

SECTION 01 2300 ALTERNATES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Alternates have been established as described in this section of these Specifications to enable the Owner to compare total costs where alternate materials and methods might be used.
- B. Materials and methods to be used in the Base Bid and in the Alternates have been described on the Drawings and in pertinent sections of these Specifications.
- C. Method of stating the proposed Contract Sum is described in the Proposal Form.
- D. All alternates described in this section are required to be reflected on the Proposal Form as submitted by Bidders. However, do not submit Alternates other than as described in this section, except as provided for "substitutions" under the General Conditions.
- E. If the Owner elects to proceed on the basis of one or more of the described Alternates, make all modifications to the work required in furnishing and installing the selected Alternates to the approval of the Architect and at no additional cost to the Owner other than as proposed on the Proposal Form.
- F. Successful bidder will be required to offer a break-down of alternates containing combined construction items.

PART 2 ALTERNATES

2.01 ALTERNATE NO. 1: Metal Panels in-lieu-of Stucco

- A. Provide an Alternate Price to the Base Bid to provide metal panels in-lieu-of replacement stucco system. See Sheet AR-201.

2.02 ALTERNATE NO. 2: Delete Gutters and Provide Drip Edge

- A. Provide an Alternate Price to the Base Bid to delete the gutter from the classroom wings and provide drip edge as designated. See Sheet AR-201.

2.03 ALTERNATE NO. 3: Wood Fiber Decking in-lieu-of Metal Decking

- A. Provide an Alternate Price to the Base Bid to use wood fiber decking for the main Cafetorium space in-lieu-of metal decking. Coordinate additional framing with the Structural Drawings.

2.04 ALTERNATE NO. 4: VCT in-lieu-of Polished Concrete

- A. Provide an Alternate Price to the Base Bid to provide vinyl composition tile in-lieu-of diamond polished concrete. Allow for two colors in pattern to be determined. Assume 60% field color and 40% accent color. See Finish Plans.

PART 3 EXECUTION

3.01 COORDINATION

- A. Immediately after award of the Contract or as soon thereafter as the Owner has made decision on which, if any, Alternates will be selected, thoroughly and clearly advise all necessary personnel and suppliers as to the nature and extent of Alternates selected by the Owner. Use all means necessary to alert those personnel and suppliers involved as to all changes in the Work caused by the Owner's selection or rejection of Alternates.
- B. When selected Alternates require similar work to other selected Alternates, provide work performed by the same sub-contractor in order to maintain continuity between Alternate work.

END OF SECTION

**SECTION 01 45 00
QUALITY CONTROL****PART 1 - GENERAL**

1.1 Definitions

- 1.1.1 Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- 1.1.2 Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Design Professional.
- 1.1.3 Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.
- 1.1.4 Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
- 1.1.5 Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria
- 1.1.6 Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
- 1.1.7 Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- 1.1.8 Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- 1.1.9 Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- 1.1.10 Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1.1.10.1 Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
 - 1.1.10.2 Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project;

being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.2 Quality Control - Contractor

- 1.2.1 Maintain quality control over products, services, site conditions, and workmanship, to produce work of specified quality.
- 1.2.2 During the work, the Contractor or subcontractor shall not be allowed to stage materials on newly installed roofing. The Contractor shall phase work and stage necessary materials at existing roofing areas. Any damage to new membrane during construction shall result in repairs to the membrane at no additional cost to the Owner, and large areas shall result in the removal and replacement of new membrane at no additional cost to the Owner.
- 1.2.3 Roofing Subcontractor shall submit the following certifications:
- Subcontractor shall certify he has been conducting business under the same name for a minimum of five years.
- Subcontractor shall provide documentation from the NCCI of an experience modification rating of 1.0 or less.
- Subcontractor shall provide the primary bonding for the roofing part of the project.
- Subcontractor agrees to conduct the work using his/her own forces and that no part of the work will be performed by sub-subcontractors without the express written consent of the Architect or Owner.

1.3 Quality Control - Owner

- 1.3.1 A minimum of 3 seam samples shall be taken across seams per day per welder or field peel tests shall be performed in accordance with the roofing system manufacturer's requirements by the roofing contractor. At a minimum, a peel test shall be performed each time machines are activated, and this test shall be dated, stored on-site, and readily available for Design Professional inspection. Samples shall be tack welded to the roof at each test location, but shall be removed before substantial completion, unless otherwise directed by the Owner.
- 1.3.2 Work found in violation of the Specifications, or not in conformance with acceptable roofing practices/standards, shall be subject to rejection including removal and replacement with new materials at Contractor's expense.
- 1.3.3 Failure of Owner or Engineer to discover or reject defective work, or work not in accordance with the Contract, shall not be deemed an acceptance thereof, nor a waiver of Owner's rights to Contractor's compliance with the Contract or performance of the work, or any part thereof. No partial or final payment, or partial or entire occupancy, by Owner shall be deemed to be an acceptance with the Contract, nor shall it be deemed a waiver by Owner or any of Owner's rights pursuant to this Contract or otherwise.
- 1.3.4 Owner intends to conduct inspections of the work by in-house personnel and/or the Owner's representative on a full/part-time basis. Such work is in addition to the Engineer's inspections which may be conducted to verify that work completed is comparable to contractor's monthly application for payment.

- 1.3.5 PVC membrane and base flashings shall be smooth to the substrate, and wrinkles in membrane or base flashings shall be grounds for rejection.
- 1.3.6 The accumulation of debris and foam adhesive beneath new membrane is not acceptable and shall be grounds for rejection.
- 1.4 Conflicting Requirements
- 1.4.1 If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Design Professional for a decision before proceeding.
- 1.4.2 The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Design Professional for a decision before proceeding.
- 1.5 Submittals
- 1.5.1 For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- 1.5.2 Prepare and submit certified written reports that include the following:
- 1.5.2.1 Date of Issue
 - 1.5.2.2 Project Title and Number
 - 1.5.2.3 Name, Address, and telephone number of testing agency
 - 1.5.2.4 Dates and locations of samples and tests or inspections
 - 1.5.2.5 Names of individuals making tests and inspections
 - 1.5.2.6 Description of work and test and inspection method
 - 1.5.2.7 Identifications of product and Specification system
 - 1.5.2.8 Complete test or inspection data
 - 1.5.2.9 Test and inspection results and an interpretation of test results
 - 1.5.2.10 Record of temperature and weather conditions at time of sample taking and testing and inspecting
 - 1.5.2.11 Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements
 - 1.5.2.12 Name and signature of laboratory inspector
 - 1.5.2.13 Recommendations on retesting and re-inspecting
- 1.6 Quality Assurance
- 1.6.1 General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- 1.6.2 Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance

- 1.6.3 Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units
- 1.6.4 Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units
- 1.6.5 Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent
- 1.6.6 Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
- 1.6.6.1 Requirement for specialists shall not supersede building codes and regulations governing the Work
- 1.6.7 Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
- 1.6.7.1 NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7
- 1.6.7.2 NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program
- 1.6.8 Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project
- 1.6.9 Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
- 1.6.9.1 Build mockups in location and of size indicated or, if not indicated, as directed by Design Professional.
- 1.6.9.2 Notify Design Professional seven days in advance of dates and times when mockups will be constructed
- 1.6.9.3 Demonstrate the proposed range of aesthetic effects and workmanship.
- 1.6.9.4 Obtain Design Professional's approval of mockups before starting work, fabrication, or construction.
- 1.6.9.5 Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
- 1.6.9.6 Demolish and remove mockups when directed, unless otherwise indicated

