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KCTCS DESIGN GUIDELINES

Revised 05/08/07

**Has not been converted to current CSI Format
Includes most recent HVAC Specs
Does not include IT Specs**

KCTCS DESIGN GUIDELINES – Revised Draft 05/08/07

Division 2 - Site Work

- 02510 WALK & ROAD PAVING:
Walks shall be constructed with a 4" DGA base, welded wire fabric and 4" thick concrete with non-slip surface. Service access to the facility may be over sidewalks designed to carry the additional loads.
1. Tactile warning shall be installed on all walks per ADA standards. This warning shall be poured integrally with the walk.
 2. Expansion joints and control joints shall be formed and tooled, not saw cut.
 3. Bituminous surfaces for the public drives and parking lots shall have a minimum of 8" compacted thickness DGA base course with a 2-1/2" bituminous base and a 1" bituminous surface. Speed bumps shall be integral to the paving. All shop aprons and service drives shall be paved with reinforced concrete on a suitable base.
 4. Ensure that all delivery route turning radii are sufficient to accommodate large trucks and tractor trailer rigs max legal length and sufficient space is available at docks for turning, backing, parking and leaving.
 5. Integral concrete curbs and gutters shall be installed around all lots and along drives. Profile shall be per KDOH Standards.
- 02720 STORM SEWAGE SYSTEM:
1. The site shall be graded to provide positive drainage to avoid localized flooding. Underground drainage should be evaluated. The consultant shall provide all drainage calculations used in storm water design for this project either in report form or on the final drawings. Criteria used in drainage calculations shall be placed on the drawings. Use a 100 year rainfall event as a minimum design criteria. Meet local restrictions where applicable.
- 02730 SANITARY SEWAGE SYSTEM:
1. The consultant shall provide criteria used in designing the sanitary system. Information is to be located on the site utility drawings. Meet all applicable state plumbing codes.
- 02900 LANDSCAPING:
1. The consultant shall include, in the contract documents, drawings and specifications for landscaping of the construction site, to include all property acquired for the development of this project. Special attention shall be given to providing a vision screen around overhead doors, delivery areas and service areas.

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2. Sod all areas disturbed by construction work. Less desirable, but acceptable, is the spreading of 4" of top soil, seed and mulch. If this method is selected, consider the possibility of using a seed/mulch matting over 4" of top soil. Disturbed areas shall have a minimum 3' wide strip of sod placed along the building and other hard surfaces.
3. Evaluate the installation of a lawn irrigation system. Break down the cost between full sprinkling of all planting areas and only around the building perimeter.
4. The architect shall examine the quality, and verify the type specified, of all planting material prior to placement in the ground.

Division 4 - Masonry

04200 UNIT MASONRY:

Concrete block should be used throughout shop and heavy use areas as interior partitions, stairwell partitions and corridor partitions unless indicated otherwise. Exposed concrete blocks to be laid in running bond pattern. All outside corners should have bullnose profile. Glass block and other design masonry materials will be considered.

All exterior wall construction using concrete block and brick shall be cavity wall with properly designed flashing systems, extruded polystyrene foam insulation, air space and moisture barrier on the face of the block.

Division 5 - Structural Steel

05120 STRUCTURAL STEEL:

Roof slope shall be designed in the structural system, minimum 1/4" per ft.

Structure shall be designed so that all classrooms and labs are clear-span.

05500 METAL FABRICATIONS:

1. Each roof level shall have access via a ladder. Ships ladder access is preferable.
2. All exterior railings shall be prefinished, polished aluminum or stainless steel.
3. Ensure that exterior canopy structures will not readily accommodate roosting fowl.

Division 6 - Wood and Plastic

06400 ARCHITECTURAL WOODWORK

1. All wall cabinets and shelving shall be securely mounted to the wall in such a way as to minimize the possibility of mounting screws pulling through the woodwork.
2. All wall cabinets, base cabinets and shelving systems shall be of wood construction and shall comply with the Architectural Woodwork Institute's "Architectural Woodwork Quality Standards".
3. All non-lab countertops shall have plastic laminate surfaces with backsplash.
4. All lab countertops, sinks and backsplashes shall be made of chemical resistant materials and of monolithic construction.
5. Refer to Division 12 for manufactured wood casework.
6. Hinges shall be specified and shall not be the totally concealed type. Drawer slides shall be commercial quality and specified.

Division 7 - Thermal & Moisture Protection

07200 ACOUSTICAL INSULATION

1. Provide adequate acoustical insulation to provide sound separation between:
 - Instructional and Mechanical Areas
 - Toilets and other areas
 - Library and other areas
 - Administrative areas and other areas
 - Student Center and other areas
 - Industrial Use Areas and Instructional Areas
 - Distance Learning & Teleconferencing Areas and Other Areas

07410 PREFORMED METAL ROOFING (for sloped roofs)

1. Provide a 20 year no-dollar limit written warranty, executed by the Contractor, Installer, and Manufacturer, agreeing to repair or replace units which fail in materials, workmanship or finish coatings within the warranty period. Failures include, but are not necessarily limited to, structural failures including excessive deflection, not being weather tight, deterioration of metals, metal finishes and finish coatings beyond normal weathering.
2. Preformed metal roofing shall be installed by the manufacturer or the manufacturer's authorized contractor.
3. Panels and accessories shall be fabricated at the factory to the greatest extent possible.

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- 07500 MEMBRANE ROOFING (for low slope design)
1. Provide a 20 year no-dollar limit manufacturer's warranty.
 2. Roof membrane shall be two-ply modified bitumen with granular surface, color to be selected. Provide modified bitumen for base flashings at curbs, parapets, etc. The entire system is to be designed to meet the manufacturer's requirements for a 20 year warranty. Other systems may be used, subject to the prior approval of the Owner.
 3. Provide minimum $\frac{1}{4}$ " per foot slope to drains (in the structure, if possible). Discuss during design phases.
- 07600 FLASHING AND SHEET METAL
1. Flashings shall be 16 oz. copper, 20 gauge aluminum, or 26 gauge stainless steel. Provide preformed interior and exterior corners, each leg a minimum 24" long.
 2. Parapet walls shall be provided with continuous pre-manufactured aluminum or steel coping with preformed interior and exterior corners, each run a minimum 10 ft. long, with concealed cleats front and back.
 3. All counter flashing shall be installed using built-in, cut, or cast-in reglets. No surface applied counter flashing will be accepted.
 4. All sheet metal work shall have a minimum 5 year warranty.

Division 8 - Doors & Windows

- 08100 METAL FRAMES & DOORS
1. All door frames shall be 16 gauge hollow metal. All metal doors shall be 18 gauge hollow metal. Metal doors shall be used in utility areas, Heavy Shop areas and as secondary exterior doors only.
 2. Doors which open into corridors shall be designed with alcoves or offsets to keep doors from opening into pedestrian traffic. Vision windows or sidelights are desirable.
- 08400 ENTRANCE AND STOREFRONTS
1. All primary exterior doors and window walls shall be aluminum with thermal break.
 2. Doors shall have medium or wide stile frames.
 3. Double doors shall have removable mullions.
 4. Primary entrance shall have one set of automatic doors.

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08500 METAL WINDOWS

1. Use energy efficient double glazed, tinted, thermal break, aluminum frame windows.
2. Provide for natural ventilation in all instructional spaces with exterior walls. The amount of natural ventilation should be sufficient to adequately ventilate the space.

08700 HARDWARE

1. All locksets shall be mortise type with lever handles. Cylinders and cores shall accommodate "Best" keying system, and will be provided by the general contractor.
2. Whenever possible, "touch bar", rim type exit devices will be used.
3. All closers shall be surface mounted. Concealed closers in frame head or floor will not be acceptable.
4. The hardware supplier/contractor will be responsible for a complete hardware schedule.
5. Classroom doors shall be lockable from the inside using latchsets which automatically unlock at the twist of the lever handle.

08331 OVERHEAD COILING DOORS

1. All overhead doors shall be insulated and factory painted.
2. Doors shall have both chain operation and electric motor operation.
3. The electric door operator shall be designed so that the operating button must be continuously depressed through the opening cycle. If the button is released, the door will stop.
4. All current safety requirements shall be met. This includes OSHA requirements.
5. Air curtains shall be installed in conjunction with all overhead doors that will be opened and closed frequently. Discuss during design.

Division 9 - Finishes

09250 DRYWALL

1. Provide USG 093 control joints with a maximum spacing of 40 feet. Contractor shall verify locations with the architect.
2. If gypsum board is permitted for use in classrooms or corridors use board with fiber reinforced face.

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09310

CERAMIC TILE

1. Ceramic tile on the walls in the restrooms shall run floor to ceiling.
2. Ceramic tile shall be provided for restroom floors. Subfloor should be constructed to provide a level surface with corridor floor when ceramic tile is in place.
3. Provide stone thresholds between restroom floor and corridor floor. Provide stone that is uniform in color and finish, fabricated to sizes and profiles required to provide transition between adjoining finished floor surfaces.
4. Ceramic tile shall be sealed with a fluid applied waterproofing. This waterproofing shall be a polyurethane rubber-based liquid membrane material, self-bonding to normal substrates, compounded specifically for the application method to be used. The compound shall have not less than 92% solids and a six-month shelf life in uncured state and shall meet the requirements of ASTM C 836.

09400

TERRAZZO

1. All corridor, lobbies and other high traffic areas shall have terrazzo floors, budget permitting.

09510

ACOUSTICAL PANEL CEILINGS

1. All acoustical tile shall be 3/4" thick regardless of tile size (preferably 2' x 2'), and the back of the tile shall be foil-backed and sealed for protection from moisture penetration.
2. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edge of each ceiling.
3. All sprinkler heads shall be positioned in the centers of ceiling tile.
4. Avoid use of less-than-half-width units at borders.
5. Suspend ceiling hangers from building structural members.
6. Architect shall provide a reflected ceiling plan in the architectural drawings.

