK **SW.35.3** (exterior domestic water piping) for requirements also applicable to interior domestic water piping.

BSRV.20.1.2 Domestic Water Metering

Water meters shall be installed at each building. Meters shall be capable of showing cumulative gallons used, and of measuring the maximum and minimum anticipated flow rates. A bypass that can accommodate full flow conditions shall be provided around all water meters and PRVs. Meters for domestic water shall be electromagnetic.

Meters for largely varying flows such as dormitories, shall be compound type meters and all others shall be turbine type, each being revenue grade, having a maximum inaccuracy of 1% of rate and span.

Meters shall be constructed of brass or bronze and shall have a strainer installed upstream.

Boiler, chiller and cooling tower make-up and blow down shall be metered separately.

Irrigation systems shall be metered separately.

Fire protection service shall not be through the domestic metered water system.

BSRV.20.1.3 Domestic Hot Water

Medium temperature hot water (MTHW), high temperature hot water (HTHW) or steam shall be used to generate domestic hot water, except where centrally generated domestic hot water is available.

Parts of the University Health Systems facilities receive domestic hot water at 140 degrees Fahrenheit. It is generated by the Central Heating Plant and delivered over a distribution system. Contact Facilities Management Utilities or Health Systems Physical Plant for specific locations served.

BSRV.20.2 MATERIALS

The selection of materials by the Architect/Engineer shall be subject to approvals coordinated by the Project Manager. All domestic water piping inside buildings shall be hard drawn copper.

(**BSRV.20.2** continued)

Supports and other metal parts subject to use shall be galvanized.

Shut off valves are required on each floor, on take-offs from all vertical risers, and at the connection to each piece of equipment.

All piping systems shall be hydrostatically tested after installation. The test pressure shall be 200 psi or 1 1/2 times the working pressure, whichever is greater.

BSRV.20.3 WATER DISTRIBUTION

Closed water piping systems shall have air vents to purge any trapped air.

Valves shall be compatible with the piping materials. Valves shall have valve tags, appropriate identification and valve sheets.

Recirculating hot water systems shall have a flow-measuring device (circuit setter) with a multi-turn flow-regulating valve.

Dielectric fittings shall be used when connecting piping of dissimilar metals.

Drain valves shall be installed in accessible locations at all low points in the piping system to permit drainage and servicing.

When plumbing fixtures are removed but not replaced, domestic water pipes shall be removed to within five (5) pipe diameters of the main to prevent leaving a long dead leg, and terminated with a capped ball valve. Where plumbing fixtures are removed but the water pipes will be reused the pipes shall be capped to prevent debris from entering pipes.

Aerators for lavatories in toilets, kitchens and similar use shall be 1.5 gpm maximum.

Hose bibbs shall be spaced at a maximum of 100 feet around the entire building.

BSRV.20.4 SANITARY WASTE SYSTEMS

The University-owned sanitary sewerage system connects to city-maintained sewerage lines and the Rivanna Water and Sewer Authority's treatment plants.

Sanitary cleanouts shall be located with a minimum floor clearance of 15 inches from adjoining walls or built-in features, such as toilet stalls or casework.

Unless approved as an exception for servicing vertical risers, cleanouts shall not be located in vertical surfaces.

BSRV.20.5 SPECIAL PLUMBING SYSTEMS

BSRV.20.5.1 Piping Systems for Gases

Piped gas systems shall be thoroughly identified and coded.

Piping of any gases in University of Virginia Health Systems (Hospital and Medical School) projects will require special coordination with Health Systems Physical Plant. All medical oxygen outlets shall be D.I.S.S. type. All piping, tubing, and fittings shall be pre-cleaned. Copper shall be type K.

A shut off valve for natural gas shall be provided at the room entrance or other location approved by Facilities Management.

Natural gas outlets shall not be installed in bio-safety cabinets or other contained rooms or areas that are not fully exhausted

BSRV.30 HEATING, VENTILATION, AND AIR CONDITIONING

BSRV.30.1 GENERAL

BSRV.30.1.1 Design Parameters

Air-conditioned spaces: 78 degrees F, d.b. Air conditioning systems shall be able to maintain an indoor relative humidity of no more than 60% regardless of the outdoor temperature and humidity, or percentage of outside air. Lower indoor humidity levels shall be maintained when justified by project criteria.

Untempered air shall not be supplied directly to occupied spaces or into the returns of fan coil units.

Constant volume systems shall only be used where required by program or where variable volume air control is impractical. Constant volume systems shall have a means to pre-cool and dehumidify outside air before being mixed with the return air. A chilled water coil, heat recovery device or other method approved by Facilities Management may be used.

Energy conservation measures that reduce the peak-cooling load (such as heat or energy recovery) with up to a 15-year payback shall be employed. Other energy conservation measures with up to a 10-year payback are acceptable.

Heated spaces: 70 degrees F, d.b. Humidification is not to be provided unless justified by special project criteria.

Spaces that require a continuous and constant supply of outside air shall have a heat recovery system. The system shall be selected for a payback of no more than 10 years.

(**BSRV.30.1.1** continued)
Desiccant-coated heat recovery devices are acceptable and encouraged.

Only HEPA filters and filters for critical areas are to have DP sensors tied into the University Energy Management System. Provide Magnahelic or inclined manometer on all other filters.

When DDC is used on air handler units (AHU), a laptop computer shelf with a required hook up shall be provided at each AHU, chiller, etc. When DDC is used, the actuators on AHU's shall be pneumatic, however, on small unitary loads such as VAV boxes, FCU's, etc. the actuators should be electronic. The vendor of electronic monitoring and controls shall provide all control devices. See BUILDING SERVICES, **BSRV.60** Electronic Monitoring and Controls.

Pneumatic actuators shall be provided with pilot positioners. Plastic bodies shall not be used.

Sequence will specify if fans run continuously or can be shut off. Supply, return, and exhaust fans shall be interlocked as required.

Controls such as carbon dioxide (CO_2) or occupancy sensors shall be used to modulate outside airflow in classrooms and auditoriums, unless demonstrated not to be cost effective. On units with CO_2 control, the sequence of operation shall specify when outside air dampers can be closed, and when fans can be shut off.

Units with CO_2 controls which serve only class room(s) will be shut off during unoccupied hours when CO_2, temp, and relative humidity are satisfied; and restarted on demand by any of those sensors. An occupancy sensor will also restart AHU. When all classrooms on a given system are empty during normal occupied hours, the outside air damper shall not close but shall go to a minimum position (approximately 1 cfm per "chair"), and the CO_2 level will be allowed to drop. If extreme conditions prevent the system from maintaining all setpoints, the CO_2 level will be allowed to drift. The EMS will monitor points as required to detect failure to maintain any setpoint.

VAV systems that simply reduce outside airflow in proportion to supply airflow shall not be used. Spaces of different uses (such as offices and classrooms) may only be served by the same AHU if CO_2 sensors or other approved controls are provided in adequate quantity and location to ensure code required outside air to all spaces.

Individual offices shall have means of ensuring acceptable temperature control (user adjustable thermostat and control device, appropriate zoning or other designed means).

AHUs should have manual override to run unit with high outside airflow (for venting odors from new carpet/furniture, floods, etc.)
(**BSRV.30.1.1** continued)

Thermafusers are not allowed.

In buildings that do not have other fire/smoke detection, the AHU smoke detectors shall be used to alarm the EMS. The AHU supply and return fans will run continuously but the outside air dampers shall be closed by occupancy sensors, carbon dioxide controls, or by the EMS during unoccupied mode. If smoke enters an AHU, the fans in that AHU shall stop; however all other fans in the building shall continue to run if allowed by code.

Perimeter heat is needed at large windows and exterior walls, and shall be interlocked with AHU/zone control. Perimeter heat will normally be supplied from a closed building LTHW loop with a converter served by the University MTHW system.