- 1.6.10 Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 02 through 22
- 1.7 Quality Control
- 1.7.1 Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified here or not.
- 1.7.1.1 Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services
- (a) Contractor shall not employ same entity engaged by Owner, unless agreed in writing by Owner
- 1.7.1.2 Notify testing agencies at least 24 hours (or as required by testing agencies) in advance of time when Work that requires testing or inspecting will be performed.
- 1.7.1.3 Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
- 1.7.1.4 Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
- 1.7.1.5 Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- 1.5.2 Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- 1.5.3 Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- 1.5.4 Testing Agency Responsibilities: Cooperate with Design Professional and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections. Notify Design Professional and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
- 1.5.5 Determine the location from which test samples will be taken and in which in-situ tests are conducted.
- 1.5.6 Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
- 1.5.7 Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
- 1.5.8 Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
- 1.5.9 Do not perform any duties of Contractor.

- 1.5.10 Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
- 1.5.10.1 Access to the Work.
 - 1.5.10.2 Incidental labor and facilities necessary to facilitate tests and inspections.
 - 1.5.10.3 Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 1.5.10.4 Facilities for storage and field curing of test samples.
 - 1.5.10.5 Delivery of samples to testing agencies.
 - 1.5.10.6 Preliminary design mix proposed for use for material mixes that require control by testing agency
 - 1.5.10.7. Security and protection for samples and for testing and inspecting equipment at Project site.
- 1.5.11 Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- 1.5.11.1 Schedule times for tests, inspections, obtaining samples, and similar activities.

1.8 Special Tests and Inspections

- 1.6.1 Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
- 1.6.1.1 Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 - 1.6.1.2 Notifying Design Professional and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - 1.6.1.3 Submitting a certified written report of each test, inspection, and similar quality-control service to Design Professional with copy to Contractor and to authorities having jurisdiction.
 - 1.6.1.4 Submitting a final report of special tests and inspections at Material Completion which includes a list of unresolved deficiencies.
 - 1.6.1.5 Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 - 1.6.1.6 Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 07 54 19
FULLY ADHERED POLYVINYL CHLORIDE ROOFING

PART 1 - GENERAL

1.1 Work Included

1.1.1 Installation of a fully adhered PVC roof membrane, as specified herein.

1.2 Related Work

1.2.1 Selective Demolitions and Preparations – Section 07 01 50.

1.2.2 Roof Board Insulation - Section 07 22 16.

1.2.3 Metal Wall Panels – Section 07 42 13

1.3 Quality Control

Maintain quality control over products, services, site conditions, produce work of specified quality.

1.3.1 During the work, the Contractor or subcontractor shall not be allowed to stage materials on newly installed roofing. The Contractor shall phase work and stage necessary materials at existing roofing areas. Any damage to new membrane during construction shall result in repairs to the membrane at no additional cost to the Owner, and large areas shall result in the removal and replacement of new membrane at no additional cost to the Owner.

1.4.1.

Subcontractor shall certify he has been conducting business under the same name for a minimum of five years.

Subcontractor shall provide documentation from the NCCI of an experience modification rating of 1.0 or less.

Subcontractor shall provide the primary bonding for the roofing part of the project.

Subcontractor agrees to conduct the work using his/her own forces and that no part of the work will be performed by sub-subcontractors without the express written consent of the Architect or Owner.

Maintain quality control over products, services, site conditions, and workmanship, to produce work of specified quality.

1.3.2 During the work, the Contractor or subcontractor shall not be allowed to stage materials on newly installed roofing. The Contractor shall phase work and stage necessary materials at existing roofing areas. Any damage to new membrane during construction shall result in repairs to the membrane at no additional cost to the Owner, and large areas shall result in the removal and replacement of new membrane at no additional cost to the Owner.

Roofing Subcontractor shall submit the following certifications:

Subcontractor shall certify he has been conducting business under the same name for a minimum of five years.

Subcontractor shall provide documentation from the NCCI of an experience modification rating of 1.0 or less.

Subcontractor shall provide the primary bonding for the roofing part of the project.

Subcontractor agrees to conduct the work using his/her own forces and that no part of the work will be performed by sub-subcontractors without the express written consent of the Architect or Owner.

1.4 Submittals

1.3.3 In accordance with Section 01 33 00 of this Specification

1.5 Environmental Conditions

1.5.1 Material installation shall proceed only when weather conditions are in compliance with the applicable manufacturer's recommendations for installation and no precipitation is imminent. Materials installed during adverse weather conditions shall be subject to removal and replacement with new materials at no additional cost to Owner.

1.6 Warranty

1.6.1 In accordance with Section 01 78 36 of this Specification.

PART 2 - PRODUCTS

2.1 Approved PVC Roofing Manufacturers are manufacturers by which the Contractor may solely furnish materials to perform the work. Materials furnished by the roofing system manufacturer are subject to the standards listed below. Any deviations from standards listed below shall only be considered if the approved system manufacturer does not produce a material to that stated standard, and must be submitted in writing by the approved roofing system manufacturer. Any substitutions shall not alter the Warranty periods as described in this specification

- 2.1.1 Sika Sarnafil International
- 2.1.2 Duro-Last Roofing, Inc.
- 2.1.3 Fibertite Roofing Systems by Seaman Corporation
- 2.1.4 Johns Manville (KEE only)

2.2 PVC Roofing Materials

- 2.2.1 PVC Membrane, minimum 60 mil overall thickness with minimum 23 mil thickness above the scrim, as manufactured by the approved roofing system manufacturer.
- 2.2.2 PVC Unsupported Flashing: Minimum 55 mil thickness as provided by the approved roofing system manufacturer.
- 2.2.3 PVC Universal Pipe Boot Flashings, as manufactured by the approved roofing system manufacturer. Pre-fabricated flashing boot shall include a draw band for securing the top of the flashing boot to the pipe
- 2.2.4 PVC Inside and Outside Corners, as manufactured by the approved roofing system manufacturer.

For use at inside and outside corners of curbs, parapets, and other similar junctures. The use of field-fabricated corner pieces is not acceptable.

- 2.2.5 PVC Membrane Adhesive (Solvent-Based), as manufactured by the approved roofing system manufacturer. For use to adhere PVC membrane substrate.
- 2.2.6 PVC Membrane Adhesive (Solvent-Based), as manufactured by the approved roofing system manufacturer. For use to adhere PVC base flashings.
- 2.2.7 Pourable sealant, as manufactured by the approved roofing system manufacturer. A two-part polyurethane sealant for filling pitch pans.
- 2.2.8 PVC Membrane Cleaner: As manufactured by the approved roofing system manufacturer. For use in removing foreign debris from the membrane prior to welding.
- 2.2.9 PVC Coated Clad Metal: As manufactured by the approved roofing system manufacturer, minimum 24 ga. galvanized steel.
- 2.2.10 Termination Bar. As manufactured or approved by the approved roofing system manufacturer.
- 2.2.11 Polyurethane Caulk: As manufactured and/or approved by the roofing system manufacturer. To be applied at those locations identified by the manufacturer.
- 2.2.12 Membrane Welding Machines: As approved by the roofing system manufacturer. Contractor shall provide written documentation that operators have received the roofing system manufacturer's required training to operate equipment. Welders shall be maintained in good working order and shall be operated and maintained in accordance with the welding machine manufacturer's written instructions.
- 2.2.13 Walkway Pads: As manufactured by the approved roofing system manufacturer. Nominal 30" wide.
- 2.2.14 Foam Core: Compression tube that is a minimum of 1.5 times larger than the expansion joint opening, as approved for use by the approved roofing system manufacturer.
- 2.2.15 Roofing Nails: With minimum 1" head, such as Simplex nails or approved equal.