09660

RESILIENT TILE FLOORING

1. All resilient tile flooring shall be 12" x 12" vinyl or rubber, 1/8" gauge.
2. Require the resident inspector and the tile installer to thoroughly inspect subfloor surfaces prior to installation. A satisfactory subfloor surface is defined as one that is **level**, clean and free of cracks, holes, ridges, coatings, etc. that prevent adhesive bond and affect performance or appearance of the tile.
3. Tile used in this project must come from lots or models that are in production

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on the date of bid. No old lots or out of stock tile will be permitted.

4. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room are of equal width. Tile shall not span control or expansion joints.
5. If rubber treads are used in stairs, provide matching rubber floor tile on landings. The rubber treads shall have a cleanable tactile surface, including the first tread on the landing. The rubber landings shall have a smooth surface.
6. Provide a transition strip between rooms and corridors, for full width and depth of jamb opening using solid vinyl, solid color.
7. The Owner will provide product data for stripper and wax to be used on the tile floors by the contractor prior to final inspection.

09678 **BASE**

1. Provide a hard surface type base for all areas, i.e. ceramic tile, glazed block, etc., unless otherwise noted in the room data sheets.
2. If resilient base is indicated, specify rubber base only. Provide base with pre-molded inside and outside corners, in maximum lengths practical. Base material shall be 1/8" thick. For long runs of base, use continuous length material.

09680 **CARPETING**

Carpeting recommended to meet the following specification (vinyl cushion tufted textiles) Soft Surface Floor Coverings.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

General Conditions, Supplementary Conditions and Division 1 of these specifications apply to the work specified in this section.

1.02 DESCRIPTION OF WORK

- A. Work includes but is not limited to providing installation labor, VCTT, floor mats, installation materials, installation accessories and moldings as noted in the Drawings and as specified in the following text.
- B. All bidders shall quote in accordance the exact specifications as detailed in this document. Any proposed substitutions to this specification must follow strictly to the specifications contained within this document and must be presented for prior approval according to the conditions detailed under Substitutions.

1.03 REQUIREMENTS FOR APPROVAL

- A. Manufacturer shall submit ten (10) days prior to Bid documentation showing a minimum of fifteen (15) years experience in the manufacture of this type of product described within.
- B. Submit ten (10) days prior to time of Bid Manufacturer's product specifications, product testing reports, and other required documents referenced within this text.
- C. Submit ten (10) days prior to time of Bid any proposed substitutions for consideration. Reference the SUBSTITUTIONS section of this document.
- D. Submit ten (10) days prior to time of Bid two (2) 13" x 18" finished samples of each type of proposed VCTT in the quality, pattern, and color proposed.
- E. Submit ten (10) days prior to time of Bid two (2) twelve (12) inch long pieces of specified molding and two (2) samples of all and any special treatment materials.
- F. Submit ten (10) days prior to time of Bid at least five (5) names of installations that have been in use for ten (10) years using vinyl backing technology as described in this document. Include contact names and phone numbers.
- G. Submit ten (10) days prior to time of Bid installation shop drawings showing areas to be VCTT, seam locations, moldings, edge strips, and details of all special treatments.
- H. Prior to VCTT delivery, submit copies of the reports specified within the PERFORMANCE ASSURANCE section of this document.
- I. Prior to installation, submit the Manufacturer's installation instructions for all products and styles.
- J. Prior to job installation, submit Manufacturer's maintenance instructions including cleaning equipment specifications and type, spot cleaning methods, and cleaning cycles.

1.04 SUBSTITUTIONS

- A. All bid submittals must conform to the specifications contained in this document.
- B. Any and all substitutions must be manufactured of the same basic type of materials, meet or exceed all specified requirements of the product, and be submitted with all requirements contained within this document.
- C. Any substitutions made and not fully detailed by the submitting party can cause a refusal of the bid product.
- D. Submit ten (10) days prior to time of Bid any proposed substitutions for consideration.

1.05 INSTALLATION QUALITY ASSURANCE

- A. Flooring contractor to be a specialty contractor normally engaged in this type of work and shall have prior experience in the installation of these types of materials.
- B. Flooring contractor to provide references.
- C. Flooring contractor must be certified by the Manufacture.
- D. Flooring contractor will be responsible for the proper product installation, including floor testing and preparation, in those areas indicated in the Drawings. The MAXIMUM amount of moisture evacuation from the floor is 3.0 pounds of water per 1,000 square feet in a 24 hour period. The acceptable floor pH range is between 7.0 and 9.0. Contractor is responsible for floor testing.
- E. Flooring contractor to provide owner a written installation warranty that guarantees the completed installation to be free from defects in materials and workmanship for a period of one (1) year after job completion.
- F. Manufacturer to provide a representative to assist in project start-up as required by the job. Manufacturer will notify Owner, Architect, General Contractor, or another designated contact if any installation instructions are not followed.

1.06 JOB CONDITIONS

- A. Sub-floor preparation is to include all required work to prepare the existing floor for installation of the product as specified in this document. Sub-floor preparation shall meet all conditions as specified in the Manufacturer's installation instructions.
- B. Sub-floor preparation will include, as required, the removal and repair of the existing floor surface. It is recommended that the sub-floor of a renovation project be inspected by the installer prior to the time of bid.
- C. All materials used in sub-floor preparation and repair shall be recommended by the VCTT manufacturer or shall be chemically and physically compatible with the VCTT system being bid.
- D. Site conditions shall include those specified in the VCTT manufacturer's installation instructions and shall also include area heat, light and power required for effective and efficient working conditions.
- E. Provide unobstructed spaces for VCTT installation including removing and replacing furniture and equipment in the installation area.

1.07 DELIVERY AND STORAGE

- A. Deliver all material to the installation site in the Manufacturer's original packaging. Packaging to contain Manufacturer's name, product name and identification number, and other related information.

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- B. All materials should be stored in a cool (above 65° F and below 90° F), dry location, safe from damage and soiling. Stack rolls horizontally no higher than two (2) high on a flat surface. Materials must be conditioned per installation instructions prior to installation.
- C. Materials must be available for inspection as required by the Owner, Architect, General Contractor, or Manufacturer.

PART 2 – SUSTAINABLE REQUIREMENTS

Vendor/Supplier must provide a statement describing how its manufacturing processes, installation methods, and products are consistent with the United States Environmental Protection Agency's Environmentally Preferable Purchasing Program.

PART 3 – DESCRIPTION OF RECYCLING & RECLAMATION PROGRAMS

Vendor/Supplier shall provide a complete description of its recycling and reclamation program to recycle carpeting recovered from facilities. Program description shall inform and include the following:

- A. Description of reclamation process.
- B. Vendor/Supplier's location(s) of recycling operation(s).
- C. Description of recycling operation.
 - 1. Operations current daily capacity in pounds
 - 2. Source(s) of raw material feed stock
 - 3. End products produced
 - a. Recycled products produced as a percentage of total output
 - b. Percentage of recycled-content products that are carpet
 - c. Percentage down-cycled into alternate product(s)
 - 4. Vendor/Supplier must state whether or not any or all used carpeting that Vendor/Supplier has ever supplied to purchaser will be accepted back for recycling.
 - 5. Vendor/Supplier must state whether or not any or all used carpeting provided for purchaser's facilities by another manufacturer will be accepted for recycling.
- D. Manufacturer must provide a warranty that carpeting returned for recycling shall not be incinerated, landfilled, or disposed of in any way. Extraction of embodied energy by incineration is not acceptable.
- E. Recycling program must be available for inspection. **This program shall not consist of incineration.**

PART 4 - PRODUCT

4.01 WARRANTY - VCTT

- A. Provide a standard, printed, non-prorated warranty from the Manufacturer. All warranty items to be full term, not pro-rated, for the indicated period. If the product fails to perform as warranted when properly installed and maintained, the affected area will be repaired or replaced at the discretion of the Manufacturer.

The term of the VCTT warranty shall be NO LESS THAN 20 years and shall cover against:

1. Excessive surface wear.
Excessive wear means more than 15% loss of pile fiber weight measured before and after use.
 2. Edge ravel.
 3. Zippering.
 4. Backing delamination.
Backing delamination is defined as separation of the secondary backing from the primary backing.
 5. Watermarking on any product not 100% loop construction.
Watermarking means an apparent color difference between areas of the same VCTT due to permanent pile reversal with random differences in pile lay direction and differences in the amount of light reflected by VCTT fibers.
 6. Excessive static electricity.
Excessive static electricity means more than 3.0 kilovolts when tested per
AATCC 134 at a relative humidity of 20% and a room temperature of 70°F.
- B. Chair pads are not required for VCTT warranty coverage.
- C. All VCTT warranties to be sole source responsibility of the Manufacturer. Second source warranties or warranties that involve parties other than the Manufacturer are unacceptable.
- D. VCTT warranties will be official standard documents, not customized, and shall not be created on a job by job basis.
- E. VCTT selected, including all components, shall be 100% recyclable. Floor coverings selected shall be recycled at the end of their useful life in an environmentally responsible program and warranted not to be land filled or incinerated. The full resource potential of returned material shall be utilized by reusing and recycling 100% of the returned VCTT into new, value-added products. No VCTT returned for recycling shall be land filled or incinerated.
- F. All VCTT warranties shall be signed and notarized by a company representative.
- G. Lifetime warranties ARE NOT acceptable. All warranties must

specify in writing the number of years covered by the manufacturer.

- H. Antimicrobials: The US Centers for Disease Control and Prevention (CDC) conducted a thorough evaluation of available literature on the use of antimicrobial treatments in carpeting and other consumer products. CDC found no epidemiological evidence to substantiate manufacturers' claims of health benefits from the use of such products.