Freeze protection shall be provided on all air handling units. Freezestats shall stop the supply fan, close the outside damper, and open the heating coil valve, by means of positively venting air from the actuators. Where DDC is used, the freezestat controls shall be completely independent of the DDC system.

BSRV.30.1.2 Chemical Treatment

The chemicals to be used by the Contractor for the specified initial treatment shall be furnished by Facilities Management and funded by the project. The owner shall provide all chemical treatments after systems have been cleaned, flushed, and filled.

All other chemical treatment procedures shall be per Section 915.11 of the 2004 Construction and Professional Services Manual.

In individual buildings, only closed loop systems, such as secondary heating water, shall have chemical treatment (chemical treatment for fluids from central systems will be provided at the heating or chiller plant)

BSRV.30.1.3 Distribution

Two pipe systems and other configurations that will allow mixing of two or more chemical treatment sources shall not be used.

Systems shall have fine and coarse mesh strainers in parallel on return water from building to loop. Supply from loop shall have a coarse mesh strainer. All strainers shall be provided with blow down valves.

All air handler coils, reheat coils, convectors and fan coil units shall incorporate isolation valves. A flow control device (circuit-setters) with a multi-turn flow-regulating valve shall be provided on constant volume systems, however circuit setters shall not be provided on variable volume systems.

BSRV.30.1.4 Testing and Balancing

All HVAC systems shall be tested and balanced in accordance with a standard of a recognized testing laboratory.

All welds in steam, steam condensate, MTHW and HTHW piping shall be x-rayed from primary to secondary systems. Welds shall satisfy ASME B-31.1.

All piping shall be tested at 200 psi or 1 1/2 times the design pressure, whichever is the greatest.

Testing and balancing of building chilled and hot water distribution pumps shall use the revenue meters rather than DP across pumps. A portable meter with the same level of accuracy as the revenue shall be used on branches which will not have full flow; a suitable meter can be borrowed from the University if available

BSRV.30.1.5 Gauges, Indicators and Thermostats

Gauges shall be specified on supply/return of pumps, chillers, converters, and where lines enter and exit mechanical rooms.

Thermometers shall be specified on supply/return water chillers, air-handling units, fan coil units, and at other points.

Where non-digital readout gauges are used, the following shall apply:

- Gauges for general use shall have screw-type recalibration, bronze bushed movements and single unit construction.
- In main mechanical rooms, provide 4.5 inch diameter gauges for all steam pressures, and mounted a maximum of 8’-0” above the operating floor.
- Gauges shall be calibrated for static head.
- All gauges shall be non-pulsating.

Gauges and thermometers shall read to twice the operating pressure or temperature.

BSRV.30.1.6 Steam Tunnels

Existing University steam tunnels shall be used, as space permits, for distribution of steam, medium and high temperature hot water and steam condensate systems. Installation of chilled water lines and piping for toxic, flammable or hazardous gases is prohibited. Electrical or communications systems shall be limited to 120 volts and shall be installed in conduit. The Facilities Management Director of Utilities shall approve design of systems within steam tunnels.

(**BSRV.30.1.6** continued)
Low points in steam tunnels shall be drained by gravity or a pump with emergency backup.

Steam tunnels to have bitumastic coating and protection board on outside and all joints to be water proofed. Tunnels installed at or below the water table shall be fully water proofed with a rubber (EPDM) membrane.

Insulation in steam tunnels shall be calcium silicate with waterproof 30 pound felt jacketing; applied to fittings with waterproof adhesive and copper or stainless steel wires.

BSRV.30.1.7 Control Air

The Architect/Engineer will confirm the existence, and capacity, of a central source of compressed air within the University building or, if required, provide a source or additional capacity.

For centralized air-handling systems, moisture-free instrument air is required.

BSRV.30.1.8 Plans and Specifications

Sequence of operations shall be on the control drawings. Specifications shall require that the Contractor permanently mount a copy near the equipment.

Air handling unit (AHU) points list, airflow schematic, and sequence of operations should be on the same sheet. AHU schedule, with gallons per minute, and detail should be on the same sheet, unless space prohibits.

Pump(s) point list, pump flow diagram, and sequence of operations shall be on the same sheet. Pump schedule and detail shall also be on this sheet, unless space prohibits.

Building plans shall have chilled water, hot water/steam, and airflow schematics. Designs for renovation projects shall update the building schematics.

Provide a component coordination responsibility matrix specifying the HVAC, ATC, and Electrical contractor's scope of work for devices that are furnished, installed, or wired by different divisions of specifications. The matrix should include the headings: Device, Furnished By, Installed By, Power By, Control Wiring By, and Fire Alarm Wiring By. See **Fig. BSRV.30-3** at the end of this section as a sample of what might be required.

BSRV.30.2 MECHANICAL LOCATION AND EQUIPMENT

BSRV.30.2.1 Mechanical Rooms

The Architect/Engineer shall, in the earliest stages of design development, be responsible for establishing and/or verifying programmatic requirements for mechanical rooms in order to:

- Provide adequate safe access and manufacturer's recommended working clearances for all equipment.
- Provide for replacement of the largest piece of equipment without removing permanent walls or large items of equipment or equipment essential to the on going day to day building use.
- Provide direct access from the exterior or main corridor for major mechanical rooms exceeding 100 net square feet suited for replacement of equipment and preventing disruption of normal building functions.
- Assure that building mechanical air intakes are located away from loading docks, emergency electrical power generators, emergency or ambulance vehicle entrances, and other external sources of noxious or toxic fumes. Consideration also shall include proximity to wind-blown dust from streets, fields and ground care activities, designated tobacco smoking areas, combustion by-products, and biogenic materials related to evaporative cooling towers or intentional human contamination.

In phased projects mechanical rooms shall be sized to include equipment for all the phases.

Attic spaces may be used for air handling equipment, however, compressors, condensers, and distribution pumps shall not be located in attics. Attic access shall be from interior stairs (or elevator where practical), which shall be large enough and suitable for replacement of the largest component of the mechanical equipment. Attic mechanical spaces shall be equipped with lighting, convenience outlets, space for storage of mechanical drawings, maintenance manuals, filters, etc., and floor moisture detectors tied to University’s Systems Control Center energy management system.

When air handling units are located in attics, zone control devices, such as VAV boxes, mixing boxes, reheat coils, etc., shall also be located in the attic rather than in the ceiling of occupied spaces below if there is sufficient space in the attic.

Unobstructed accesses to filters, manual valves, zone control devices, automatic control equipment, etc., shall be provided.

Mechanical rooms shall be ventilated by a thermostatically controlled fan, and shall have a floor drain.

Access to ducted fan coil units on occupied floors shall be from corridors, rather than through offices, classrooms, laboratory ceilings, or other occupied spaces.

(**BSRV.30.2.1** continued)
Air conditioning compressors, condensers, and similar equipment serving buildings shall be in an exterior, ground-mounted location readily accessible for maintenance, and effectively shielded from view. Such installations may be subject to approval by Facilities Management.

Mechanical equipment rooms shall be provided with Ethernet jack(s) in locations coordinated with Systems Control.

See GENERAL REQUIREMENTS **GR.5.5**, Building Systems Access and Equipment.

BSRV.30.2.2 Ceiling Access

Access panels are not required in lay-in acoustical tile ceilings, except where ceiling clips are required.

BSRV.30.2.3 Equipment

All coils, pumps and fan coil units shall have adequate isolation valves to allow replacement without a total system draindown.

All air handler units shall be provided with a single point of electrical hook up when appropriate to size or type. All other air handlers shall show all circuits and voltages necessary for fans, lights, etc.

BSRV.30.3 HEATING

BSRV.30.3.1 Sources

General: All steam, condensate, and MTHW systems shall have high performance lugged wafer butterfly valves with M-filled Poly Tetra Fluro Ethylene (PTFE) seat and seals and gear operator or high performance full port ball valves with carbon steel body, stainless steel ball and stem, and M-filled PTFE seat and seals on smaller lines.