PART 3-EXECUTION

3.1 Inspection

- 3.1.1 The substrate shall be clean, smooth, dry, free of debris and all foreign matter prior to installation of the roof membrane and in a condition to receive the manufacturer's product in accordance with manufacturer's instructions. Application of new materials shall constitute approval of the substrate by the Roofing Contractor.
- 3.1.2 Cover board joints with gaps greater than 1/4" shall be filled with roof insulation and/or cover board material in order to provide a smooth surface.
- 3.1.3 The accumulation of debris and foam adhesive beneath new membrane is not acceptable and shall be grounds for rejection.

3.1.4 Completely clean asphalt residue from substrate prior to applying mastic, sealant, or caulking.

3.2 Roof Membrane Installation

3.2.1 Sweep the substrate with a stiff broom to remove materials that will interfere with the proper installation of the membrane.

3.2.2 Roll out membrane and allow the membrane to “relax” in accordance with manufacturer written instructions. Back roll the membrane prior to application.

3.2.3 Pour the water-base adhesive over the substrate, and spread adhesive to an even and uniform thickness using notched squeegees in accordance with manufacturer written instructions. The adhesive shall be applied to the substrate so that the constant rate of coverage is 1-1/4 gallon per square, unless manufacturer has more stringent requirements. Care shall be taken not to apply adhesive over an area that is to be later cleaned and spliced to another sheet of flashing.

Note: No adhesive is to be applied to the back side of the membrane.

3.2.4 While the adhesive is still wet, carefully roll the membrane into the adhesive, being sure to lap membrane in accordance with the roofing system manufacturer’s written instruction. However, laps shall wide enough to allow for at least a 1-1/2 inch weld when automatic machine welding and a 2 inch weld when hand-welding, unless manufacturer has more stringent requirements.

Note: The formation of film on top of the adhesive shall not be allowed to occur, and the adhesive shall not be applied if the application temperature is below 40°F or expected to be below 40°F during drying time.

3.2.5 Using a water-filled, foam covered lawn roller, firmly press the membrane to ensure full contact with the adhesive layer by frequent rolling in two directions.

3.2.5.1 Membrane shall be smooth to the substrate, and wrinkles in the membrane shall be grounds for rejection.

3.2.6 Water-based adhesive shall not be used on vertical surfaces. When extending membrane over wood blocking , furnish and install the roofing system manufacturer’s approved flashing adhesive to adhere the membrane to the substrate.

3.2.7 Furnish and install the roofing system manufacturer’s termination bar at the base of all tapered edge strips and at transitions, peaks, and valleys as required by the manufacturer in details and application instructions. Strip in the termination bar in accordance with the manufacturer’s approved written instructions.

3.2.8 Turn membrane up vertical surfaces a minimum of 2 inches and using the roofing system manufacturer’s fasteners and termination bar in accordance with the roofing system manufacturer’s approved written instructions. Apply water cut-off mastic behind the membrane prior to fastening, and apply sealant at the top of the membrane after securing. Fasteners shall penetrate the substrate at spacings and depths approved by the roofing system manufacturer, however, depth shall be a minimum of 1 inch and spacings shall not exceed 8 inches on center.

3.2.9 At eaves, extend membrane over the wood blocking and down past the exterior outside face of the

blocking a minimum of 1 inch.

- 3.2.10 At gutters, extend the membrane over the wood blocking and into the gutter a minimum of 2 inches.
- 3.2.11 At drains, extend the membrane over the drain. Cut an opening in the membrane at the center of the drain bowl so that the membrane extends past the edge of the drain bowl a minimum of 1 inch. Apply water block between the membrane and the drain bowl prior to applying the drain clamping ring. If a field membrane seam lies within 18 inches of the center of the drain bowl, furnish and install a new minimum 36 inch by 36 inch target patch. Fully adhere the target patch to the field membrane using the membrane manufacturer bonding adhesive. Fully weld target patch splices to the field membrane a minimum of 2 inches on all sides. Weld in accordance with this section of the specification. Refer to Drawing No. A-304.
- 3.2.12 Hot air weld all membrane seams using either a machine or hand-held hot air welder approved by the roofing system manufacturer. A copy of the operating instructions shall be provided to the Engineer prior to the start of the project.
- 3.2.13 Monitor the temperature of the hot air welder so as to minimize the amount of smoke that should develop and to insure that the material from the bottom of the sheet begins to soften and flow from the seam. Hand held welders shall insure that membrane welding is immediately followed by a hand roller to press the heated membrane surfaces together with slow, even movements.
- 3.2.14 All seams shall be manually probed using a blunt rounded instrument daily. Any fishmouths or other seam defects where the seam is not fully adhered shall be repaired in accordance with the roofing system manufacturer's instructions.
- 3.2.15 After seams have set for approximately 8 hours, the Contractor shall make a minimum of 3, 4" x 12" test cuts across the seam for every day of welding. Test cuts shall be repaired by the Contractor daily and shall be done at no additional cost to the Owner. In lieu of test cuts, the contractor may perform pull test. Pull test shall be performed with two 4" x 12" pieces of membrane that shall be welded together 1-1/2 inch for the machine welder and 2 inches for hand welders. The membrane shall be pulled apart across the seam. Test shall be dated, and one test shall be performed every time a welding device is turned on. An archive of test shall be available for Engineer inspection.
- 3.2.16 Seams shall be tested in accordance with the roofing system manufacturer's instructions and evaluated for seam integrity. Seams that fail this test shall be subject to additional test cuts, as directed by the Engineer and/or roofing system manufacturer, in order to further quantify the extend of the deficient condition. Repairs to deficient seams and/or test cut locations shall be performed by the Contractor at no additional cost to the Owner.
- 3.2.17 Furnish and install the roofing system manufacturer's patches at all required locations such as intersection field seams. Apply the manufacturer's approved seam caulk, as required, at locations specified by the roofing system manufacturer.
- 3.2.18 Prior to final inspection, the surface of the membrane shall be cleaned of all debris, dust, and foreign material. This may require the use of water, detergents, and other cleaning agents approved by the roofing system manufacturer. Contractor will be responsible for providing the necessary items to perform this task. Do not use any abrasive pads that can score the polymer.

3.2.18.1 During the work, the Contractor or subcontractor shall not be allowed to stage materials on newly installed roofing. The Contractor shall phase work and stage necessary materials at existing roofing areas. Any damage to new membrane during construction shall result in repairs to the membrane at no additional cost to the Owner, and large areas shall result in the removal and replacement of new membrane at no additional cost to the Owner.