Antimicrobial treatments are registered with EPA as preservatives of the carpet only, and no health benefit should be claimed or expected. Therefore, except for carpets that, in the opinion of the manufacturer, are constructed in such a manner or of such materials that these treatments must be added in order for the carpet to have reasonable performance expectations, we do not recommend that manufactures be required to add these treatments.

4.02 PERFORMANCE ASSURANCE - GENERAL

- A. Flammability Requirements (See Section 2.03)

The VCTT product when tested with its attached backing, as represented by averages of testing from random samplings of production lots, must meet flammability requirements for the following nationally recognized Building Codes for floor coverings:

- BOCA National Building Code
- NFPA 101 Life Safety Code for Safety to Life in Buildings and Structures
- Standard Building Code (SBC)
- Uniform Fire Code (UFC)

- B. Face Fiber Characteristics (See Section 2.04)

Continuous Filament Nylon (CFN) type 6,6.

- C. Stain Inhibiting (See Section 2.04)

Stain inhibitor applied to the product during manufacture to resist fiber staining and soiling.

- D. Backing Characteristics (See section 2.04)

1. Thermoplastic vinyl composite.
2. Fully fused to provide for no delamination.
3. Closed cell, vinyl cushion backing.
4. Backing system to provide a barrier to moisture penetration.
5. Product to provide for a chemically welded seam.

- E. Adhesive System Characteristics

1. VCTT as installed to be securely attached to the floor in compliance with Americans with Disabilities Act (ADA), Section 4.5.3.

2. Product to be installed without the use of wet adhesives.
3. Products supplied with a cured Microencapsulated Tackifier applied to the back at the time of manufacture are preferred.

F. Environmental Impact Characteristics

1. Product, inclusive of adhesive, to comply with the 1994 State of Washington protocol. The product, when tested as manufactured (no air-out period required), shall pass the protocol as written and shall have the following characteristics:
 - a. Less than 0.05 ppm (part per million) of formaldehyde.
 - b. Less than 0.50 mg/cubic meter of total volatile organics.
 - c. Less than 50 ug/cubic meter of total particulates.
 - d. Less than 1.0 ppb (part per billion) 4-PC.
 - e. Test over a 96 hour time period.
 - f. Submit compliance table.
2. VCTT to be delivered with a recycle bag for recycling of the plastic film used to protect the Microencapsulated Tackifier.
3. All VCTT products must pass the University of Pittsburgh protocol for toxicity being "no more toxic than wood" when burned under the same conditions.
4. VCTT to be a reduction barrier to radon flow.
5. VCTT to provide asbestos enclosure properties.
Enclosure means an airtight, impermeable, permanent barrier around ACBM (Asbestos Containing Building Material) to prevent the release of asbestos fibers into the air.
6. VCTT to be installed without the use of wet adhesives.
7. Company to have an in-place, operational recycling program for product (at the end of its useful life) and manufacturing waste. Program shall recycle 100% of the product in the same operation. **This program shall not consist of incineration.**

4.03 PERFORMANCE ASSURANCE - TESTING

- A. Test reports shall be submitted for all performance assurance specifications listed below.
- B. Requirements listed below must be met by all products.
- C. All submitted test numbers shall represent average results for production goods of the referenced style.
- D. Required Test Reports
 1. Flooring Radiant Panel
ASTM E-648 or NFPA 253: Class 1 (CRF greater than 0.45 Watts/Sq Cm)
 2. Backing Cellular make-up: Closed cell
Microscopic - As manufactured

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3. Backing Cellular make-up: Closed Cell
Microscopic - After 50,000 Phillips Chair Cycles
4. VOC Chamber Testing Results
ASTM D 5116: Passing 1994 State of Washington Protocol
5. University of Pittsburgh Protocol (LC-50) for toxicity: "no more toxic than wood" when burned under the same conditions.
6. Radon Flow Barrier Testing - Certified Lab
Flow Reduction Barrier
7. Moisture Barrier
Moisture Penetration by Impact at SEAMS @ 10 psi: No penetration after 10,000 impacts
**The British Spill Test IS NOT an acceptable measurement for moisture barrier.
8. Air Permeability of Textile Fabrics: No air flow (0.0 cubic ft. /min)
9. Seam Integrity after Phillips Chair Test:
Seam to remain intact after 50,000 cycles
10. Delamination of Secondary Backing of Pile Floor Coverings
ASTM D-3936: No delamination
11. Vetterman Drum Test: Minimum 3
12. Lightfastness
AATCC 16E: Min 4 after 100 AFU
13. Static Propensity
AATCC 134: 3.0 KV or less
14. Static Coefficient of Friction
ASTM C-1028: Passes ADA requirements
15. Backing Density
ASTM D 1667: 18.5 lbs/cu ft +/- 5%
16. Backing Compression Set
ASTM D 1667: Max - 10%
17. Backing Compression Deflection
ASTM D 1667: Min 7 lbs/sq in at 25%

4.04 MANUFACTURING SPECIFICATIONS

A. General Specifications

1. Product Name – See *attached*

2. Product Type –Closed Cell Vinyl Cushion Backing
 3. Product Style Number – *See attached*
 4. Product Color Number – *See attached*
 5. Total Product Weight – No greater than 20-ounce face weight.
- B. Face Construction
1. Construction – NO LESS THAN 100 stitches per square inch
 2. Width - Six (6) feet
 3. Gauge – NO LESS THAN 12th Gauge
 4. Face Weight – NO MORE THAN 20 ounces
 5. Pile Height Average – No GREATER THAN 0.156 inches
 6. Pile Thickness – *see attached*
 7. Fiber System – Nylon continuous filament only
 8. Dyeing Method – Solution or Yarn died
- C. Backing System
1. Primary Tufting Substrate - Synthetic Non-woven
 2. Sealant Coat (Pre-Coat) - Sealant Vinyl
 3. Backing Type - Closed Cell Vinyl Cushion ONLY
 4. Backing Weight - 35.5 oz/sq yd
 5. Backing Density - 18.5 lbs/cu ft
 6. Backing Thickness - 0.156 inch
 7. Backing Compression Set - max 10%
 8. Backing Compression Deflection - min 7 lbs at 25%
 9. Installation Adhesive System – Factory supplied or applied adhesive with no detectable VOC's. A cured Microencapsulated Tackifier applied to the back at the time of manufacture is preferred.
- D. Product Notes
1. Product specifications are derived from averages resulting from normal manufacturing tolerances in fiber, yarn, temperature, humidity and color and may vary within normal industry and standardized testing tolerances.
 2. These specifications reflect mean averages based on tests of production runs of this VCTT style by testing laboratories. A range of variances is implicit in the testing. Furthermore, the standard test methods established to derive these specifications lack a high degree of precision and repeatability and therefore, individual test results on the actual VCTT purchased may vary above or below the mean average.
 3. Colors may vary slightly from dye lot to dye lot.
 4. Backing or other materials may be changed without prior notice when shortages occur or when technological advancements become available which provide for improvement of the product's performance.

PART 5 - EXECUTION

5.01 PRE-INSPECTION AND PREPARATION

- A. All floors must be inspected and approved by a manufacturing

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representative and the installation contractor prior to installation of VCTT.

- B. There will be no exceptions to the provisions stated on the Manufacturer's installation instructions.

5.02 INSTALLATION

Product installation to proceed as specified in the Manufacturer's installation instructions.

5.03 PROTECTION AND CLEANING

- A. All rubbish, wrappings, debris, trimmings, etc. to be removed from the site and disposed of properly.
- B. All usable scraps of VCTT should be left for use by the owner.
- C. VCTT to be completely vacuumed using a beater brush/bar commercial vacuum after installation.
- D. VCTT to be protected as needed from damage from other trades.
 - 1. Require the resident inspector and the carpet installer to thoroughly inspect subfloor surfaces prior to installation. A satisfactory subfloor surface is defined as one that is **level**, clean and free of cracks, holes, ridges, coatings, etc. that prevent adhesive bond and affect performance or appearance of the carpet.

09705 RESINOUS FLOORING AND SEALERS

- 1. Provide self-leveling, non-slip epoxy flooring system that includes an epoxy primer/sealer, 100% solids epoxy resin mortar, topped with a clear high performance urethane coating. Areas of use will be indicated in the Room Data Sheets.
- 2. Floors to receive epoxy coatings are not to receive sealer of any kind.**

09900 PAINTING

- 1. No epoxy paint shall be used on this project, with the exception of the epoxy floor finishes in various laboratories.
- 2. All exterior surfaces to be painted shall be painted with exterior acrylic satin enamel.
- 3. All interior surfaces to be painted shall be painted with interior acrylic satin or low gloss enamel.

Division 10 - Specialties

10100 VISUAL DISPLAY BOARDS

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1. Furnish all marker boards and tackboards by a single manufacturer.
2. Provide and install white markerboards and tackboards in all spaces indicated on the room data sheets.
3. Provide tack boards in main corridors at locations to be determined during design.

10155 TOILET COMPARTMENTS:

1. Provide toilet and urinal partitions in the restrooms. Partitions shall be wall mounted, floor supported, and overhead braced. Partitions shall be constructed of solid phenolic material. No metal partitions shall be permitted.

10410 BUILDING DIRECTORY:

1. A directory shall be provided for each building and shall be located in the main lobby. The directory should contain a graphical representation of the building and be backlighted.

10420 BUILDING PLAQUE:

1. A building plaque shall be provided. It shall be located near the main building entrance. Plaque contents will be provided by the Owner during Phase "C".

10430 EXTERIOR SIGNS:

1. Provide a main campus entrance sign.
2. Signage shall be designed to KCTCS standards and submitted to the KCTCS signage committee for review.
3. The sign shall be externally illuminated.