Steam: Steam is available to most University of Virginia Health Systems (Hospital and Medical School) buildings at 180 psig. In many buildings in the Central Grounds, steam is available at 125 psig. However, all HPS and MPS piping shall be designed for 250 psig. Steam is generated year-round at the Central Heating Plant. Steam shall NOT to be used as primary building heat where medium temperature hot water is or can be made available. Steam or MTHW shall be used for summer humidity control where required.

Steam shall also be used for process use in laboratories, food preparation areas and domestic hot water generation systems.

(**BSRV.30.3.1** continued)
All uncontaminated steam condensate, including condensate from clean steam humidification systems must be returned to the system. Steam from the central plant shall not be used directly for winter humidification. Plant steam or MTHW may be used to make clean steam for humidification.

High Temperature Hot Water (HTHW): HTHW is available for the North Grounds area, and shall be used as the principal energy source for building heating systems for this area. Water temperature is normally 230 degrees Fahrenheit. Normal operating pressure is 120 psi. All HTHW shall be designed for the maximum operating temperature and pressure, 417 degrees Fahrenheit and 300 psi. The water temperature will be reduced to 190° in summer months.

Medium Temperature Hot Water (MTHW): The University maintains a MTHW loop originating at the Central Heating Plant. Much of the University of Virginia Health Systems area and Central Grounds area are served by this system. MTHW shall be used as the principal energy source for building heating systems in the Central Grounds. Water temperature varies inversely with outside air temperature from 190 degrees to 230 degrees, and leaves the heating plant at 125 psig leaving pressure. Piping shall be designed for 180 psi, 230 degrees Fahrenheit. Consult Facilities Management Utilities for MTHW reset chart, and to confirm the operating cycle in effect prior to beginning design.

Gas: Natural gas is generally available from the Gas Division of the Charlottesville Department of Public Works for distribution to the facility for which gas use is proposed. The gas meets the standards for pipeline quality gas. Natural gas piping systems within buildings shall be black steel. Outside distribution piping shall be approved plastic. Lateral piping, valving into each new building and metering shall be included in the project, unless established otherwise. The Architect/Engineer must verify the capacity and pressure of the lines serving the area in which work is to be done. Gas piping systems shall be coordinated through Facilities Management Utilities to the Gas Division of the City of Charlottesville.

The use of electric resistance as the primary source of heat is not allowed.

BSRV.30.3.2 Materials

All duct reheat coils shall have access doors or panels to allow door inspection and cleaning of coil inlet.

a All HPS and HPR fittings shall be class 300 malleable iron, cast steel, or forged steel (not cast iron).

b Steam strainers shall be installed horizontally so condensate does collect in them.

(**BSRV.30.2.2** continued)

c Equipment traps shall have bypasses; drip traps shall not.

d Inverted bucket traps shall not be used. F&T traps are preferred for equipment loads and bimetallic traps are preferred for drip.

e Provide ¼" test ports with ball valves just up stream of the check valve after all steam traps.

f Specify pressure powered condensate pumps rather than electric where steam is available and there is no back pressure.

g All steam condensate lines shall be schedule 80 and all fittings on condensate lines shall be class 300.

h. All MTHW to LTHW converters and steam to LTHW converters shall have 90/10 copper/nickel tubes and brass tube sheets.

All boilers shall have low NOX burners.

BSRV.30.3.3 Controls

The secondary heating water for a building shall be between 90 and 190 degrees Fahrenheit for heating. A means of night, weekend, and holiday, setback control shall be provided on each converter for energy conservation purposes.

Hot water valves shall be three-way normally open.

BSRV.30.3.4 Building Distribution

Fan coil units, perimeter radiation, preheat coils, reheat coils, and all other heating in occupied spaces, shall use a secondary heating water generated in an exchanger in the building rather than one of the sources in BSRV.30.3.1 above. These secondary heating water systems shall be designed as part of a 4-pipe system rather than dual temperature systems.

Ethylene Glycol shall not be used. Propylene Glycol is acceptable.

In inpatient buildings and other critical buildings as specified provide valved and capped tees on the building steam system or LTHW loop for connection of a temporary boiler for emergency heat. The backup system shall be sized for all building loads, including domestic hot water, humidifiers, sterilizers, autoclaves, etc. Consult with the Project Manager, HSPP, and UVa Utilities for specific requirements.

BSRV.30.4 VENTILATION

BSRV.30.4.1 Sources

Outside air intakes shall not draw in exhaust air from adjacent systems, loading docks, parking lots, emergency generators, chemical storage, sewer manholes, or other external sources of noxious or toxic fumes. Outside air intakes shall be well enough above grade to discourage or prevent criminal contaminations.

BSRV.30.4.2 Materials

Internally lined duct is not permitted on University projects. Acoustical duct lining shall be epoxy or Mylar coated.

Duct elbows must have turning vanes or an inside radius of at least 1/2 of the duct width. Transition elbows are not acceptable.

Transitions from low to high velocity at outlet of air handling units shall be smooth and tapered. Outlet plenums that are the full size of the AHU or cooling coil, with small high velocity outlets, are not acceptable.

Mixing boxes, blenders, or equal are required where outside air and return air mix to prevent stratification.

Filters shall be provided on both sides of heat recovery devices. A window and light shall be provided to allow viewing of filters without stepping into the exhaust air stream.

Perforated returns shall not be used.

BSRV.30.4.3 Controls

Unless demonstrated not to be cost effective, controls such as occupancy sensors or carbon dioxide sensors shall be provided to minimize the flow of outside air (rather than full design flow) to rooms that are not occupied for periods of time.

All buildings shall have a nominal positive pressure. Positive pressure is to be maintained during all modes, but may be neutral if all exhaust fans are off. The total building shall maintain positive pressure wherein special use rooms, laboratories, etc. may require negative pressure.

Outside air dampers shall have feedback of actual position to the Energy Management System, or other means of confirming operation.

Outside air dampers shall have a full closed position as well as a minimum position for normal occupied mode.

(**BSRV.30.4.3** continued)
The "Hand" position of the HOA switch shall be configured so that after a fire the unit can run to evacuate smoke without the unit smoke detector tripping. Any connection to the building fire alarm system shall be hard wired, not through the DDC system.

BSRV.30.4.4 Distribution, General Exhaust

Plenum returns are not permitted above suspended acoustic tile ceilings. Plenum returns may by allowed in fully enclosed soffits for normal return air. Exhaust air must be fully ducted.

Individual exhaust fans in janitor's closets or single toilet restrooms shall not be used where central systems are available or reasonably achieved. If such individual exhausts are used, they shall be equipped with timers or occupancy sensors to turn fans off after an approved period of time.

Outlets of multiple exhaust fans shall not be manifolded together unless backdraft protection is provided.

All roof top exhaust systems shall be vertical up discharge.

Minimal exhaust requirements above code requirements are:

- Copy rooms - not less than 0.5 cfm per square foot.
- Areas with sinks and/or microwaves - 50 cfm each.
- Custodial rooms and rooms having mop or service sinks - 75 cfm each.
- Showers, bath tubs, whirlpools, spas, etc. - 50 cfm exhaust each; 50 cfm per person for fixtures designed for more than one occupant; unless demonstrated that less exhaust is required due to diversity.
- Electrical and communications closets - shall be exhausted.
- Battery charging rooms – not less than 0.5 cfm per square foot.

Electrical or computer equipment shall be cooled to temperature recommended by equipment manufacturer. Exhaust, or return if approved, shall be provided near heat producing equipment such as freezers, refrigerators, icemakers, cold drink machines, incubators, autoclaves, etc.

Kitchens shall be supplied with tempered make-up air in the summer. Supply air shall be tempered per code requirements, or be drawn from adjacent dining rooms.

BSRV.30.4.5 Fume Hoods

Hoods and hood exhaust systems shall be either variable air volume with sensors and controls as necessary to modulate exhaust airflow as the sash is moved, or constant volume with heat recovery and night/ weekend/ holiday/ proximity airflow setback.