3.3 Base Flashings Installation

3.3.1 Apply the roofing system manufacturer's approved flashing adhesive to the inside face of vertical surfaces, such as parapets, curbs, and/or wood blocking, at the rate specified by the roofing system manufacturer for the substrate using the manufacturer's approved applicator.

Note: At locations where membrane flashing will be applied directly to smooth residual asphaltic materials, the Contractor may furnish and install 60 mil thick, white, asphalt resistant membrane flashing furnished by the approved roofing system manufacturer in accordance with this Section of the specification.

3.3.2 Roll out the membrane to be used for base flashings and allow to relax in accordance with the roofing system manufacturer's written instructions.

3.3.3 Cut flashing pieces so as to extend onto the roof a minimum of 8 inches and 3 inches past the fastener at the edge of the membrane sheet and up the vertical surface a minimum of 8 inches.

3.3.4 Apply the roofing system manufacturer's approved flashing adhesive to the back of the base flashing material and substrate at the rate specified by the roofing system manufacturer for the substrate. At side laps and the edge of the base flashing extending onto the roof, do not apply adhesive at these locations so as to allow hot-air welding. Allow adhesive to dry sufficiently so as to produce strings when touched with a dry, clean finger.

3.3.5 Roll the base flashing material onto the previously coated substrate without voids using a hand roller to insure positive contact of the substrate and base flashing material. Overlap all adjacent flashing sheets a minimum of 3 inches.

3.3.5.1 Base flashing shall be smooth to the substrate, and wrinkles in base flashing shall be grounds for rejection.

3.3.6 Hot air weld all side laps and the edge of the base flashings that extend onto the roof in accordance with hot-air welding instructions listed in this section and/or the instructions provided with the welding machine. Fully weld all laps, even those extending beneath flashings and units.

3.3.7 All seams shall be probed daily using a blunt, rounded instrument. All defects shall be corrected in accordance with the roofing system manufacturer's written instructions.

3.3.8 Seal the edges of the base flashings where the reinforcing fabric is cut with the roofing system manufacturer's approved seam sealant, as required by the membrane manufacturer. Such work shall be done on a daily basis.

3.3.9 At those locations where the top of the base flashings will not be secured with counter flashings, or as shown on drawings, furnish and install a nominal 1" x 1/4" flat bar or the roofing system manufacturer's termination bar along the top edge of the base flashings. Secure with appropriate

fasteners at spacings not to exceed 8 inches on center. Apply a bead of the roofing system manufacturer's water cut-off mastic behind the top edge of the base flashing. Apply a bead of the roofing system manufacturer's approved caulk along the top edge of the base flashings.

- 3.3.10 In the event that base flashings terminate at a corner and edges would be exposed, furnish and install new 4 inch wide PVC-coated metal closures with an exterior edge caulking cove. The closure shall be set in water cut-off mastic and fastened to the substrate using appropriate fasteners at spacings not to exceed 12 inches on center. Completely hot air weld the base flashings to the PVC-coated metal. Apply a non-shrinking sealant, such as NP-1 or approved equal, to the caulking cove at the exterior edge of the closure. Completely remove all residual asphalt from the substrate prior to installing any sealant or caulking.
 - 3.3.11 At inside and outside corners of curbs, Contractor shall use the roofing system manufacturer's pre-fabricated corner pieces. The use of field-fabricated pieces is not acceptable. Pre-fabricated pieces shall be installed in accordance with the roofing system manufacturer's written instructions.
 - 3.3.12 Use the roofing system manufacturer's termination bar at base flashing edges at changes in base flashing height. Fastener spacings not to exceed 12 inches on center. Set flashing in water cut-off mastic, set the bar over the edge of the base flashing, and apply caulk at the top of the flashing.
 - 3.3.13 At a minimum, extend base flashings up and over the top horizontal surface of curbs and inside the curb a minimum of 1 inch, unless otherwise stated in specification or shown on drawings.
- 3.4 Roof-to Roof Expansion Joint
- 3.4.1 Furnish and install new PVC membrane expansion joint flashings at roof-to-roof expansion joints, as specified. Refer to Drawing No. A-301.
 - 3.4.2 Secure the field membrane at the base of the curb using the manufacturer approved termination bar. Secure the termination bar to the curb using appropriate fasteners at spacings not to exceed 8 inches on-center.
 - 3.4.3 Continue the field membrane over the new and existing wood blocking/curbs and fully adhere the membrane to the substrates using solvent-based bonding adhesive. Do not apply adhesive at section laps for welding. Form an envelope filled with batt insulation in the joint. Roll the expansion joint cover material onto the previously coated substrate without voids using a hand roller to insure positive contact of the substrate and expansion joint cover. Overlap all adjacent sections a minimum of 3 inches and fully weld a minimum of 2 inches using a hand hot-air welder.
 - 3.4.4 Install and fully adhere base flashing in accordance with Paragraph 3.3 above. Extend base flashing over the top of the expansion joint curbs, batt insulation, and opening. Lap sections a minimum of 3 inches, and welded splices a minimum of 2 inches using a hand hot-air welder. Fully welded base flashings to the horizontal field membrane in accordance with manufacturer recommendations.
 - 3.4.5 Install foam core that is a minimum of 1.5 times larger than the expansion joint opening over the base flashing, fully adhering the foam core to the substrate.
 - 3.4.6 Furnish and install a new PVC membrane expansion joint cover, fully adhering the cover to the foam core and base flashings. Run the cover over the foam core and onto to the vertical base

flashings a minimum of 2 inches.

- 3.4.7 Roll the expansion joint cover material onto the previously coated substrate without voids using a hand roller to insure positive contact of the substrate and expansion joint cover. Overlap all adjacent expansion joint cover pieces a minimum of 3 inches.
- 3.4.8 Hot air weld all side laps and the edges of the cover that extend onto the base flashings in accordance with hot-air welding instructions listed in this section and/or the instructions provided with the welding machine. Reinforce all seams in PVC membrane over foam core with unsupported PVC membrane per manufacturer's written instructions, as required by the membrane manufacturer.
- 3.4.9 All seams shall be probed daily using a blunt, rounded instrument. All defects shall be corrected in accordance with the roofing system manufacturer's written instructions.