10440 INTERIOR SIGNS:

1. Room identification and number signs for all openings will be provided and installed by contractor. Identification signage shall be interchangeable.
2. The consultant is responsible, with the Owner's approval, for the numbering system as outlined hereafter.
 - Each space addressed to a corridor shall be given a number designation.
 - Auxiliary spaces addressed to a larger room shall be given a letter designation, i.e., 201A, 201B, etc.
 - The space designations used on the drawings shall become the permanent space identification numbers. Care shall be taken to use a logical numbering pattern during design.
3. All interior signage shall conform to the Commonwealth of Kentucky's "Interior Signage Standards for State-Owned and Operated Facilities" (copy

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included in this program), and current ADA requirements.

10522 FIRE EXTINGUISHERS:

1. Provide fire extinguishers of the proper rating and quantity as required by code, in recessed cabinets.

10800 TOILET ACCESSORIES:

1. Restrooms shall have the following accessories:
 - Paper towel recessed waste disposal unit only. College to provide dispensers.
 - Toilet tissue dispensers: should be coordinated with College, vendor may supply.
 - Grab bars
 - Sanitary napkin disposal units
 - Soap dispensers: should be coordinated with College, vendor may supply.
 - Mirrors
 - Electric hand dryers: should be coordinated with College.
 - Coat hooks and book shelf in each toilet compartment

Division 11 - Equipment

11130 PROJECTION SCREENS

1. Projection screens for all spaces shall be part of the base bid.
2. Screen operation and mounting type shall be as indicated on the room data sheets.
3. The size requirements for each screen shall be determined by the consultant.
4. Provide motorized projection screens only in high ceiling rooms or those designated as executive conference rooms.

Division 12 - Furnishings

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12302 MANUFACTURED WOOD CASEWORK

1. Unless requested by the college, casework for laboratories shall be of wood construction with wood veneer for all exposed surfaces.
2. All drawers and storage areas shall have chrome label holders and keyed locks.
3. Countertops for all labs shall be modified epoxy, cast in a resin material.

12510 BLINDS

1. The contractor shall provide and install blinds for all windows. Both interior and exterior views of the windows shall be considered in the color selection. Blinds in areas with projection equipment should be selected for room darkening capability.

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12690 FLOOR MATS & FRAMES

1. At each public entrance provide recessed entrance walk-off mats with aluminum frames. These mats should be easy to clean.
2. At corridor entrances to industrial labs, provide some type of recessed mat to clean shoes prior to exiting labs into corridors. These mats should be easy to clean.

Division 14 - Conveying Systems

14240 HYDRAULIC ELEVATOR

1. Elevator(s) shall be sized to allow for the movement of furnishings, equipment and supplies throughout the building.
2. Elevator shall comply with all applicable codes, including ADA.
3. Provide full maintenance service by skilled competent employees of the elevator installer for a period of 12 months following date of final completion. Include monthly preventive maintenance, performed during normal working hours.
4. The elevator should be on the emergency generator circuit.
5. Provide corrosion protection for the cylinder.

14630 BRIDGE CRANE

1. Refer to Room Data Sheets for location(s) of bridge crane(s), if any.
2. Any bridge crane required shall have a minimum 2 ton and a maximum 5 ton lifting capacity. Specific sizes will be listed on Room Data Sheets.

Division 15 - Mechanical

15010 BASIC MECHANICAL REQUIREMENTS

1. The HVAC system for this facility shall not be so complex that it cannot be effectively operated by a person inexperienced in mechanical systems operation.
2. Contractor shall provide all necessary preventive maintenance work on the HVAC system for one year from substantial completion. Manufacturer's authorized service for major system components is to be available within 24 hours.
3. **When there are significant savings opportunities, provide Phase "A" proposals for energy conservation and recovery systems, i.e. geothermal.**
4. Water filtration shall be added for both domestic water and boiler usage. The filter shall be easily changed and of a type that is readily available for replacement.
5. Provide written agency approvals for any deviation or variance from codes, standards, etc.
6. Refer to room data sheets for specific information and requirements for each space.
7. All major floor mounted equipment subject to vibration is to be mounted on a concrete inertia pad (4 inches minimum thickness). Provide additional vibration isolation as required.
8. Provide utility markers for all utilities.
9. Contact all utility providers whose service is to be used for this project. Determine their requirements, make all required submittals and obtain the required approvals. The consultant is responsible for compliance with the provider's comments and requirements.
10. Provide valving at all utility branch lines for flexibility and isolation.
11. The gas pressure coming into the building needs to be verified to avoid mechanical problems later.

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15055

BASIC PIPING MATERIALS AND METHODS

1. No plastic (PVC) pipe is to be used inside any building or structure unless otherwise approved by the Division of Engineering. No plastic domestic water lines, hot or cold, will be permitted. Plastic pipe inside a facility will be reviewed and approved on a case-by-case basis.
2. Plastic pipe below a slab can be used provided:
 - Burial and back fill is properly monitored to insure proper installation.
 - Minimum schedule 40 pipe shall be used in all cases. If lines are going to be backfilled with an excessive amount of unknown material, schedule 80 should be considered.
 - All lines must be excavated and inspected if any heavy traffic should occur over them. This must be done before construction can continue.
3. No hub piping is acceptable above the ground level.
4. All water pipe must be Type L hard copper unless otherwise approved. Solder shall be lead-free for safety purposes. Type K should be used underground.
5. Provide dielectric couplings wherever dissimilar metals are joined. Particular care should be taken when piping penetrates metal walls.
6. Provide gas service to this campus. The gas service shall be sized to handle future campus expansions.
7. Plastic pipe for gas lines is acceptable with marker tape for location identification. The gas pipe is to conform to ASTM D 2513 Specification for Thermoplastic Gas Pressure Pipe.
8. Sewer and water lines through trees, unsettled areas, isolated locations, etc. should be hi-density polyethylene pipe.
9. Provide appropriate utility markers for buried lines.
10. Back flow preventers shall be installed where domestic water enters into any equipment water system.
11. Provide external, freeze proof wall hydrants.
12. Treated water systems shall be PVC plastic pipe with a circulation loop and minimal dead end sections.
13. No site pipe lines are run under the building, with the exception of building drainage systems.
14. List excavation materials as "Unclassified". Provide a unit price for unclassified earthwork as excavation.

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15. Provide concrete thrust blocks at all turns on appropriate buried piping systems. Do not allow joints, bolts, etc. to become inaccessible because of the placement of concrete.

15300 FIRE SUPPRESSION

1. Provide a 100% coverage fire suppression system.
2. Sprinkler systems are to be hydraulically designed by the consulting engineer. It is the responsibility of the consulting engineer to review the contractor's shop drawings, approve the drawings, and submit same to the Department of Housing Building and Construction for approval.
3. Halon systems will not be used.
4. Provide a method by which sprinkler systems can be flushed and drained.
5. The Engineer is responsible for the acquisition of required water flow information. All water flow information should be included on the drawings. Contractor confirmation would be desirable.
6. Sprinkler zones should be the same as fire alarm zones. These zones should be identified on drawings along with control valves, alarm switches, etc.
7. Provide an external water gong or similar alarm.
8. Provide freeze protection where the system is subject to freezing.
9. The post indicator valve and fire department connection are to be clearly labeled as to the building served.
10. State the building and sprinkler classification on the drawings.

15400 PLUMBING:

1. All plumbing fixtures are to be vitreous china, cast iron, chrome plated or stainless steel. No extended type lavatories are to be used. No gooseneck spouts or wrist blade handles, except in health laboratories, or as specified in Room Data Sheets.
2. Laboratory fixtures are to be chrome-plated brass.
3. Domestic hot water is to be generated using a large or multiple smaller gas fired unit(s).
4. If possible, eliminate the need for a domestic hot

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water recirculating system by clustering the hot water demand points near the hot water source. Small, point-of-use, instant water heaters may be used for limited remote locations.

5. Provide acid-resisting enameled cast iron utility sinks with a rim guard, or seamless terrazzo or acid-resisting enameled cast iron floor sinks with a rim guard and splash guard. Provide faucets with 3/4" hose thread, a supporting bracket and bucket hook. P-traps are to be cast iron, with rust protective coating, cleanout plug and grid starter.
6. Provide floor drains in mechanical spaces subject to spills, drainage or heavy cleaning. All blow down or drain lines shall be plumbed to a floor drain. Floor drains shall be located conveniently to prevent drain lines from crossing aisle ways or high traffic areas. Drains shall remain accessible.
7. Evaluate the use and reliability of automatic flush valves on all toilets, urinals, and sinks in restrooms. Direct wiring will be acceptable, coordinate with college if battery operated is preferred.

15500

HEATING, VENTILATING & AIR CONDITIONING

The K.C.T.C.S desires an energy efficient, low maintenance and quiet operating mechanical system. The use of alternate energy sources, i.e. geothermal, passive solar, etc., is encouraged.

The HVAC system shall have the capability of heating and cooling simultaneously with humidity control incorporated in system. We prefer staged multiple units to minimize operation down time in heating and cooling. All classrooms and lab spaces shall be individually control zones or their own independent HVAC unit. All offices shall have individual temperature control with thermostat for individual temp control. All classrooms, labs or other rooms and offices spaces within building shall have full range temperature control thermostats.

A boiler installation over 3,000,000 BTU / HR. must be reviewed by the Department of Energy as it would relate to burning coal. The information required is a 20 year life cycle cost analysis comparing a coal boiler with the proposed system. This information shall go through the Division of Engineering to the Department of Energy.

No rooftop units or electric resistance heat is to be used on this project without Division of Engineering approval.

Ventilation: Meet or exceed ASHRAE standards. There must be a minimum outside air of 20 CFM per person or 10% of the total supply air. All outside air must be dehumidified and conditioned before injecting into building space. Minimum humidity control range is 45% to 55%.