(**BSRV.30.4.5** continued)
Phoenix controls, when justified for procurement, shall only be used in labs that have fume hoods, and where it is acceptable for the number of lab air changes per hour to be reduced when the fume hood sash is closed and when proximity sensor allows reduced hood airflow.

See GENERAL REQUIREMENTS, **GR.3.18** Environmental Health and Safety.

If lab air changes must remain constant, a constant volume supply air system shall be used along with constant volume bypass type hoods.

In labs with fume hoods combine all exhausts from each lab into a single duct provided with an airflow measuring station before connecting to the building exhaust system.

Controls for fume hoods shall be included in Division 17 of the Specifications.

BSRV.30.5 AIR CONDITIONING

BSRV.30.5.1 Sources

Central chiller plants provide chilled water to many of the University of Virginia Health Systems buildings and several portions of the Grounds. All air conditioning shall use chilled water from a University central plant unless another source is approved by the Facilities Management Utilities and Operations Departments.

At the earliest stages of planning, the Architect/Engineer shall contact the University Director of Utilities through the Project Manager in writing to request the availability of plant-chilled water for a particular site. The written request shall specify the required tons of cooling, location, and date required.

If chilled water is not currently available to a site, but is planned to be available by the completion of a project, then that project shall be designed to utilize plant-chilled water.

If central plant chilled water will not be available when needed, a water chiller should be provided for multi-zone systems; DX or window air conditioners may be utilized only for single zone systems. The proposed cooling system shall be submitted for approval to the Facilities Management Operations Department at the schematic or earliest stage of design.

Glycols and other heat transfer fluids shall only be used in limited systems such as heat recovery loops, or thermal storage systems that serve only a single central station AHU.

(**BSRV.30.5.1** continued)
Water-cooled condensing units using domestic, potable water on a single-pass cycle are prohibited.

BSRV.30.5.2 Refrigeration Systems

Installations shall be complete with dryers, sight glasses, thermostatic expansion valves and thermostatically controlled solenoid valves for pump-down operation (except for capillary tube units). Refrigerant liquid and suction piping shall be type "K" hard-drawn copper. Suction lines shall be insulated. The need for defrosting is not limited to electrical units. In larger installations, hot gas defrost is required. Installation shall be provided with necessary protective devices, including, but not limited to, electrical overload devices, low suction-pressure cutouts, high head-pressure cutouts, phase protection low lube-oil pressure cutouts, oil traps, crankcase heaters, anti-cycling timers and head pressure control.

Main piping fittings for dryers, sight glasses, expansion valves and controls shall be flared. A nitrogen purge shall be maintained while soldering all joints. Copper-to-copper joints between compressor and condenser shall be made with silver solder. Refrigerant systems shall be evacuated to 29.5 inches (water) gauge vacuum and held for at least 24 hours under this vacuum prior to charging the system with refrigerant. Facilities Management shall approve refrigerant.

Refrigerant sensors, which can detect small leaks, are preferred to oxygen deprivation sensors.

The choice of air-cooled versus water-cooled condensers will depend on the size of the unit and its location. The choice of hermetic versus open-drive compressors will depend on the size of the unit and its application.

When refrigerant systems greater than 4 tons are removed, specifications shall state that Facilities Management Operations will remove the refrigerant, and that the contractor shall not demolish the equipment until notified in writing by Facilities Management Operations that the refrigerant has been removed.

BSRV.30.5.3 Materials and Equipment

If copper is used, a dielectric joint shall be used where the copper joins the University ductile iron chilled water distribution pipes. Copper chilled water lines shall be type L hard drawn .

Chilled water distribution piping inside buildings shall not be polyvinylchloride (PVC) pipe.

See SITE WORK, **SW-35.3** Exterior Domestic Water and Chilled Water Piping.

Chilled water lines shall be wet tapped with resilient seat gate valve at connection point to main.

Pumps shall be enclosed in a waterproof insulated metal box, constructed of minimum 18 gage galvanized or stainless steel. Box shall be screwed to facilitate easy removal and reinstallation.

Chilled water coils shall be sized for 42-degree supply water temperature and 62 degree return water temperature at peak load conditions. During off peak conditions it is acceptable for the return water temperature to be above 62 degrees.

Chilled water coils shall be sized for a maximum face velocity of 475 feet per minute.

Cooling coil casings and drain pans shall be stainless steel. All structural supports, etc. in air handling units immediately downstream of humidifiers shall be stainless steel.

Cooling tower fan blades shall be aluminum.

Cooling tower fans shall have variable frequency drives (VFDs).

Condenser water pumps shall have VFDs unless an engineering and economic analysis indicates that they are not feasible, or are not in accordance with manufacturers recommendations.

Cooling tower make-up water shall be filtered.

BSRV.30.5.4 Controls

Chilled water loads shall be variable volume utilizing two-way control valves.

Building (tertiary) chilled water pump controls shall be designed per **Figure BSRV.30-1** at the end of this Section.

BSRV.30.6 COOLING COIL CONDENSATE

BSRV.30.6.1 Removal

Cooling coil condensate shall be piped to a French drain if it can be coordinated with landscaping. If not, pipe to a sanitary drain.

BSRV.30.6.2 Materials

Cooling coil condensate lines shall be minimum 1-1/4 inch diameter ID.

BSRV.30.6.3 Controls

Pumped condensate systems shall not be used.

BSRV.30.6.4 Building Distribution

Cooling coil condensate lines shall have cleanouts that allow access of all branches of the condensate drain system.

SAMPLE

COMPONENT COORDINATION (scope of work/responsibility matrix)						
	Device	Furnished By	Installed By	Power Wiring	Control/ Interlock Wiring	Fire Alarm Wiring
	Air Handler Devices					
1	Duct Smoke Detectors	16000	15000	N/A (from FA system)	N/A	16000
2	Duct Smoke Detector Auxiliary Contents	16000	16000	16000	17000	16000
3	Smoke Dampers at AHU's	15000	15000	N/A	17000	N/A
4	Smoke Damper Actuators at AHU's	15000	15000	16000	17000	N/A
5	Fire Dampers	15000	15000	N/A	N/A	N/A
6	Air Flow Stations	17000	15000	N/A	17000	N/A
7	Automatic Control Dampers (unless specified with unit)	17000	15000	N/A	17000	N/A
8	Automatic Control Damper Actuators	17000	17000	17000	17000	N/A
9	Variable Speed Drives	15000 or 16000	16000	16000	17000	N/A
10	Humidifiers	15000	15000	16000	17000	N/A
11	Humidifier Control Valve	15000	15000	N/A	17000	N/A
12	Humidifier Isolation Valve	17000	15000	N/A	17000	N/A
13	Humidifier Airflow Switch	15000	15000	N/A	17000	N/A
	VAV and Terminal Units					
14	Supply & Exhaust Terminal Boxes (VAV's)	15000	15000	16000	17000	N/A
15	Terminal Flow Pick-up	15000	15000	N/A	15000	N/A
16	Terminal Damper Actuator (if not provided by box manufacturer)	17000	15000	N/A	17000	N/A
17	Terminal DDC Controller	17000	15000	16000	17000	N/A
18	Terminal Reheat Valves	17000	15000	N/A	17000	N/A
	Laboratory Controls					
19	Supply, Hood Exhaust & General Exhaust Air Valves	17000	15000	N/A	17000	N/A
20	Controls at Fume Hood	17000	17000	16000	17000	N/A
21	Isolation Room Controls	17000	17000	16000	17000	N/A
	Meters					
22	Water Flow Meters	17000	15000	16000	17000	N/A
23	Electrical Demand Meters	16000	16000	16000	17000	N/A
24	Steam Flow Meters	17000	15000	16000	17000	N/A
	Digital Control Panels					
25	DDC Panels if shown on Electrical Drawings	17000	17000	16000	17000	N/A
26	DDC Panels if **NOT** shown on Electrical Drawings	17000	17000	16000 if 120V	17000	N/A
	Control Air					
27	Air Compressor	17000	15000	16000	N/A	N/A
28	Air Dryer	17000	17000	16000	N/A	N/A
	Water Systems					
29	Hydronic Control Valves	17000	15000	N/A	17000	N/A
30	Water Flow Switches for Chiller	15000	15000	16000	17000	N/A
31	Cooling Tower	15000	15000	16000	17000	N/A
	Miscellaneous Systems					
32	Refrigerant Monitoring	17000	17000	16000	17000	N/A
33	Split System (Heat Pumps, etc.)	15000	15000	16000	17000	N/A
34	Chemical Feed Systems	15000	15000	16000	17000	N/A
35	Kitchen Hood System	15000	15000	16000	16000 or 17000	16000

Fig. BSRV.30-3

BSRV.40 FIRE PROTECTION SYSTEMS

BSRV.40.1 GENERAL

In buildings requiring sprinklers, fire pumps or fire protection standpipes, a separate backflow for fire protection shall be provided. Fire protection service shall not be through the domestic metered water system.