3.5 Roof-to-Wall Expansion Joint

- 3.5.1 Furnish and install new PVC membrane expansion joint flashings at roof-to-roof expansion joints, as specified. Refer to Drawing Nos. AR-301 and AR-303.
- 3.5.2 Secure the field membrane at the base of the curb using the manufacturer approved termination bar. Secure the termination bar to the curb using appropriate fasteners at spacings not to exceed 8 inches on-center.
- 3.5.3 Continue the field membrane over the new and existing wood blocking/curbs and fully adhere to the substrate using solvent-based bonding adhesive. Do not apply adhesive at section laps for welding. Form an envelope filled with batt insulation in the joint. Roll the expansion joint cover material onto the previously coated substrate without voids using a hand roller to insure positive contact of the substrate and expansion joint cover. Overlap all adjacent sections a minimum of 3 inches. Extend field membrane up the vertical substrate to a point that is a minimum of 2 inches above the foam core once installed and a minimum of 8 inches above the new roofing.
- 3.5.4 Install and fully adhere base flashing in accordance with Paragraph 3.3 above. Extend base flashing over the top of the expansion joint curbs and opening. Extend base flashings up the vertical substrate to a point that is a minimum of 2 inches above the foam core once installed and a minimum of 8 inches above the new roofing.
- 3.5.5 Install foam core that is a minimum of 1.5 times larger than the expansion joint opening over the base flashing, fully adhering the foam core to the substrate.
- 3.5.6 Furnish and install a new PVC membrane expansion joint cover, fully adhering the cover to the foam core and base flashings. Run the cover over the foam core and onto to the vertical base flashings a minimum of 2 inches. Extend cover up the vertical substrate to a point that is a minimum of 2 inches above the foam core and a minimum of 8 inches above the new roofing.
- 3.5.7 Roll the expansion joint cover material onto the previously coated substrate without voids using a hand roller to insure positive contact of the substrate and expansion joint cover. Overlap all adjacent expansion joint cover pieces a minimum of 3 inches.
- 3.5.8 Hot air weld all side laps and the edge of the cover that extend onto the base flashings in accordance with hot-air welding instructions listed in this section and/or the instructions provided

with the welding machine. Reinforce all seams in PVC membrane over foam core with unsupported PVC membrane per manufacturer's written instructions, as applicable.

- 3.5.9 All seams shall be probed daily using a blunt, rounded instrument. All defects shall be corrected in accordance with the roofing system manufacturer's written instructions.
- 3.5.10 Secure the top edge of the roofing membrane, base flashing, and expansion joint cover with the roofing system manufacturer's termination bar along the top edge of the flashings. Secure with appropriate fasteners at spacings not to exceed 8 inches on center. Apply a bead of the roofing system manufacturer's water cut-off mastic behind the top edge and in between all of the flashings. Apply a bead of the roofing system manufacturer's approved caulk along the top edge of the flashings after securing with the termination bar.

Note: Do not secure with termination bar where membranes will be behind cleat for drip edge flashing.

3.6 Walkway Pad

- 3.6.1 Furnish and install one row of walkway pads around four sides of all units and as shown at Drawing AR-104.
- 3.6.2 Furnish and install walkway pads at locations as shown on roof plan.
- 3.6.3 Walkway pads shall be spaced approximately 1 inch apart.
- 3.6.4 Clean the surface of the membrane to receive the walkway pads in accordance with the roofing system manufacturer's written instructions. Fully adhere the walkway pad to the membrane and hot-air weld all sides of the pads to the surface of the membrane in accordance with the roofing system manufacturer's written instructions.

END OF SECTION

**SECTION 230923
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes a complete and functional direct digital Energy Management Control System (EMCS) as specified herein. The EMCS Contractor shall have total system responsibility for the installation including the following:
1. BACnet Installations: Furnish and install a totally native BACnet-based system including applicable software to be installed on an Owner provided operator workstation (OWS) in accordance with this specification. All building controllers, application controllers, and input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. Provide all software, hardware, database, conduit, wire, cable, building level controller units, floor level controller units and required connections for a complete and functional system to monitor and control points as specified, including software and database generation, loading, debugging and startup. Provide all necessary BACnet-compliant hardware and software to meet the systems functional specifications. Provide Protocol Implementation Conformance Statements (PICS) for windows-based control software and every controller in the system.
 - a. Operator Workstation Software:
 - 1) All applicable software to facilitate direct connection to the building EMCS.
 - 2) Any necessary software/hardware “keys” required for EMCS communication software.
 - 3) Any additional hardware cabling or equipment that may be required to facilitate direct connection to EMCS field devices (Serial Communication adapters, etc)
 2. Furnish and install all network cabling, conduits, network switches, routers for a complete and functional network system, ending at the facility’s top-level building network switch, or at the nearest existing building level controllers as determined by Owner. Standard mode of connection shall be Ethernet or BACnet over IP unless approved otherwise by Owner.
 3. Generation of color graphic displays at the existing graphic terminal for each mechanical system connected to the system. Graphics to include all dynamic point data information associated with each major mechanical system and setpoints.

4. Provide complete hardware and software documents, shop drawings, operating and maintenance manuals and classroom training of operators and maintenance personnel at the site. Provide as-built control drawings in CAD format to Owner.
 5. Provide a dedicated power supply to each controller cabinet and communications interface. Provide manufacturers recommended grounding to each controller cabinet, and dedicated 120V, 20A circuit with locking clip on breaker. Clearly label circuit in panel.
 6. Provide an uninterruptable power supply (UPS) for all direct digital control systems supporting laboratory animal systems. UPS to be manufactured by SOLA HD, series DIN RAIL AC UPS, model SDU 850-5, or approved equal.
 7. Accomplish acceptance tests, including point-to-point verification, with alarming verification including messages for all critical alarm and life safety points. Typical points requiring messaged alarming include but are not limited to:
 - a. Control air compressor
 - b. 24 hour fans and pumps (i.e. Freeze Protection)
 - c. Critical temperature and humidity control areas (i.e. Archiving/Museum)
 - d. Critical pressure control areas and systems (i.e. Laboratories and Lab Systems)
 - e. Critical systems (i.e. Fire and Security)
 - f. State/Federally regulated areas (i.e. Animal Areas)
 8. Provide connections for all electrical devices provided by the EMCS contractor to the controllers.
 9. Provide proper marking and identification of all devices, wiring, and controls. Equipment labels should indicate device name, address, room location, etc.
 10. Schedule all non-24 hour equipment in accordance with generally approved University guidelines for energy usage and in accordance with the Owner. Non-24 hour equipment shall be scheduled as soon as practical to avoid excessive use of University resources prior to turnover to the University.
 11. Provide any additional support that may be required to facilitate full integration of all control devices, including hardware communication troubleshooting with 3rd party devices (Variable Frequency Drives, packaged controllers, etc).
 12. Demolition Requirements: Demolition shall include removal of all associated control components (sensors, switches, etc.), wiring, and database at the front end (point definitions, programming, etc.)
 13. Guarantee.
- B. The EMCS Contractor shall bid directly to and be contracted directly by the General Contractor or Construction Manager.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. RTD: Resistance temperature detector.

1.4 SYSTEM DESCRIPTION

- A. The temperature control system shall be of the DDC type, connected to the Schools present Energy Monitoring and Control System.
- B. NOT USED
- C. BACnet implementation shall be completely based on ANSI/ASHRAE Standard 135-2001, BACnet, and is to control all listed equipment using native BACnet-compliant components. Non BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited. Any device designated to act as a BACnet Broadcast Management Device (BBMD) shall be designed for and dedicated to that purpose and shall not be utilized to control any other aspect of the building system.
- D. System controllers connected to floor level (BACnet MS/TP) devices shall perform all necessary MS/TP network routing to facilitate network efficiency and reduce communication and control lag. When system controllers cannot perform this function, dedicated BACnet MS/TP routing hardware shall be provided.
- E. All materials and equipment used shall be standard components, regularly manufactured for Siemens Building Control Systems or ALC Controls and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use, and shall include, but not be limited to:
 - 1. Controller cabinets with all electronics and transducers, including on-board communications capability and database memory battery back-up. Provide latest revision firmware and largest available memory board.
 - 2. Communications interface devices.
 - 3. Printed circuit assemblies, point modules.
 - 4. Auxiliary device enclosures.
 - 5. Control and status relays.
 - 6. Current transformers.
 - 7. Thermowells (Mechanical Contractor shall install wells furnished by the EMCS contractor)
 - 8. Temperature and pressure transmitters.
 - 9. Water flow sensors and transmitters.
 - 10. Electric to pneumatic transducers.
 - 11. Pneumatic to electric transducers, standard shall be 0 to 20 psi unless noted otherwise, include brass fittings on all pneumatic devices.
 - 12. Power supplies to controller cabinets, transducers, and other control devices.