Chilled water coils should be located down stream of the heating coils. All

chilled water coils are to have modulating valves.

1. Testing and balancing shall be an allowance to the General Contractor. The general contractor will obtain 3 quotes for work from an independent certified air balance firm. Have the air balance firm approved by the consulting engineer and owner. Air and water balance requirements are to be included in the mechanical specifications. HVAC design engineer shall field verify all balance reports from air balance company.

Specifications should include the requirement for the balancing contractor to review site and drawing for any air related problems.

Provide a schematic diagram of the HVAC system, showing control points.

Keep all units on floor at walk in level access for servicing unless building design will not allow. When units are mounted above the ceiling, service space and access must be provided. Prevent pipe, duct, conduits, etc. from entrapping equipment.

This must be coordinated between the architectural and mechanical consultants.

All mechanical rooms must be properly ventilated. Mechanical ventilation is recommended in most areas. Proper work service area must be provided around all mechanical equipment.

Air quality concerns must be in accordance with ASHRAE-62.

Air intake and exhausts must be located so they are properly separated to assure acceptable air quality. No air intakes to located adjunct to generator, loading dock, garbage dumpsters, welding exhaust units, or welding gases.

2. The consulting engineer is responsible to work with the owner and contractor to obtain a construction and operating permit form the Natural Resources and Environmental Protection Agency. Any fee involved will be paid for by the Commonwealth of Kentucky.
3. The consulting engineer is responsible to obtain all approvals from the boiler inspection division as well as the Environmental Protection Agency.
4. Modular equipment installations shall be piped to allow removal of any one unit without disrupting operations.
5. Piping and boiler related equipment will be designed for easy removal within the boiler tube service space.
6. Provide a water meter in the make-up water line to the boiler.
7. The system design must minimize the potential of freezing.

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8. Include the following information, as it applies, on the drawings;

- Gross Floor Area
- Net Floor Area
- Design Conditions
- Heating Load
- Diversity Factor
- Boiler Capacity
- 2 or 3 Way Valves
- Major supply line sizes
- Duct air velocity range
- Gross Surface Area
- Thermal Transmittance
- Cooling Load
- Natural Gas/ Electric Requirements
- Chiller Capacity

9. All appropriate piping and equipment is to be insulated and identified with flow direction indicated.

10. All valves are to have an open / closed indicator.

11. Provide fittings and equipment as required for water treatment in all water systems any water loop that requires chemicals be added on regular bases to be of automatic type injection system that rates of flow can be set. Water treatment shall be the responsibility of the contractor during the warranty period.

12. The consulting engineer is to lay out all steam distribution lines and identify approximate expansion joint locations as well as guide and anchor locations (if applicable).

13. Steam piping shall be schedule 80 welded steel pipe for condensate return and minimum schedule 40 welded steel pipe for supply (if applicable).

14. Buried steam piping shall be insulated and protected from exterior corrosion. All insulation must be water tight (if applicable).

15. All chillers shall be factory tested and certified. Tests shall be witnessed by the consulting engineer and/or a representative from the Division of Engineering.

16. HCFC 123, HFC 134A and HCFC 22 are acceptable refrigerants for use on this project.

17. All chillers must have valves located so pipe section can be removed for access to chiller tubes. Bubble tight butterfly valves are acceptable. Use basic rubber sealed valves only.

18. Noise levels shall be identified in specifications. These values must be measurable in the field.
19. Energy consumption per ton shall be defined in specifications for certification test. ARI-550 IPLV shall be used unless otherwise approved by the Division of Engineering.
20. Chiller capacity shall be specified as follows:
 - Minimum
 - Maximum
 - Nominal
 - Acceptable tolerance range
 - Partial Loads (if critical)
21. An accessible, full size, in-line strainer must be placed in the chilled water lines.
22. Temperature and pressure gauges shall be included in all facilities.
23. All chillers shall have a refrigerant emission sensor furnished as part of the equipment.
24. All D.X. units with more than 30 feet of refrigerant lines must be approved by the manufacturer and the Division of Engineering.
25. Provide absorption material, shielding, isolation, etc. to insure that the cooling system operates without objectionable noise, vibration, or heat build-up.
26. Install start counter and hour meter for each compressor.

15890

DUCTWORK

1. Low pressure air systems are to be metal ductwork with external insulation. Flexible terminations are acceptable.
2. Flexible ductwork must be properly secured. A detail on the print is recommended that defines the following:
 - Duct will have inner and outer barrier films.
 - Barrier film will enclose fiberglass insulation and wire helix support.
 - Duct will be secured at both ends with a minimum of 2 screws catching at least one turn of the wire support.
 - Plastic or metal bands shall be used to secure all layers of material and sealed.
3. Provide access doors in all ducts for cleaning and servicing of coils, filters, fire and smoke dampers, movable dampers, controls, etc.
4. The consulting engineer is responsible to insure that all duct, piping, etc. fits into mechanical spaces. The engineer needs to show details in congested spaces and warn the contractor of such conditions. Access for service openings are to be shown on drawings.
5. The building shall have supply and return air ducts

from each space. Any variance from this must be approved by the Division of Engineering.

6. The outside air intake will be a minimum of 20 CFM per occupant or set at 10% of total air supply.
7. The consulting engineer will require that all wall and floor penetrations be sleeved or the openings be constructed to match the exact size of the duct. Sleeves in floors shall extend 1" above the floor, and all openings must be of quality for sealing and fire stopping.

All air handlers must have service space for removal of coils, etc. identified on prints with easy access to outside for change out of equipment and coils.

The bend radius on flexible duct must not be less than 2 duct diameters.

8. No fiberboard duct is to be used.
9. All insulated air handling units must be double wall. **No fiberglass insulation will be exposed to the air stream.**
10. All air handling units should have stainless steel, copper or galvanized coated drain pans. Drain piping must have an appropriate trap in-line and piped to a drain without becoming a hazard.

SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

GENERAL

1. RELATED DOCUMENTS

- a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

2. SUMMARY

- a. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- b. Related Sections include the following:
 - Division 15 Section "Sequence of Operation" for requirements that relate to this Section.

3. DEFINITIONS

- A. ARP: Address Resolution Protocol.
- B. ASC: Application Specific Controller.
- C. CAC: Custom Application Controller.

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- D. CSMA/CD: Carrier Sense Multiple Access/Collision Detect.
- E. DDC: Direct Digital Control.
- F. DDE: Dynamic Data Exchange.
- G. FTT: Free Topology Transceivers.
- H. GUI: Graphical User Interface.
- I. HVAC: Heating, Ventilation, and Air Conditioning.
- J. LAN: Local Area Network.
- K. MER: Mechanical Equipment Room.
- L. ODBC: Open Database Connectivity.
- M. PID: Proportional, Integral, Derivative.
- N. PES: Portable Engineering Station.
- O. POT: Portable Operator's Terminal.
- P. SNVT: Standard Network Variables Types.
- Q. SQL: Structured Query Language.
- R. UDP: User Datagram Protocol.
- S. UNC: Universal Network Controller.
- T. VAV: Variable Air Volume Box.
- U. I/O: Input/Output.
- V. PC: Person Computer.

4. SYSTEM PERFORMANCE

- a. Comply with the following performance requirements:
 - Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - Object Scan: Transmit change of state and

change of analog values to control units or workstation within six seconds.

- Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
- Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
- Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
- Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - Water Temperature: Plus or minus 1 F (0.5 C).
 - Water Flow: Plus or minus 5 percent of full scale.
 - Water Pressure: Plus or minus 2 percent of full scale.
 - Space Temperature: Plus or minus 1 F (0.5 C).
 - Ducted Air Temperature: Plus or minus 1 F (0.5 C).
 - Outside Air Temperature: Plus or minus 2 F (1.0 C).
 - Dew Point Temperature: Plus or minus 3 F (1.5 C).
 - Temperature Differential: Plus or minus 0.25 F (0.15 C).
 - Relative Humidity: Plus or minus 5 percent.
 - Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - Airflow (Terminal): Plus or minus 10 percent of full scale.
 - Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
 - Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
 - Electrical: Plus or minus 5 percent of reading.

5. SYSTEM DESCRIPTION

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- A. The network cabling is to be twisted shielded pairs. Cabling in air plenums are to be installed in conduit or be fire and smoke rated. Cabling installed in areas subject to damage are to be in conduit.
- B. The system communications should be transparent, meaning that the user of the control program does not need to know the details of system architecture and operation.
- C. Furnish all labor, materials, equipment programming, and service necessary for a complete and operating temperature control system, utilizing a high speed peer to peer network of interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphic displays available on at least 64 client computers, electronic interfaces and actuation devices, and as described in the contract documents. The number of user licenses shall be the same for Server Base, Client Base or Web Browser based software installations. Thus providing a seamless installation and interface for the owner.

Note: Selected vendor shall work with local IT department to secure open ports and IP addresses.

- D. The Local Area Network (LAN) shall be either a 10 or a 100 Mbps Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Universal Network Controllers (UNCs), user workstations and a local host computer system.
- E. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
- F. The system will consist of an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Both the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the two leading HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
- G. Where necessary or desired, LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth.
 - 1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide-lines for such encapsulation and shall be based on industry standard protocols.
 - 2. The products used in constructing the BMS shall be LonMark™ compliant.

3. In those instances in which Lon-Mark™ devices are not available, the BMS contractor shall provide LonWorks™ devices with application source code, device resource files, and external interface definitions.
- H. The software tools including cables and connectors required to network manage both the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that is required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet/Ethernet IP.
1. The supplied system must incorporate the ability to access all data using non specific version of Java enabled browsers without requiring proprietary operator interface and configuration programs.
 2. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage.
 - a. This data shall reside on a supplier-installed server for all database access.
 - b. Systems requiring proprietary database and user interface programs shall not be acceptable.
 - c. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
 - d. Systems employing a "flat" single tiered architecture shall not be acceptable.
- I. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of The Control Contractor. The Control Contractor shall have a minimum rated qualification of 15 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of The Control Contractor. Supplier shall have an in place support facility within 75 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.
- J. Provide a Portable Operator's Terminal (POT) color display personnel computer, software, and interfaces to provide uploading/downloading of Custom Application Controller and Application Specific Controllers databases, monitoring of all LonMark™ Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all

controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.