BSRV.40.2 FIRE PROTECTION SPRINKLERS

BSRV.40.2.1 Application

In addition to required building codes, automatic fire suppression sprinkler systems:

- Shall be used in new buildings, additions and renovations of existing buildings, consistent with University administrative policy.
- Shall provide a sprinkler head above each landing of all stairwells

BSRV.40.2.2 Installation, Inspection And Acceptance

Fire department building and riser connections shall be coordinated through the University Office of Environmental Health and Safety Fire Safety Officer. The location of Post Indicator Valves and Fire Alarm Control Panels shall be approved by the authorized person from the Charlottesville Fire Department, or appropriate jurisdiction for projects not located on University Grounds.

In buildings of two or more stories, risers shall occur in each exit stair with fire department hose connections at each level.

Specifications shall indicate that following the completed installation Facilities Management or its independent consultant will inspect the installation prior to final inspection and acceptance by the State Fire Marshal, and report any deficiencies.

BSRV.40.2.3 Standpipe and Hose System

Standpipes and fire valve cabinets shall be provided. Renovations of spaces that have fire hose cabinets shall remove hoses.

BSRV.40.2.4 Fire Protection Specialties

The University provides portable fire extinguishers.

Fire extinguisher cabinets shall be specified.

BSRV.40.2.4 (continued)
Tops of cabinets shall be mounted level with the door head and the bottom not higher than 44 inches above the finished floor.

BSRV.40.3 PROTECTION DURING CONSTRUCTION

In renovation projects where the building is to remain occupied during construction, the following measures shall be included in the contract documents:

All operational standpipes are to be maintained at all times

Sprinkler systems in areas being renovated shall be fully operational when the contractor leaves the site each day. A fire watch shall be provided at all times that a sprinkler system is inactive.

BSRV.50 ELECTRICAL SYSTEMS

BSRV.50.1 SERVICE AND DISTRIBUTION

BSRV.50.1.1 Power

The University purchases electric power for its main Grounds from Dominion Virginia Power, distributing power from University-owned substations through underground duct bank systems to secondary distribution points. New services shall be connected to the University's distribution system. Where existing services are connected directly to Dominion Virginia Power, renovation and addition projects shall convert these services to the University's distribution system.

Transformer vault rooms on Grounds may contain either Dominion Virginia Power or University-owned transformers. The Project Manager and/or Architect/Engineer shall determine ownership through the Facilities Management Utilities Department.

The University’s primary electrical service voltages are 12,470 volt and 4160 volt, 3 phase, 60 hertz. However, there are areas throughout the University that have direct service from the Virginia Dominion Power at voltages varying from 120 volts to 34,500 volts.

Some areas of the University Grounds have spare ductbanks for future electrical expansion. Due to previous agreements, Dominion Virginia Power does have lines in excess of 600V that are direct buried on University property.

A description of the areas and buildings served by each University-owned substation is available from Facilities Management Director of Utilities.

BSRV.50.1.1 (continued)
Where new buildings are added to the University's primary feeders, or a substantial change to an existing structure is made, submit a calculation at the contract document submission showing the existing load on the feeder, new load and feeder capacity.

BSRV.50.1.2 Transformers and Primary Switches

All new or replacement transformers in the existing 4,160-volt service shall have: dual primary taps for 12,470/4,160 volts.

All primary transformers shall have copper windings. Primary taps shall be sized for 600A conductors.

Internal tank fuse links or fuses are prohibited. All primary overload protection shall be external to the transformer. All buildings shall be fed with two primary feeders, where dual primary feeders are available. Transformers serviced with dual feeder configuration shall have a separate external fused 15 KV selector switch.

Exterior transformers shall be pad mounted, liquid-filled type with the following characteristics:

- Live front, spade-connected type
- Temperature rise of 55°/65° C
- OA cooled
- Where exterior pad-mounted transformer and/or switches are used, Facilities Management in consultation with the Architect for the University shall approve their locations.

- Interior transformers shall be dry-type with the following characteristics:
- Temperature rise of 115 ºC maximum
- HV BIL of 95 kV
- A cast primary and either a vacuum pressure impregnated (VPI) or cast secondary is preferred
- AA cooled with at least the provisions for FA cooling.

As an alternative, a silicone or other less-flammable liquid-filled transformer (as defined by NEC 450-23) may be used indoors. The liquid shall be Factory Mutual approved. Transformer characteristics shall be the same as for exterior liquid-filled transformers.

Electrical services for research facilities shall be designed utilizing a double-ended transformer configuration with a secondary tiebreaker. They shall be designed with manual override on the breaker. Dual transformers shall be designed to permit replacement of either unit without disturbing the other transformer.

BSRV.50.1.3 Distribution

BSRV.50.1.3 .1 Primary Cable

- Shall be copper, listed for 15 kV service
- Type MV-105, insulated to 133% insulation level, 220 mils. EPR is preferred
- All cable shall be suitable for use in wet or dry locations
- Shielding may be either a copper tape shield or corrugated drain wire system
- Cable shall be identified by phase markings on the outer jacket at intervals not to exceed two feet
- Cable shall be installed in concrete encased underground ductbanks and electrical vaults. Direct burial of primary cable (>600V) is not allowed.

BSRV.50.1.3 .2 Terminations

- All manhole medium voltage cable splices shall be made with re-connectable modular splice kits that meet ANSI/IEEE Standard 386-1995.
- In manholes and other accessible enclosures, wrap individual primary cables separately with fire retardant tape.

BSRV.50.1.3 .3 Ductbanks

- Shall use six-inch Schedule 40 PVC conduit for runs between manholes. Ductbanks runs from last manhole to primary switch may use 5-inch conduits.
- Shall be a continuous concrete structure with reinforcing. Reinforcing shall be minimum four corner bars (#4 or larger depending on ductbank size) and #3 stirrups at 48” o.c. for small and 36” o.c. for large ductbanks.
- Top of ductbank shall be a minimum of 24” below finished grade
- Shall slope to drain to prevent accumulation of water in the ductbank, and shall not have any low points.
- A utility marker tape shall be buried 12” above each ductbank.
- A mandrel shall be pulled through all ductbanks prior to cable installation.
- Concrete for ductbanks and manholes shall have a minimum compressive strength of 3,000 psi at 28 days, meeting requirements of ACI 318 and ACI 301.