1.5 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.
- B. Shop Drawings:

1. Submit complete shop drawings of the proposed EMCS for approval including sequence of operation, valve ranges, DDC logical points and physical addresses, typical system information such as fan CFM, voltage, FLA, HP, GPM, etc.
 2. Submit complete shop drawings of the proposed EMCS system for approval including, but not be limited to the following:
 - a. I/O point summary with recommended set points, start/stop times, time delays, etc.
 - b. Operator and hardware point numbers, logical names and user names.
 - c. Controller unit schematic wiring, layout sheet including logical point names, valve ranges, etc.
 - d. Fan and mechanical system schematic diagrams showing EMCS sensor locations, including valve ranges, CFM, voltage, FLA, GPM and areas served.
 - e. One-line diagrams for sensors, control points, and terminations, including labeling to controller cabinets, with all components, signal values, and cables.
 - f. Terminal cabinets, including labeled terminal blocks.
 - g. Connections to existing loops, controls, and panels.
 - h. Internal and external wiring of relays and contacts.
 - i. Schematic of all major equipment provided.
 - j. Operator, maintenance, and software programming manuals.
 - k. Spare parts list and prices.
 - l. Complete sequence of operation, description, control logic flow diagrams, and completed programming sheets in manual form for each mechanical system controlled.
 3. All manufacturer's drawings, catalog cuts, and specifications shall be properly identified with the Engineer's project number and title. Each piece of equipment shall be properly identified as to its location and equipment number. Verify Equipment numbering with the Owner.
 4. SUBMITTALS data relevant to panel schedules and other pertinent equipment information requiring approval prior to field installation shall be forwarded from the EMCS Contractor. Upon receipt of approval, the EMCS Contractor shall proceed with installation, set-up, calibration and check out of the various control and monitoring systems. At the completion of components and systems installation the Contractor shall request in writing that the Owner inspect and approve satisfactory operation as specified under "Acceptance Procedure".
- C. As-built Drawings:
1. At the completion of the project as-built drawings shall be submitted to the Owner, showing conduit size and location, cable and wire identification, panel and sensor locations, and device layouts with panels, branch circuit numbers, and wiring diagrams for each type of typical field point wiring and for each specific variation, and data trunk riser diagram.
 2. Furnish 3 sets of neatly drawn as-built diagrams of the temperature control systems, complete with sequence of operations, valve ranges, cabinet layout sheets, point logical names and physical addresses. One set to be mounted in plastic covers located in control cabinets in the field, two sets to be delivered to Construction Representative for Archives and records. One set of AutoCAD as-built drawings on CDROM shall be furnished to

Design Representative to be delivered to Engineering and Architectural Services. File naming convention shall be as determined by Owner.

3. EMCS Contractor is to keep a current marked-up copy of as-built drawings on site at all times once installation started.

D. Operations and Maintenance Manuals:

1. The system shall be provided with complete maintenance and operation instructions including, but not limited to the following:
 - a. Complete electronic schematic wiring diagrams for printed circuit boards, DDC Controller cabinets and other equipment included in these Specifications.
 - b. Complete instruction set in manual form for operation of the system.
 - c. Complete instruction set in manual form for adding and deleting of points and interface device panels including all relevant parameters such as descriptor inputs, point types, change-of-state type, functions, etc.
 - d. Complete diagnostic and trouble shooting procedures set in manual form.
 - e. Complete instruction set in manual form for all software and firmware.
2. Any updates to firmware, software, and hardware shall be fully documented at or before the time of delivery.

1.6 INPUT/OUTPUT SUMMARY FORM

- A. The following I/O Summary Form is a sample form illustrating the typical information required of the various building systems. Any device connected to the EMS that is also controlled by some local device (e.g.: light switch, P.E., high limit stat, twist timer, etc.) must be defined as an DI point. Provide dry contact from local device to digital input at controller and programming necessary to accomplish sequence of operation.
- B. Control points connected to the EMCS system are indicated on plans. Abide by all chatham county standards

1.7 QUALITY ASSURANCE

- A. 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.
- B. Comply with ASHRAE Standard 135 for DDC system components.
- C. Comply with ASHRAE Standard 135-2001, BACnet where applicable.

1.8 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.
- C. Salvaged Materials and Components: Existing control components (Building Controllers, Application Specific / Advanced Application Controllers, Point Expansion Components, etc) when removed from the field as part of a controls replacement or upgrade shall be returned to the owner for reuse or recycling at the owner's discretion.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical branch circuits for control units.
- C. Coordinate controller addresses with Maintenance Services/ School System Central Control.

1.10 WARRANTY

- A. The EMCS system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the EMCS. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.
- B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).
- C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.
- D. The EMCS Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved, and work accomplished.
- E. Owner shall be able to make changes to data base, when prior data base is stored on disk in case of error in change, without affecting or voiding warranty.

PART 2 PRODUCTS

2.1 CURRENT SENSORS (TRANSFORMERS)

- A. Current sensors used for monitoring motor operation shall be sized according to motor horsepower. The output shall be compatible with the EMCS field device with necessary interfacing transducers provided.
- B. The current sensors shall have mounting brackets for attachment to the motor starter enclosure.
- C. Manufacturers: Veris model 921, or approved equal.

2.2 CURRENT SENSING RELAYS

- A. Current sensing relays shall be used for monitoring motor operation, and sized according to motor HP.
- B. Manufacturers:
 - 1. Veris model 908
 - 2. RIB Model RIBXGTA.
 - 3. Honeywell

2.3 TEMPERATURE DETECTORS

- A. Temperature detectors shall be wire wound or thin film platinum resistance type sensors, or 10K Ohm thermistor type, referenced at 77 degree F, either having a minimum accuracy of $\pm 0.5^{\circ}$ F over the noted range. All sensors of a particular category shall be of the same type and manufacturer.
- B. Resistance Temperature Detectors (RTD) shall be two-wire type, and shall be provided with local 4-20 MA signal conditioning transducers shall be provided where necessary. The minimum temperature range for all sensors will be 20 °F. to 120 °F. Sensors shall have a maximum time constant of three seconds per degree change. Sensors shall not require recalibration at any time. Where required, linearizing, ranging, and resistance change versus temperature curve interpretations shall be made by software programming at the CPU or Controller. Minimum room temperature sensor range is 40-90 degree F. Wider range may be required for special applications.
- C. Temperature detectors shall be either stem or tip sensitive types. Sensors installed outdoors, in piping systems, and in corrosive environments shall be hermetically sealed in type 316 stainless steel enclosures, with all joints and closures Heliarc welded. Soldering or brazing is not approved. Entire assembly, including external trim, shall be a watertight, vibration proof, heat resistant unit.