6. SUBMITTALS

- a. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- b. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and all other control devices.
 - Wiring Diagrams: Power, signal, and control wiring.
 - Details of control panel faces, including controls, instruments, and labeling.
 - Written description of sequence of operation, and either 1) programming ladder logic diagrams or 2) control logic block diagrams, fully populated with initial set point and control values.
 - Schedule of dampers including size, leakage, and flow characteristics.
 - Schedule of valves including flow characteristics.
 - DDC System Hardware:

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- Wiring diagrams for control units with termination numbers.
- Schematic diagrams and floor plans for field sensors and control hardware.
- Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
- Control System Software:
 - List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - Hard copy of each graphic screen proposed.
- Controlled Systems:
 - Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - Written description of sequence of operation including schematic diagram, and either 1) programming ladder logic diagrams or 2) control logic block diagrams, fully populated with initial set point and control values.
 - Points list.
- c. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks and BACnet standards.
- d. Software and Firmware Operational Documentation: Include the following:
 - Software operating and upgrade manuals.
 - Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - Device address list.
 - Printout of software application and graphic screens.
 - Software license required by and installed for DDC workstations and control systems.
- e. Software Upgrade Kit: For Owner to use in modifying software to suit future

systems revisions or monitoring and control revisions.

- f. Qualification Data: For Installer and manufacturer.
- g. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Include the following:
 - Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - Interconnection wiring diagrams with identified and numbered system components and devices.
 - Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - Calibration records and list of set points.

7. QUALITY ASSURANCE

- a. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project. The manufacturer is to be ultimately responsible for the installation quality and warranty.
- b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Bids by wholesalers and non-franchised contractors shall not be acceptable.
- D. The system manufacturer shall, as a minimum, manufacture and supply the Custom Application Controller, Application Specific Controller, and Graphical User Interface.
- E. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the direct employment of the temperature control system manufacturer.
- F. The Building Management System contractor shall have a full service facility within 75 miles of the project that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing LonWorks instructions and routine emergency maintenance service on all system components.
- G. Mechanical equipment manufacturers desiring to provide DDC type controls as factory mounted equipment shall provide a separate bid for their products less

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all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BMS contractor. All factory mounted DDC controls in pre-package form shall be capable of interfacing with all LonTalk and BACnet protocol meeting ANSI / ASHRAE Standard 135-2004.

- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- I. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems".
- J. Comply with National Electric Code, UL-916 Energy Management Systems, LonMark™, ULC, FCC Part 15, subpart J, Class B Computing Devices.
- K. Comply with EIA Standard 709.1 LonTalk™ protocol for DDC system control components.

8. DELIVERY, STORAGE, AND HANDLING

- a. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- b. System Software: Update to latest version of software at Project completion.

9. COORDINATION

- a. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- b. Coordinate with the Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses.

10. WARRANTY AND MAINTENANCE

- a. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion unless extended warranty by owner or mfg is greater then on year. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within forty-eight (48) hours standard working hours. Emergency service shall be available within twenty-four (24) hours.

11. OWNERSHIP OF PROPRIETARY MATERIAL

- a. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. All software licensing shall be made to the owner not the contractor or vendor, and such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All software shall be capable of adding other manufacture licensed vendors if of the same firmware. All project developed software, control software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

PRODUCTS

1. MANUFACTURERS

- a. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2. CONTROL SYSTEM

- a. Control system suppliers:
 - Only suppliers and vendors that can meet the requirements of guideline set forth will be considered.
- b. Control system shall consist of _____ sensors, indicators, actuators,

final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

- c. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

3. DDC EQUIPMENT

- a. Workstation server hardware station: IBM-compatible microcomputer with minimum configuration as follows:
 1. Operating System: Windows operating system will be furnished by owner.
 2. Chassis Type: 1U rack-optimized chassis or desktop server as requested by owner.
 3. Processor: (1) Intel® 3 GHz Xeon™ w/ 800MHz FSB and 1MB L2 Cache.
 4. Memory: 2GB Single Rank 333-MHz DDR ECC SDRAM (2x1GB modules).
 5. First Expansion Slot Riser: One (1) Low-Profile 64-bit PCI-X.
 6. Second Full-height Expansion Slot Riser (Choose One): One PCIe (x4) expansion slot.
 7. Hard Drive: (Total 3) 80GB SATA 7200RPM Hard Drive and RAID card.
 8. Hot-Swap SATA Drive Upgrade: Three (3) Hot-Swap SATA drive support.
 9. RAID Card: LSI MegaRAID 150-6 SATA PCI 64/66 RAID Controller.
 10. RAID Level: RAID Level to be specified by owner.
 11. Standard Disk Controller: Integrated dual port SATA controller (supports embedded RAID 0/1).
 12. Floppy Drive: 3.5" 1.44MB diskette drive.
 13. Optical Drive: 20x/48x IDE CDR-ROM.
 14. Server Management: Gateway Systems Manager.

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15. Video: Integrated PCI Graphics - 8MB.
 16. Modem: Modem only if requested by owner.
 17. Network Card: Dual PCI 10/100/1000 Twisted Pair Ethernet.
 18. Extended and On-Site Service Programs: 3Yr parts, labor, 1Yr on-site -- next business day limited warranty, 3Yr HW tech support.
 19. Server Installation Suite: Deployment services available, please contact your sales person for custom pricing.
 20. Rack Accessories: Tool-less slide rails and Cable Management Arm (CMA) (1533697).
 21. Monitor: VX755 17" Black Flat CRT Monitor (16.0" viewable).
 22. Keyboard: QWERTY, 105 keys in ergonomic shape.
 23. Mouse: Two button.
 24. Printer: One of the following printer styles will be selected by owner.
 - Provide a Printer Dot-matrix type Alarm Printer:
 - Print Head: 24 pin, 360 x 360 dpi resolution.
 - Carriage: Wide, 132 characters per line of paper.
 - Paper Handling: Fan-fold paper, with 2 cartons containing minimum of 2500 sheets each and two (2) printer ribbons or cartridges.
 - Print speed: Minimum of 120 characters per second.
- B. Provide printer color, ink-jet type.
1. Print Head: 1440 x 1440 dpi photo quality color resolution.
 - a. Internal Memory Buffer: 32KB.
 - Paper Handling: Minimum of 100 sheets.
 - Print Speed: Minimum of 8 ppm in black and 4 ppm in color.
- C. UPS (un-interruptible power supply) shall be installed at the server size for 50% spare capacity with sufficient capacity to allow emergency power for a minimum of 10 minutes backup.
- D. GUI Server Application Software: Include the following:
1. Input/output capability from operator station for monitoring and controlling all of the points listed in the input/output point list. The operator shall be able to monitor and access all points by means of

clear concise English names without having to understand or reference hardware point locations or controller programs.

- a. Operating System: The GUI shall run on Microsoft Windows XP Pro, NT Workstation 4.0, Service Pack 4, Windows 2000, or later.
- b. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- c. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

- Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
- Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
- Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
- Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

- Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
- Adjustments to analog objects,

such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

- System configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
 - Create, delete or modify control strategies.
 - Add/delete objects to the system.
 - Tune control loops through the adjustment of control loop parameters.
 - Enable or disable control strategies.
 - Generate hard copy records or control strategies on a printer.
 - Select points to be alarm-able and define the alarm state.
 - Select points to be trended over a period of time and initiate the recording of values automatically.
- On-Line help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- System diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- Alarm console.
 - The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and

- acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
 - Operator interface. Furnish PC-based workstation thick client. This workstation shall be able to access all information in the system. This workstation shall reside on the same high-speed network as the Building Controllers.
- E. Workstation communication shall adhere to the industry standard format IEEE 802.3 or EIA 709.1.
- F. Workstation: This IBM-compatible operator workstation and custom programming workstation shall consist of the following:
1. Processor: Intel Pentium III, 950 MHz, or faster.
 2. Random-Access Memory: 512 MB, minimum.
 - Cache Memory: 512kB.
 - Graphics: Super video graphic adapter (SVGA), minimum 1024 x 768 pixels, 4.0-MB EDO video memory.
 - Monitor: 17 inches (17.4 viewable, minimum), non-interlaced, color, with maximum 0.28-mm dot pitch.
 - Keyboard: QWERTY, 105 keys in ergonomic shape.
 - Floppy-Disk Drives: 1.44 MB.
 - Hard-Disk Drive: 40.0 GB, minimum.
 - DVD-CD ROM Drive: 12x max. variable DVD-ROM with software decoding.
 - Mouse: Two button.
 - 8X RW-CD, minimum.
 12. Operating System: Furnished by owner will be Microsoft Windows XP Pro, NT/2000 or version required for system operation.
- G. Web browser clients.