BSRV.50.1.3 .4 Manholes

- Minimum of eight feet by eight feet by six and one-half feet high
- Minimum 3'-0" diameter frame and cover opening for access from outside
- Shall be waterproofed with coal tar bitumen
- Covers in paved areas shall be sealed
- Shall have 18" x 18" x 12" deep corner sump. Floor to slope gently to sump. Sump shall be drained through percolation (improved if required with stone filled pit) or through a drainpipe sloped to daylight with the end protected against rodent entry.
- Manhole shall be equipped with a ladder.
- A ground rod shall be provided at each manhole. Ground rod penetration shall be watertight.
- Precast manholes shall not have more than two sections. The joint between sections shall be sealed watertight.
- All construction including vocer shall be HS 20 traffic rated

BSRV.50.2 BUILDING INTERIOR SYSTEMS

BSRV.50.2.1 General

Electrical equipment and circuits shall be marked and labeled for identification purposes in accordance with the NEC. Laminated nameplates shall be used on the exterior surfaces of all electrical equipment. Junction and pull boxes may be labeled using a black indelible marker. Receptacles and devices are to have a label on the back of the coverplate. Labels for equipment served from a generator shall be a different color than those on normal power. Emergency light fixtures shall be identified by a red dot/circle on the frame.

Conductor color-coding shall match the existing building convention. If none exists, the phase colors for 120/208V systems shall be red, blue and black. The phase colors for 277/480V shall be yellow, orange and brown.

The following calculations shall be submitted with contract document drawing submissions: building short circuit, building load, feeder voltage drop, and generator load calculations. Where generator requires stepped load starting, the load sequence, time delays and how the stepping will be achieved shall be indicated on the drawings.

BSRV.50.2.2 Demolition

All wire shall be removed back to the last active device, junction box or panelboard. All exposed and/or accessible conduits and boxes shall be removed.

BSRV.50.2.2 (continued)
When telecommunications systems are replaced, abandoned wire and cabling shall be removed with walls and ceilings restored to their pre-existing condition. Coordinate with University Information Technology and Communications personnel through the Project Manager.

The contractor shall coordinate the disposal of PCB ballasts and fluorescent lamps through the University Project Manager.

BSRV.50.2.3 Panels, Switchgear and Transformers

Building switches and switchgear shall be located in appropriate electrical rooms. Switches (and other electrical equipment) will be permitted, by exceptions, on the exterior of buildings. Approval for exterior switches, based upon drawings submitted for review, is required from the Director of Facilities Planning and Construction prior to completion of the contract documents.

Service conductors from transformer to building shall be concrete encased. Reinforcing shall be provided for large and/or lengthy runs.

Bussing shall be copper. Separate neutral and equipment grounding busses shall be provided. Loadcenters are not permitted.

Schedules shall be provided for all electrical construction involving panelboards and switchboards. The panelboard schedule shall, as a minimum, provide the information shown in **figure BSRV.50.1**. Schedules shall indicate all loads, and their locations using final room numbers, served by each breaker. Spares shall be left in the OFF position.

Provide transient voltage surge suppression (TVSS) at main switchgear (for new buildings and major renovations).

A copy of the one line diagram shall be permanently mounted near the main switchgear. For renovation projects changes to the one line diagram shall be added and posted.

All new panelboards shall have spare capacity for future use. Provide four 1-inch conduits stubbed out into an accessible ceiling space for new recessed mounted panelboards.

Dry-type transformers shall have copper windings. Transformers shall meet or exceed the requirements of NEMA TP-1 for energy efficient transformers.

K-factor transformers shall be used where large quantities of harmonic producing loads are present.

BSRV.50.2.4 Metering

Metering shall be installed in each building main switchboard as a minimum. Separate metering for large loads, such as chillers, may be required.

Metering shall be digital, with the following features as a minimum:

- True rms metering through the 31st harmonic
- Real-time readings for current, voltage, real power, reactive power, apparent power, power factor, frequency, THD and k-factor
- Demand readings for current, power factor, real power, reactive power and apparent power
- Energy readings for real, reactive power
- RS-485 comm port
- 0.2% accuracy class
- Alarm/relay functions
- On-board data logging
- Date/time for each min./max.
- Downloadable firmware

Meter shall have KZY pulse output tied to building automation system and be setup to accommodate kilowatt-hours at the Systems Control Center.

Meters shall be installed and operational prior to connection to utilities. Accuracy of meters shall be verified and corrected if necessary, within 10 working days of connection to utilities.

BSRV.50.2.5 Conduits and Wiring

Minimum conduit size shall be ¾". Flexible metal conduit not exceeding 6-feet in length shall be used only for connections to lighting fixtures and equipment. All empty conduits shall have a 65-lb test polymer (or equivalent) pull string tied off at both ends.

All conduits shall be concealed in finished areas. Surface mounted raceways may be used for horizontal distribution of electrical and data cabling in computer rooms, computer classrooms and research laboratories. Pre-existing conditions of surface mounted wiring and conduit does not constitute permission to add surface mounted hardware and raceway.

All wiring shall be run in conduit, surface metal raceway or cable tray. Conduit from the communications or control wiring (under 50V) wall outlet box may terminate several inches above the ceiling where lay-in ceiling tile is used. Cabling above the ceiling shall be neatly bundled and attached to or independently supported from the building structure above. Wiring, conduit or cable shall not be laid on the ceiling system or attached to the ceiling suspension wire. Support from the building structure.

BSRV.50.2.5 (continued)
All conductors shall be copper with 75 ºF insulation or better. All power conductors shall be #12 AWG or larger. Minimum control wires shall be #14 AWG and minimum signal wire no smaller than #18 AWG unless otherwise recommended by manufacturer.

All new circuits shall have a green equipment-grounding conductor sized per NEC 250.

No more than eight (8) current-carrying conductors shall be run in a single conduit.

BSRV.50.2.6 Devices

Ground fault circuit interrupter outlets or breakers are required on all power outlets within 6-feet of water sources. Where the presence of water or grounded surfaces contributes to a hazardous environment, ground fault protection is required.

All devices shall be 20A, heavy-duty specification (minimum) grade devices. Residential grade devices are not permitted. All receptacles used in the University of Virginia Health Systems (patient care and Medical School) shall be hospital grade.

Receptacles shall be mounted with the ground pole in the UP position unless otherwise directed.

BSRV.50.2.7 Lighting

The following energy conservation measures shall be used wherever possible:

- Building designs shall take maximum advantage of natural light. Ambient light sensors, dimmers and programmable controllers are to be used where cost effective.
- Occupancy sensors shall be used in rooms such as restrooms, single person offices, storage rooms, custodial or janitorial closets, etc.
- Unless impractical, occupancy sensors shall be used in conference rooms and classrooms.
- Multiple circuits/switching shall be provided in classrooms and other large rooms to permit reduced power consumption.
- Fluorescent or metal halide lamps shall be used for lighting. The use of incandescent lamps shall be limited to applications approved by Facilities Management.
- 12-hour timer switches are to be used to control lights in major mechanical rooms.

BSRV.50.2.7 (continued)
Fluorescent fixtures shall use T-8 or compact fluorescent lamps. Fluorescent lamps shall have a minimum CRI of 80. Lamp temperatures shall be 3500 ºK unless otherwise directed by the University Project Manager. All fluorescent ballasts shall be electronic except in areas where the usage requirements take precedence. Lamps are to be the low-mercury content, "green tip" type, passing the EPA test for non-hazardous waste.

Exit signs shall be red LED type with diffused lenses.

Non-catalog and custom lighting fixtures shall not be used unless economically justified and approved by Facilities Management.

Interior lighting levels shall comply with the recommended foot-candle levels found in IESNA Lighting Handbook, 8th edition. Lighting levels for mechanical and electrical rooms shall be 20-30 foot-candles. Lighting level for telecommunications rooms or closets shall be 50 foot-candles. The use of task lighting is to be maximized. The illuminance ratio for maximum to minimum light levels shall not exceed 10:1 in any occupied space.