- D. Sensing elements installed in piping systems shall be provided with separable wells constructed of type 316 stainless steel. Elements shall be inserted into the wells with appropriate heat transfer compound.
- E. Sensors installed outdoors shall be of weatherproof construction, protected from sunlight and wind effects with a stainless steel protective shield.
- F. All duct mounted temperature sensors shall be of the averaging type, with 17' or 25' long sensing elements. Averaging elements shall be installed across the full air flow area in a serpentine fashion, on rigid supports designed specifically for mounting of such elements. The averaging element shall be protected against vibration and wear at each point of contact with the element supports. Strain on the element shall be relieved at the junction box to prevent tension on the internal electrical connections.
- G. Rigid stem averaging sensors will be allowed where duct size is smaller than 3' square.

2.4 STATIC PRESSURE TRANSMITTERS

- A. Static pressure transmitters shall be industrial quality, capable of transmitting 4-20mA analog output signal proportional to differential (static) pressure input signals. Transmitter shall have a minimum 1% accuracy rating over the range of the device, zero and span adjustment, and stainless steel case.
- B. Manufacturers: Setra Model C264, or approved equal.

2.5 ELECTRONIC TO PNEUMATIC TRANSDUCERS

- A. Accessories: In-line filter, dual valve and gauge.
- B. Manufacturers: Model EPC2GFS style by Advanced Control Technologies, Inc, or approved equal.

2.6 DAMPER END SWITCHES

- A. Damper end switches shall be two position, encapsulated non-mercury style mounted on the shaft arm, SPDT, unless noted otherwise. Where electronic actuators are used end switches provided with actuator will be allowed upon prior approval by owner.

2.7 EMCS CABLE

- A. All EMCS cable shall be installed in conduit. EMCS cable shall comply with manufacturer's recommendations. Separate raceway systems shall be supplied for Class I and Class II circuits.
- B. Data transmission trunk cables and equipment grounding procedures shall meet the latest FCC guidelines (FCC rules, part 15, subpart J) for electromagnetic field generation.

- C. No splicing of RS-485 or RS-232 data cabling shall be allowed. Communication trunk shall be installed per manufacturers recommendation for operation at 19,200 baud or higher, continuous daisy chain with no tees and trunk terminators installed where appropriate. All communication and analog input wiring shall be AWG size as recommended by manufacturer with teflon jacket.
- D. Splicing of temperature sensor cable is not allowed.
- E. Splicing of binary status or command cable shall take place at the field cabinet or motor starter only.

2.8 DDC CONTROLLERS

- A. Controllers shall be complete assemblies consisting of modular hardware including power supply, microcomputer, input/output modules, termination modules, and battery. Battery shall be non-rechargeable lithium with 10 year life, and be capable of supporting all memory within the control unit if the house power to the unit is interrupted or lost for a minimum of 60 days total down time.
- B. Controllers shall be furnished as newest revision level with largest available memory configuration unless prior approval by Owner. Verify controller type to be used in design with Owner. Most recent revision firmware shall be supplied unless otherwise noted. Point extension/slave devices shall NOT be utilized in the design without prior approval by the Owner. Each controller shall be provided with 10% spare point capacity. All controllers shall be provided with floor level (subnet) network capability and H-O-A switches at the output points unless approved otherwise by the Owner.

C. All points from a given mechanical system shall reside in the same controller.

D. Each Controller cabinet shall be able to monitor the following types of inputs:

<u>Analog Inputs</u>	<u>Digital [Binary] Inputs</u>
4-20 mA	Dry contact closure
0-10 VDC	Pulse accumulator
1000 ohm [10K Ohm]	

E. Controller cabinets shall directly control pneumatic and electronic actuators and control devices. Each control unit shall be capable of providing the following control outputs:

<u>Analog Outputs</u>	<u>Digital [Binary] Outputs</u>
4-20 mA	Motor starters, sizes 1 to 4
0-10 VDC	

F. All temperature control functions shall be executed within the same DDC Controller. Loop control shall be executed via direct digital control algorithms. The user shall be able to customize control strategies and sequences of control, and shall be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. Upon Owner

request the EMCS shall demonstrate stable loop control by utilizing test cabinet simulation program and trending the data. Control loops shall support any of the following control modes:

1. Two position (on-off, slow-fast, etc.)
 2. Proportional (P)
 3. Proportional plus integral (PI)
 4. Proportional, integral, plus derivative (PID)
- G. It shall be possible to fully create, modify, or remove control algorithms within a specific DDC Controller while it is operating and performing other control functions. Input for these changes may be made directly into the DDC Controller or via the network. Each control loop shall be fully user definable in terms of:
1. Sensors/actuators that are part of the control strategy.
 2. Control mode.
 3. Gain.
 4. Control action.
 5. Sampling time.
- H. DDC Controllers shall be able to share point information such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other DDC Controllers within the network. If the network communication link fails or the other DDC Controller malfunctions, the control loop shall continue to function using the last value received from the Controller.
- I. The system shall permit the generation of job-specific control strategies that can be activated in any of the following ways:
1. Continuously.
 2. At a particular time of day.
 3. On a pre defined date.
 4. When a specific measured or controlled variable reads a selected value or state.
 5. When a piece of equipment has run for a certain period of time.
- J. Upon a loss of commercial power to any DDC Controller, the other units within the network shall not be affected and the loss of operation of that unit shall be reported at the designated operator's terminal. All control strategies and energy management routines defined for the DDC Controller shall be retained during power failure via the internal battery for a minimum of eight (8) hours. Upon resumption of commercial power the control unit shall resume full operation without operator intervention. The unit shall also automatically reset its clock such that proper operation of timed sequences is possible without the need for manual reset of the clock.
- K. Location of DDC Controller cabinets shall be approved by the Owner prior to installation.
- L. Enclose and install control devices and equipment such that they will not be subject to vibration, excessive temperature, dirt, moisture, or other harmful effects or conditions beyond their rated limitations. If devices must be located so as to be subjected to conditions beyond their recommended or rated limitations, provide the necessary protective enclosures or furnish the equipment constructed of materials and features capable of withstanding the adverse conditions.

Controls and devices subject to wetting or to the weather shall be corrosion resistant weather tight enclosures.