1. The system shall be capable of supporting 64 clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are only acceptable if 64 licensed copies of the client machine software are provided, installed, and tested.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall only be acceptable if 64 workstations or workstation hardware upgrades are provided.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - d. Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - e. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

- Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - View logs and charts
 - View and acknowledge alarms
- g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

H. Portable engineering stations.

1. Provide; uploading/downloading of Custom Application Controller and Application Specific Controllers databases, monitoring of all LonMark™ Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. PES connectivity shall be via digital wall sensor connected to controller.
2. The Portable Engineering Station shall use Visio and all programming shall be graphical.
3. The Portable Engineering Station shall be able to access any other controller on that segment of the LAN
4. Connection of a PES to the Custom Application Controller or Application Specific Controller shall not interfere with normal network operation in anyway that prevent alarms from being transmitted or centrally initiated commands from being executed.
5. If the PES cannot be used for both the CAC's and ASC's, provide, in addition to the PES, the separate color display personal computer(s), software, and interfaces required to provide full PES functionality for both the CAC's and ASC's.
6. Hardware for the PES shall consist of the following:

- a. Pentium IV processor or greater Operating system provided by owner.
 - b. Large 15" UXGA active matrix (TFT) display.
 - c. 512 MB 133 MHz SDRAM memory.
 - d. 60 GB internal hard drive.
 - e. Ethernet 10/1000.
 - f. Integrated 56 Kbps modem.
 - g. PCMCIA LON Card.
7. Functionality of the PES connected to any CAC or ASC shall include:
- a. Uploads and downloads of CAC and ASC controller databases.
 - b. Uploads and downloads of CAC and ASC LonMark™ SNVT NCI values.
 - c. Editing of LonMark™ SNVT NCI values for minor equipment operational parameters (including minimum on/off and delay times, changeover values, minimum position set points, etc.). All such mechanical equipment editable NCI values shall contain internal CAC and ASC Controller safety range limits to prevent accidental entry of out of range or invalid values.
 - d. Monitoring of all LonMark™ Standard Network Variables Types (SNVTs) including display of all bound SNVTs and test overrides of NVI SNVTs.
 - e. Monitoring and overrides of all controller physical input/output points including timed overrides that automatically revert back to their normal value.
 - f. Display of digital sensor values including diagnostics and calibration.
 - g. Editing of controller time/date.
 - h. Editing and overrides of resident controller time schedules.
 - i. LonMark™ information including program ID, Neuron ID, domain, subnet, and node.
- I. Control units general.
- 1. Provide an adequate number of control units to achieve monitoring and control of all data points specified and necessary to satisfy the sequence

of operation for all mechanical systems shown on the plans. Provide a minimum of one separate controller for each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all points associated with individual control loops are assigned to the same DDC controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. Each of the following panel types shall meet the following requirements.

2. Controllers shall be suitable for the anticipated ambient conditions.
 - a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non condensing.
 - b. Controllers used in conditioned ambient space shall be mounted in dustproof enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non condensing.
 3. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 4. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 5. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.
 6. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
 7. Automatic staggered restart of field equipment after restoration of power and short cycle protection.
- J. Universal network controllers (UNC).
1. The Universal Network Controllers (UNC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the UNC. It shall be capable of executing application control programs to provide:
 - a. Calendar functions.
 - b. Scheduling.

- c. Trending.
 - d. Alarm monitoring and routing.
 - e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization.
 - f. Integration of LonWorks controller data and BACnet controller data.
 - g. Network management functions for all LonWorks based devices.
2. The universal network controller must provide the following hardware features as a minimum:
 - a. One Ethernet Port – 10/100 Mbps.
 - b. Two RS-232 ports.
 - c. Two RS-RS485 ports electrically isolated.
 - d. One LonWorks Interface Port – 78KB FTT-10A with Weidmuller connector.
 - e. Power supply 24 VAC or 24 VDC.
 - f. Battery Backup.
 - g. Real-time clock.
 - h. Processor @ 200 MHz or greater.
 - i. 8 Mb flash memory for long term data backup. If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity.
 - j. 64 Mb Ram or greater.
3. The UNC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the UNC shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
 4. The UNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.
 5. Event Alarm Notification and actions.
 - a. The UNC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

- b. The UNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
- c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - 1. To alarm.
 - 2. Return to normal.
 - 3. To fault.
- d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e. security, HVAC, fire, etc.
- e. Provide timed (schedule) routing of alarms by class, object, group, or node.
- f. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- g. Control equipment and network failures shall be treated as alarms and annunciated.
- h. Alarms shall be annunciated in any of the following manners as defined by the user:
 - 1) Screen message text.
 - 2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - a) Day of week.
 - b) Time of day.
 - c) Recipient.
- i. Pagers via paging services that initiate a page on receipt of email message.
- j. Graphic with flashing alarm object(s).
- k. Printed message, routed directly to a dedicated alarm printer.
- l. The following shall be recorded by the UNC for each alarm (at a minimum):

- 1) Time and date.
 - 2) Location (building, floor, zone, office number, etc.).
 - 3) Equipment (air handler #, access way, etc.).
 - 4) Acknowledge time, date, and user who issued acknowledgement.
 - 5) Number of occurrences since last acknowledgement.
- m. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- n. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- o. A log of all alarms shall be maintained by the UNC and/or a server (if configured in the system) and shall be available for review by the user.
- p. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- q. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- r. An error log to record invalid property changes or commands shall be provided and available for review by the user.
6. Data collection and storage.
- a. The UNC shall have the ability to collect data for any property of any object and store this data for future use.
 - b. The data collection shall be performed by log objects, resident in the UNC that shall have, at a minimum, the following configurable properties:
 - 1) Designating the log as interval or deviation.
 - 2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
7. All log data shall be stored in a relational database in the UNC and the data shall be accessed from a server (if the system is so configured)

or a standard Web Browser.

8. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
9. All log data shall be available to the user in the following data formats:
 - a) HTML.
 - b) XML.
 - c) Plain text.
 - d) Comma or tab separated values.
10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Server, Oracle 8i or Express, Hyperion Solutions™ SQL Server.
11. The UNC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other UNC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - a) Archive on time of day.
 - b) Archive on user-defined number of data stores in the log (buffer size).
 - c) Archive when log has reached its user-defined capacity of data stores.
 - e) Provide ability to clear logs once archived.
12. Audit log.
 - a. Provide and maintain an Audit Log that tracks all activities performed on the UNC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the UNC), to another UNC on the network, or to a server. For each log entry, provide the following data:
 - 1) Time and date.
 - 2) User ID.
 - 3) Change or activity: i.e., Change set point, add or delete objects, commands, etc.
13. Database backup and storage.
 - a. The UNC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
 - c. Copies of the current database and, at the most recently saved database shall be stored in the UNC. The age of the most recently saved database is dependent on the user-defined

database save interval.

- d. The UNC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

K. Custom application control units.

1. Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. CAC's shall be provided for roof top units, boiler plant, chiller plant and other applications as shown on drawings and shall have published Lon-Works™ application source code, device resource files and external interface definitions
2. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.
3. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Peer to peer primary network level communications supporting at least 200 LonMark™ Standard Network Variables (SNVTs) per CAC utilizing at least 100 different SNVT types as documented by the LonMark™ Interoperability Association to assure present and future compatibility with third party LonMark™ devices. The 200 LonMark™ SNVTs, minimum, must be configurable in any combination – all inputs or all outputs or any combination of input/outputs in any combination of the 100 different, minimum, SNVT types. The XIF SNVT order shall be definable, rather than random, to provide logical and effective LonMark™ network management.
 - b. Automatic communications loss detection to maintain normal control functionality regardless of available network communications.
 - c. Discrete/digital, analog, and pulse input/outputs.
 - d. Monitoring, controlling, or addressing data points.
 - e. Local energy management control strategies
 - f. Incorporate internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to CAC's.

5. Communication: ASC's shall communicate with the Building Controller and CAC's at a baud rate of not less than 78.8K baud using LonTalk™ communications protocol (EIA 709.1).

M. ASC room sensor.

1. The ASC Sensor shall provide room temperature value to the ASC.
2. The ASC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller.
3. The ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
4. There shall be one ASC Sensor per floor wired so that the communication jack will provide for a connection to the LON communication trunk to which the ASC controller is connected.
5. By connecting to this ASC Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the Portable Engineering Station.
6. The ASC Sensor shall be supplied in the following manner:
 - a. LCD display for viewing up to four possible displays, each showing a current value in the ASC or on the network.
 - b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
 - c. LED indication of override state.
 - d. The room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:
 - 1) Subnet and Node Address
 - 2) Errors
 - 3) Alarms
 - 4) Temperature Offset

N. ASC – VAV controller functionality.

1. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV ASC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All

input/output signals shall be directly hardwired to the VAV ASC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ASC sensor or GP tool connected at the wall sensor location.

2. LonMark™ VAV profiles for including support for all mandatory and optional LonMark™ standard network variable types (SNVTs) as documented by the LonMark™ interoperability association.
 3. The VAV ASC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAV ASC shall provide internal differential pressure transducer for pressure independent applications with an accuracy of ± 5 %. Flow through transducers requiring filter maintenance are not acceptable.
 4. All input/output signals shall be directly hardwired to the VAV ASC. A minimum of one input point of the VAV ASC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ASC shall be of the relay and universal analog form. All digital outputs shall be relay type. ASC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the graphical programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ASC or shall be available as I/O points for other controllers throughout the network.
 5. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box.
- O. VAV box room sensor.
1. The VAV box room sensor shall provide room temperature value and humidity to the controller.
 2. The VAV box room sensor shall connect directly to the controller box and shall not utilize any of the I/O points of the controller.
 3. The VAV box room sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.

4. There shall be one VAV box room sensor per floor wired so that the communication jack will provide for a connection to the LON communication trunk to which the VAV controller is connected.
5. By connecting to this VAV box room sensor, the connected controller, and all other devices on the LON bus shall be accessible by the portable engineering station.
 - a. The VAV box room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:
 - 1) Subnet and node address.
 - 2) Errors.
 - 3) Alarms.
 - 4) Temperature offset.

P. ASC VAV – air balancing.

1. Through the Portable Engineering Station, the VAV ASC shall support a fully prompted Air Balance sequence. The Portable Engineering Station shall, when connected through the wall sensor, access the connected VAV ASC unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAV ASC. Upon completion of the balancing sequence, the flow values presented by the VAV ASC shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the balance settings shall be archived for future use if the controller were to require replacement. Systems not able to provide a formatted air balance Graphical Programming Tool shall provide an individual full time during the Air-balancing process to assure full balance compliance.