Drawings and/or specifications shall require coordination and field verification to prevent obstructions by ducts and piping that either prevent the required illumination or reasonable access to re-lamp, maintain and replace the light fixture. For safety reasons light fixtures will be located at or around equipment so that maintenance personnel will not obscure the required illumination. Unless resulting from actions of the Owner or Architect/Engineer, the contractor or subcontractor's responsibility shall include relocation of a light or installation of additional light fixtures as required to meet these requirements

Foot-candle (fc) calculations for normal and emergency modes shall be submitted with the contract document submission. Design fc, IES illuminance category, and any weighting factors used, shall be indicated on the fc calculations. Submit fixtures cuts of all proposed fixtures at the preliminary design submittal. Submit any revised or added fixture cuts with the contract document submission.

Recessed light fixtures are to be suspended from the structure. Do not support solely from the ceiling suspension system.

The use of 2' x 2' light fixtures shall be limited to those areas that are architecturally appropriate.

The locations of light fixtures in mechanical spaces shall be field coordinated so that access to lights for relamping, maintenance and replacement is maintained with appropriate illumination levels.

See SITEWORK, **SW.20.2** Site Lighting.

BSRV.50.2.8 Motors and Starters

Motors ¾ hp and larger shall be 3-phase, using the highest available appropriate voltage. All such motors shall be equipped with permanently lubricated bearings.

All motors shall be high-efficiency type, with a service factor of 1.1 or better and shall meet the standards set forth in NEMA standard MG1-1993 revision 1 through 4, Table 12-10. All motors between 1 and 200 hp shall exceed these standards where possible and economically justified.

Sheaves and V-belts on belt driven equipment shall be rated for 150 percent of motor horsepower. Belts shall be guarded to provide safety protection, ventilation and cool operation. Solid sheaves and band belts shall be used to minimize vibration in multiple V-belt driven equipment.

All motors, except light-duty fractional horsepower motors, shall be provided with motor controllers. Controllers shall provide under-voltage protection when used with momentary contact control devices and under-voltage release when used with maintained contact control devices.

All motor variable frequency drives (VFDS) shall meet IEEE standard 519. Where multiple VFDs are fed from the same panel or MCC, the contractor shall provide a harmonic analysis, at that point, to show compliance with IEEE 519. Include analysis with drive submittals.

VFDS shall be pulse width modulated (PVM) type. VFDS shall be provided with by-pass isolation switches.

A lockable disconnecting means shall be provided at all motor locations.

BSRV.50.3 SPECIAL SYSTEMS

BSRV.50.3.1 Telecommunications

See GENERAL REQUIREMENTS, **GR.5.6** Information Technology and Communications.

The University owns its own telephone system and integrates its information technology and cabling for telecommunications under management by the Department of Information Technology and Communications.

BSRV.50.3.1 (continued)
Provide a system of conduits, outlet boxes, backboards, etc., to support the installation of cabling by others, unless otherwise directed by the Project Manager in writing. The conduit or raceway system shall be sized to accommodate the foreseeable uses of the building plus 25 percent. Outlet boxes shall be a standard 4" x 4" outlet box with single gang plaster ring. All buildings, including residential facilities, require information technology outlets, unless otherwise directed by Project Manager in writing.

The Project Manager will determine if there is any application, particularly in existing buildings, for telephone service from the local (non-University) telephone company.

Telecommunications rooms/closets shall have a minimum of two (2) 20A, 125V duplex receptacles. For the main room/closet, each receptacle shall be on its own dedicated circuit. For smaller, secondary closets, the dedicated circuit may serve both receptacles.

Sleeves through floor assemblies for conduit, cabling or other penetrations shall extend at least 1" above the finished floor.

In existing buildings the precise location of penetrations shall be marked on the site with an "X" mark on the floor or wall for review and approval by designated Facilities Management personnel prior to coring.

Provide a green grounding conductor back to the main service ground from each telephone backboard. Leave a minimum of 12" slack at the backboard for connection to equipment by others.

A lighting level of 50 foot-candles at 2'-6" above the floor shall be provided. Wall fixtures shall not be used unless it is demonstrated this level of light can be maintained, and done so without personnel working in shadows at equipment servicing locations.

See SITEWORK, **SW.20.8** Emergency Telephones.

BSRV.50.3.2 Cable Television

Cable television services shall be provided in University residential facilities. Cable connection is obtained from the holder of the local cable franchise or from a University system as coordinated through the Project Manager.

Provide a system of conduits, outlet boxes, backboards, etc. to support the installation of cabling by others unless directed otherwise by the Project Manager in writing.

BSRV.50.3.3 Security

The Architect/Engineer shall determine in consultation with the University Project Manager the application of security systems for each project. The issue of security is particularly applicable for computer operations, University of Virginia Health Systems facilities, residential facilities and exterior access doors.

The Architect/Engineer through the Project Manager shall consult the University of Virginia Police Department during the design of security systems to insure that the proposed system meets Police Department recommendations for compatibility with existing systems and the adequacy of the proposed design.

Card reader access systems shall be required at a minimum of one major, visible building entrance as coordinated with the University Police through the Project Manager. See GENERAL REQUIREMENTS **GR.5.3**, Card Reader Requirements.

Security alarm systems are monitored at either the University Police Station on Route 250 West or at the Systems Control Center in Leake Hall. In some circumstances, it may be more economical to utilize the capabilities of the JC-85 for monitoring security systems when the JC-85 is also being used for fire alarm monitoring.

However, the JC-85 shall not be used for security system monitoring in any instance where the building program requires the use of listening devices, video surveillance equipment or other similar devices. In such cases, a dedicated security surveillance system approved by the University Police Department shall be installed.

At a minimum, provide a system of conduits, outlet boxes, backboards, etc. to support the installation of a security system by others unless directed otherwise by the Project Manager in writing.

BSRV.50.3.4 Fire Alarm

The fire alarm system shall be intelligent device addressable, analog directing, low voltage and modular with digital communications techniques.

Where new devices will be added to an existing system, they shall match the types of, or be compatible with, the system already in place unless otherwise directed by the Project Manager in writing. Devices added to an existing system shall be able to communicate with the existing system regardless of manufacturer.

All buildings with fire alarm systems shall have either the fire alarm panel (FACP) or remote annunciator at the main entrance or other location approved by the local fire department.

BSRV.50.3.4 (continued)
All fire alarm systems in University facilities shall be monitored by the Facilities Management Systems Control Center (SCC). Minimally, any project should ensure that dry-type contact relay pairs are available from building fire alarm panel(s) for remote communication of alarm and trouble conditions. More outputs may be used or desired for alarms, for instance on a floor-by-floor basis. Near the time of project commissioning, the owner will provide suitable communication devices and interface into the monitoring system at SCC. The Architect/Engineer should check with representatives in the early stages of the project design to find out if there may be particular problems for the owner in establishing communications to any particular facility.

All wiring for new fire alarm/detection systems shall be installed in conduit.

The candela level for visual devices shall be indicated on the contract document drawings.

BSRV.50.3.5 Other

Other special systems such as nurse call, intercom, audio or paging shall be provided on a project-by-project basis.

BSRV.50.4 ELECTRICAL TESTING

All electrical systems shall be tested prior to acceptance. All testing shall be in accordance with the International Electrical Testing Association (NETA) Acceptance Testing Specifications; manufacturer's recommendations or other approved testing standards. An independent testing company shall perform testing. Contractor shall notify the testing agency when the systems are ready for testing. Copies of test reports and any recommendations shall be furnished to the Project Manager. Facilities Management shall be notified in advance of testing and shall have the option of witnessing any or all tests.

All testing of electrical systems of a capacity of greater than 30 kW must be coordinated at least two (2) working days in advance with the Department of Operations or the Health Systems Physical Plant, as appropriate and coordinated by the Construction Administration Manager. Testing may be required to be performed during off-hours.