Q. ASC – fan coil unit, unit ventilator, heat pump, or packaged rooftop controller functionality.

1. Controls shall be microprocessor based as shown in the drawings or indicated in the sequence of operations. The ASC shall be a single integrated package consisting of a microprocessor, power supply, field terminations, and application software. The units shall be started and stopped from the BMS. A low limit protection thermostat in the mixed air section of the unit shall close down the outdoor air damper, open coil valves, and alarm the BMS when a temperature below 38°F (adjustable) is sensed. All input/output signals shall be directly hardwired to the ASC controller. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC.
2. All ASCs must have an operating temperature range -40°F to 140°F and 5 to 95% RH, non- condensing because they are located in the

proximity of extreme temperatures (hot water/steam pipes or the outdoor air).

3. All ASCs shall have capability for both ASHRAE Cycle II and ASHRAE Cycle III fully tested and validated. Bidder shall provide application documentation for ASC ASHRAE Cycle II and III compliance including sequence of operation, controller program, and available SNVT's. The control program shall also be fully customizable in the field to accommodate any local or project specific requirements that may be required.
4. All duct averaging sensors for ASCs must be true continuous averaging units that sense the mean temperature over the complete length of the sensor end to end. Sensors that provide four or nine sensing points, which may be accurate due to air temperature stratifications, are not acceptable.
5. All ASCs shall be easily replaceable for ease of future maintenance and to minimize downtime.
6. The outputs of the ASC shall be of the relay Form C and universal analog form. All digital outputs shall be relay type Form C. ASC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices.

R. LANs:

1. Capacity for a minimum of 64 client workstations connected to multi-user, multi-tasking environment with concurrent capability to access DDC network or control units.
2. Enterprise network LAN:
 - a. Media: Ethernet (IEEE 802.3), peer-to-peer CSMA/CD, operating at 10 or 100 Mbps, cable 10 Base-T, UTP-8 wire, category 5
3. Primary controller network LAN:
 - a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K.
4. Secondary network LAN (if required):
 - a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K.
5. Remote connection:
 - a. SDN, ADSL, or T1 (service provided by building owner)

S. Software:

1. Controller and system HVAC applications update to latest version of software at project completion. Include and implement the following capabilities from the control units if documented by the specified sequence of operations.
2. Controller and network setup software:
 - a. Network management tools for LonTalk™ protocol and the ANSI/ASHRAE™ Standard 135-2004, BACnet protocol shall be provided including a network learn function, LonMark bindings, service pins, winks, and diagnostics.

4. ELECTRONIC SENSORS

- a. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- b. Thermistor temperature sensors and transmitters.
 - Manufacturers:
 - BEC Controls Corporation.
 - Ebtron, Inc.
 - Heat-Timer Corporation.
 - I.T.M. Instruments Inc.
 - MAMAC Systems, Inc.
 - RDF Corporation.
 - Reference section 2.2.A "Control System Supplier".
 - Accuracy: Plus or minus 0.5 F (0.3 C) at calibration point.
 - Wire: Twisted, shielded-pair cable.
 - Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 - Averaging Elements in Ducts: 72 inches (1830 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
 - Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

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- Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- c. Pressure transmitters/transducers:
- Manufacturers:
 - BEC Controls Corporation.
 - General Eastern Instruments.
 - MAMAC Systems, Inc.
 - ROTRONIC Instrument Corp.
 - TCS/Basys Controls.
 - Vaisala.
 - Reference section 2.2.A "Control System Supplier".
 - Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - Output: 4 to 20 mA.
 - Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
 - Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
 - Water pressure transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
 - Water differential-pressure transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
 - Differential-pressure switch (air or water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 - Pressure transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- d. Room sensor cover construction: Manufacturer's standard locking covers.
- Set-Point Adjustment: Concealed. Limited to +/- 3°F adjustment.

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- Set-Point Indication: Concealed.
 - Thermometer: Not displayed.
 - Color: Standard.
 - Orientation: Horizontal.
- e. Carbon dioxide sensors/transmitters:
- Manufacturers:
 - Kele.
 - Johnson Controls.
 - Honeywell.
 - Texas Instruments.
 - Vaisala.
 - Reference section 2.2.A "Control System Supplier".
 - Carbon dioxide transmitter: Non-directional sensor with 0-2000ppm range for wall mount neutral pressure application.
 - Accuracy: +/- 50ppm.
 - Output: 4 to 20 mA.
 - Power Supply: 24 VAC/DC.
 - Display: None.
 - Calibration Interval: Three years or longer.

5. STATUS SENSORS

- a. Status inputs for fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- b. Status inputs for electric motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- c. Current switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- d. Electronic valve/damper position indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

6. ACTUATORS

- a. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
- Manufacturers.
 - Belimo Aircontrols (USA), Inc.
 - Delta Control Products.
 - Reference section 2.2.A "Control System Supplier".
 - Dampers: Size for running torque calculated as follows:
 - Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
 - Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
 - Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
 - Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
 - Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
 - Coupling: V-bolt and V-shaped, toothed cradle.
 - Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 - Power Requirements (Two-Position Spring Return): 24-V ac.
 - Power Requirements (Modulating): Maximum 10 VA at 24-V ac.
 - Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

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- Temperature Rating: Minus 22 to plus 122 F (Minus 30 to plus 50 C).

7. DAMPERS

a. Manufacturers.

- Air Balance Inc.
- Don Park Inc.; Autodamp Div.
- TAMCO (T. A. Morrison & Co. Inc.).
- United Enertech Corp.
- Vent Products Company, Inc.
- Ruskin.
- Johnson Controls.
- Reference section 2.2.A "Control System Supplier".

b. Dampers: AMCA-rated, opposed-blade design; 0.108-inch (2.8-mm) minimum thick, galvanized-steel or 0.125-inch (3.2-mm) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch (1.6-mm) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

- Secure blades to 1/2-inch (13-mm) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
- Operating Temperature Range: From minus 40 to plus 200 F (minus 40 to plus 93 C).
- Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
- Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

8. HUMIDITY SENSORS

A. Manufacturers:

- Kele.

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- Vaisala.
 - Reference section 2.2.A "Control System Supplier".
- a. Humidity sensors shall be capacitance or bulk polymer resistance type.
 - b. BDuct and room sensors shall have a sensing range of 20 to 80% with accuracy of +/- 5% R.H. Duct sensors shall be provided with a sampling chamber.
 - c. Outdoor air and high limit humidity sensors shall have a sensing range of 20 to 95% R.H. It shall be suitable for ambient conditions of -40°F to 170°F.

9. CONTROL CABLE

- a. Electronic and fiber-optic cables for control wiring are specified in Division 16 Section "Voice and Data Communication Cabling."

10. CONTROL PANELS

- a. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels

EXECUTION

1. EXAMINATION

- a. Verify that power supply is available to control units and operator workstation.

2. INSTALLATION

- a. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- b. Connect and configure equipment and software to achieve sequence of operation specified.
- c. Verify location of thermostats, humidistats, other exposed control sensors, and control units with Drawings and room details before installation. Install devices in accordance with KBC 3311.5, 3311.6, and ADA.
 - Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- d. Install automatic dampers according to Division 15 Section "Duct Accessories."
- e. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- f. Install labels and nameplates to identify control components according to

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Division 15 Section "Mechanical Identification."

- g. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.
- h. Provide clear and thorough Owners Manuals with extensive diagrams and examples. Also provide documentation such as installation drawings and software documentation.
- i. Provide operational information on the system. This will include file drawings and framed schematics and operation sequences posted in the area.

3. ELECTRICAL WIRING AND CONNECTION INSTALLATION

- a. Install building wire and cable according to Division 16 Section "Conductors and Cables."
- b. Install signal and communication cable according to the following:
 - Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - Install exposed cable in raceway.
 - Install concealed cable in raceway.
 - Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- c. Connections, switches, LED's, major components, etc. inside the enclosures are to be labeled in the unit.
- d. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- e. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

4. ADJUSTING

- a. Calibrating and adjusting.

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- Calibrate instruments.
- Make three-point calibration test for both linearity and accuracy for each analog instrument.
- Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
- Control system inputs and outputs:
 - Check analog inputs at 0, 50, and 100 percent of span.
 - Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - Check digital inputs using jumper wire.
 - Check digital outputs using ohmmeter to test for contact making or breaking.
 - Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistance source.
- Flow.
 - Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - Manually operate flow switches to verify that they make or break contact.
- Pressure.
 - Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- Temperature:
 - Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - Calibrate temperature switches to make or break contacts.
- Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

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- Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- Provide diagnostic and test instruments for calibration and adjustment of system.
- Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

b. Adjust initial temperature and humidity set points.

5. DEMONSTRATION

a. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
3. Review data in maintenance manuals.
4. Review data in maintenance manuals "Operation and Maintenance Data."
5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

6. ON-SITE ASSISTANCE

a. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

7. TRAINING

A. Provide a minimum of 32 hours of on-site or classroom training throughout the contract period for personnel designated by the Owner. Each session shall be a minimum of four hours in length and must be coordinated with the building Owner. Train the designated staff of Owners Representative and Owner to enable them to:

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1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand DDC system components.
4. Understand system operation, including DDC system control and optimizing routines (algorithms).
5. Operate the workstation and peripherals.
6. Log on and off the system.
7. Access graphics, point reports, and logs.
8. Adjust and change system set points, time schedules, and holiday schedules.
9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
10. Understand system drawings, and Operation and Maintenance manual.
12. Understand the job layout and location of control components.
13. Access data from DDC controllers.
14. Operate portable operators' terminals.

END OF SECTION 15900