BSRV.50.5 RECORD OR AS-BUILT DOCUMENTS

Electrical or "as-builts" documents shall contain the following information at a minimum:

- Location of all underground electric lines, telephone lines, manholes, pull boxes, etc.
- Location of all conduits in and/or under slab

BSRV.50.5 (continued)

- Location of all device boxes in slab
- Location/routing of all conduits greater than 1" and any associated pull boxes
- Location of all transformers, panelboards, switchgear, etc.
- Final one-line and/or riser diagram to include the final fuse sizes
- Final circuit numbers for all devices and final panel schedules
- Final manufacturer and make for all fixture types
- Exterior lighting information as detailed in SITEWORK, **SW.20.2**
- Final location of all exit and emergency lighting
- Final locations of all fire alarm devices, terminal cabinets, etc.
- Final locations of all telephone, and other low voltage system backboards

See GENERAL REQUIREMENTS **GR.11.3**, Project Record Documents.

PANELBOARD SCHEDULE

ANEL NO.	OLTAGE_____	ND. BUS _____	AIN BRKR. SIZE_____
	HASE _____	OUNTING_____	. L.O. SIZE _____
	IRE _____		RKR. MIN. KAIC_____

OAD DESCRIPTION	OAD (KVA)			RKR ZE	OLE	IRCUIT UMBER		OLE	RK ZE	OAD (KVA)			OAD DESCRIPTION
	∅	∅	∅							∅	∅	∅	
OTAL LEFT SIDE													OTAL RIGHT SIDE
OTAL RIGHT SIDE													
OTAL KVA				_____KVA									

OTES:

OTAL KVA = _____KVA = _____ A X _____%DF = _____ A
KV KV

Figure BSRV.50-1

BSRV.60 ELECTRONIC MONITORING AND CONTROLS

BSRV.60.1 GENERAL REQUIREMENTS

BSRV.60.1.1 Application

The University Systems Control Center (SCC) has been established to provide a high level of continuous computerized monitoring and control capabilities. SCC is located in the Leake (Facilities Management) Building at 575 Alderman Road.

Architects/Engineers are directed to utilize these existing systems for such monitoring and control. If it is determined that the University's existing systems do not meet project specific needs, the Architect/Engineer is to request the Project Manager to arrange discussions with SCC personnel to effect an appropriate solution.

Systems requiring some form of remote monitoring and/or control include, but are not limited to, heating, ventilation and air conditioning (HVAC), fire alarm and security systems. The extent and nature of any controls and/or monitoring systems shall be determined and submitted for approval in the Preliminary Design phase of the project.

Building automation systems (BAS) sensors used for energy monitoring shall be "matched" with a minimum accuracy of 1% so as to provide information suitable for billing.

In vivarium and other spaces as specified, local temperature and humidity displays that are also the controlling sensors shall be provided.

Critical safeties on HVAC systems shall be hard wired rather than controlled by the DDC system.

BSL-3 labs and other spaces as appropriate shall have a means to completely shut off the supply air if exhaust air is lost to prevent a positive pressure in the space. This shall be through a hard wired connection rather than through the DDC system. Bubble or gas tight dampers on the supply air may be appropriate in some situations.

Critical exhaust fans (Vivarium, BSL suites, rad hoods, perchloric acid hoods, etc) that run continuously should not have a start/stop function on the DDC system. Provide a manual hand/off/auto switch and failure alarm to the DDC. Where two fans are provided the "lead" fan will be in the "hand" position and the "lag" fan will be in the "auto" position so the DDC system can start the "lag" fan automatically upon a failure of the "lead" fan.

BSRV.60.1.1 (continued)

In buildings with critical loads as determined by UVa Facilities Management, all necessary components of the HVAC, control, and communications systems shall be on emergency power. If emergency power is not available in the building the chilled water pump bypass valve (V-3) and cooling coil control valves on critical loads shall fail open on the event of a power failure to allow free flow from the distribution system; chilled water valves on non-critical loads shall fail closed.

Smoke detectors shall have 3 sets of dry contacts for separate hard wired connection to the fire alarm system, the interlocked fan, and the DDC system.

BSRV.60.1.2 Bidding Procedures

The Architect/Engineer and University Project Manager, through the Facilities Planning and Construction Office of (construction) Contract Management, will prepare documents to negotiate with two proprietary BAS suppliers. Drawings and specifications shall be provided during the development of project working drawings, prior to finalization of the bid documents for the overall project. The BAS supplier proving to be the most suitable, considering the negotiated price for BAS functions, connectivity to existing systems, and other factors relative to the University's overall satisfaction with the project, shall be assigned the work and the bid documents shall include assignment of this negotiated price to all bidders.

In isolated exceptions, it may be more beneficial to permit bidders to select one of the approved systems, as would be the case with any other specified component while preparing bids.

BSRV.60.1.3 Division 17 Specifications Guidelines

Unless otherwise agreed in consultation with the University and the Systems Control Center, the following shall be included in the Division 17 specifications:

SECTION 17000

BUILDING AUTOMATION SYSTEM

I. GENERAL

A. VENDOR PROPOSALS

1. The University will solicit proposals for the work specified herein from the two BAS vendors that have previously been established to provide such systems. The University will subsequently evaluate the proposals, and the negotiated price for the work will then be assigned to the contract.

Note: This paragraph may be different depending on the method of BAS vendor selection used under the **Bidding Procedures** section above.

B. WORK INCLUDED

1. The work under this Section shall include furnishing all labor, materials, equipment and services necessary to provide the control systems as specified herein, and on the contract documents, including all required input/output, tubing and miscellaneous electrical and pneumatic appurtenances necessary for a complete and operational system.

2. Equipment connections involving magnetic controllers:

a. The provision for the branch circuit, the unit disconnect, connections (line and load) to the controller, and final connection to the equipment shall be as specified under Division 16.

b. All wiring associated with automatic controls from any BAS panel required to energize the controller holding coil shall be under this division.

3. Equipment connections involving three phase or single phase 208 volt or 480-volt manual motor controllers:

a. The provisions for the branch circuit, the unit disconnect, connections (line and load) to the controller, and final connection to the equipment shall be as specified under Division 16.

BSRV.60.1.3 (continued)

4. Equipment connections involving single-phase 120-volt equipment:

   a. Connections and the provisions for the branch circuit, the unit disconnect, unless supplied with equipment, and final connections to the equipment shall be as specified under Division 16.

   b. All wiring from the unit disconnect to automatic controls from any BAS panel shall be under this division.

II. PRODUCTS

A. SYSTEM HARDWARE

1. Acceptable Systems

   a. Johnson Controls Inc. Metasys Extended Architecture (Web based).

   b. Automated Logic Corporation WebCTRL System .

2. All BAS component hardware will be new, and will consist of the manufacturer's latest technology.

III. EXECUTION

A. INSTALLATION

1. The installation of all equipment shall be in strict accordance with manufacturer's instructions and installation book.

2. It is intended that, in general, the Division 17 Contractor will be responsible for all control sequences, both pneumatic and electronic. Critical safety interlocks which are not directly wired by the Division 16 sub-contractor, such as freezestats, high limit protectors, end switches etc., shall be directly connected, through wire or pneumatic tubing, so as not to depend on any digital control system " Sequence of Operation" to perform their safety function.

3. All pneumatic actuators, valves and dampers specified on the contract documents, or necessary for the control system to function as specified under Division 17 are to be furnished and installed under this section.

4. Automatic control dampers shall be furnished and installed under this division unless they are part of factory-assembled equipment.

BSRV.60.1.3 (continued)

5. All conduit, wiring, etc., to accomplish the sequence of operation in this section, shall be provided under this section. All electrical work performed under this section shall comply with the National Electric Code and Underwriters Laboratories where applicable, and shall be installed by licensed journeyman electricians.

6. Furnish to the Division 15 Contractor for installation, wells for any sensors that are to monitor water temperatures. Provide stainless steel separable wells.

7. Furnish to the Division 15 Contractor for installation, any sensors such as flow sensors, which are to be installed in water lines.

8. Furnish to the Division 15 Contractor for subsequent factory pre-mounting to the VAV boxes, all DDC VAV box controllers.

9. Air pressure indicating gauges 1-1/2" in diameter shall be provided at each BAS panel for indication of supply pressure, and each control pressure output.