- M. DDC programs shall follow Chatham County form and shall include discrete sections of code that are not intermingled with other sections of control, per the following:
1. Increment line numbers by 10 or more. First line number shall be greater than or equal to 10, last line number shall be less than or equal to 32000.
 2. Place all time-based commands (e.g. WAIT, TOD, SAMPLE, LOOP) such that they are evaluated each pass through the program.
 3. Include comments describing each section of code.
 4. Section A shall include all diagnostic, power return, emergency point and other related code.
 5. Section B shall include all equipment schedules.
 6. Section C shall include all DDC and other equipment control.
 7. Section D shall include all two-speed sequencing, alarm delays, alarm limits and miscellaneous code, and odd month determination.
 8. Each DDC program shall include the alarm indicators code in Section A. Each DDC program shall include code in Section E that initialize the run time totals on all equipment defined for totalization.
 9. Any air handling unit with a heating coil controlled through DDC shall include programming which places the unit in special operation on discharge sensor failure to prevent freezing of the heating and cooling coils.
 10. Each controller cabinet shall include only as many programs as is necessary for programming modularity and ease of troubleshooting. If device operation is such that the existence of multiple programs within a single control has an effect on system performance or control timing, the presence of these multiple programs must receive prior approval by the Owner. Multiple programs, if present, shall be independent in functionality and shall not perform similar or identical functions (i.e. Start/Stop, Time of Day, etc). Each program shall be tested utilizing a test cabinet simulation to verify program functions properly, prior to loading in field cabinet.
- N. Hot Water Heating Systems designed with 100% backup shall alternate pump/converter operation based on Odd/Even month per school system standard programming. If a pump fails to operate, the backup pump shall be commanded on and a critical messaging output shall be sent to the appropriate destination workstation or printer (refer to item 1.2.A.6).
- O. Point database entry shall follow these conventions:
1. Descriptors: AI: use range of device, e.g. 20-120; AO: use range of device and normal position of device, e.g. NC 3-15 (normally closed 3 to 15 PSI); DO: use valid commands, e.g. ON OFF; DI use word STATUS.
 2. Alarmability: All alarmable points shall be displayed at each console screen on all applicable systems and the system event printer in School Sytem Central Control.
 3. Critical Alarming: Include Critical Alarm messaging notification with necessary configuration and files tested for accuracy.
 4. Change of Value Limit: No less than 2% and no greater than 10% of range of device.
 5. Engineering Units: DEG F, AMPS, PPM, IN WC, PCT RH, PSI, CFM, GPM, etc.

6. Command String and State Descriptors: These two shall typically match each other. Some common entries are ON/OFF, ENABLE/OFF, OPEN/CLOSE, FAST/OFF/SLOW, ON/OFF/AUTO.
7. Totalization: All points that indicate the run-time of a piece of equipment shall be included in this summary with time totalized per hour.
8. Contact State Descriptor: Fire alarm and fire trouble points: use a period for both states. Control air compressor: use a period for the normal state and LOW for the off-normal state. Avoid using the words NORMAL and ALARM as state descriptors for alarmable points. Return to Normal Printouts: Yes, in all instances. Critical Alarms shall not report their return to normal state to via a message to the critical massaging output device unless approved by the Owner.
9. Naming convention shall follow School System Standard and approved through Central Control.
 - a. Definitions:
 - 1) BLDG: Building abbreviation provided by Central Control.
 - 2) SYS: System abbreviation, e.g., HW=Hot Water Heating, CHW=Chilled Water, HVAC or HV=Air Delivery Systems (AHU is NOT allowed).
 - 3) #: Unit or room number shown on construction documents or approved by Central Control.
 - 4) DESC: Point/equipment description, e.g., VAV, CAV, FCU, FTR.
 - b. Building System Format: Shall use either spaces or underscore (_) between name sections and shall be in the following order: BLDG_SYS_#_DESC
 - c. Room Level Controller Format: Shall use either spaces or underscore (_) between name sections and shall be in the following order: BLDG_RM_#_DESC

2.9 ADVANCED APPLICATION CONTROLLERS

- A. Each DDC controller shall be able to extend its performance and capacity through the Use of floor level (subnet), advanced application controllers (AAC).
- B. Each AAC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each AAC shall be a microprocessor-based, multi-tasking, real-time digital control processor, and fully programmable.
- C. Terminal Box Controllers - Provide control of individual pieces of equipment including, but not limited to, the following:
 1. Variable air volume (VAV) boxes.
 2. Constant air volume (CAV) boxes.
 3. Unit Conditioners.
 4. Unit Ventilators.
- D. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences.
- E. Each controller performing space temperature control shall be provided with a matching room temperature sensor. Each room temperature sensor shall be provided with a terminal jack to be

used to connect a portable operator's terminal to control and monitor AAC points, setpoint adjustment dial, temperature indicator, and override switch.

- F. A dedicated power source and separate isolation transformer for each AAC Power Trunk shall be provided. Transformer shall be mounted in a separate auxiliary enclosure.

2.10 APPLICATION SPECIFIC CONTROLLERS

- A. Application specific controllers (ASCs) shall NOT be utilized unless approved by the Owner prior to project bid.

2.11 ELECTRONIC ACTUATORS

- A. Unless approved otherwise by the Owner, all actuation shall be electronic.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install engraved laminated plastic nameplates under each instrument in the control panel to designate its function.
- B. All devices connecting to EMCS such as contactors, motor starters, electric pneumatic transducers, pressure electric transducers, resistance temperature detectors, relays, terminal box controllers, etc., shall be marked with the same point number used on the shop drawing SUBMITTALS for the system so as to identify the point and its function for University field service personnel. Marking shall be done with gummed paper tags installed on the surfaces that have been steel wool cleaned and sprayed with clear enamel for waterproofing.
- C. Wire shall be color coded according to the Construction Representative's directions.
- D. Dedicated circuits shall be installed in branch lighting panels to serve controller cabinets. Circuit breakers shall be equipped with locking clips, and shall be clearly identified.
- E. All Controller Cabinets and auxiliary enclosures shall be supplied with engraved phenolic nameplates permanently attached identifying their field cabinet number, area, fan systems controlled, etc.
- F. Special equipment shall be installed in accordance with manufacturer's instructions and recommendations of Service Engineer where specified or required. All control instruments, valves, etc., shall be carefully adjusted and set for proper operating of the equipment served as noted herein or as required by the equipment manufacturer's instructions and recommendations.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of the work, the EMCS Contractor shall instruct the Owner's Operating Engineer and acquaint him with all of the operating characteristics of all equipment installed by him including the EMCS and all other systems, at the same time operating each and every system individually for a period of two days, unless otherwise specified. During this two day period the building's Operations Manual shall be used for reference.
- B. During system commissioning and at such time acceptable performance of the installed system hardware and software has been established, the Contractor shall provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours will be performed by competent contractor representatives familiar with the computer's software, hardware, and accessories.
- C. At a time mutually agreed upon during system commissioning as stated above, the EMCS Contractor shall give an absolute minimum 24 hours of instruction to the Owner's designated personnel on the operation of all equipment included in the project. Operator orientation of the automation system will include, but not be limited to equipment functions, commands, advisories, appropriate operator intervention required in responding to the system's operation, and any other training needed in the operation of the system. An Owner's manual prepared for this project by the Contractor will be used in addition to the instruction. Six (6) manuals shall be provided.
- D. Additional instruction time as deemed necessary by the Owner shall be provided by the Contractor as an extra service, and will be paid for in accordance with the State Prevailing Wage Rates for Engineers and Technicians.

3.3 ACCEPTANCE PROCEDURE

- A. SUBMITTALS data relevant to point index, functions limits, sequences, interlocks, power fail/restarts, logs, software routines and associated parameters, and other pertinent information for the operating system and data base shall be forwarded from the EMCS contractor to the Owner.
- B. Approved data base will be entered into the central computer, debugged, and down line loaded to Controllers. Prior to on-line operation a complete demonstration and readout of the computer command shall be performed in the presence of the Owner. In addition, a printout of the data base generated for all points shall be reviewed with the Owner by the EMCS contractor. Modification to the data base shall be made by the EMCS contractor as directed by the Owner.
- C. All points shall be verified prior to "punch-out" for correct and accurate correspondence between the CRT data display and actual field location and equipment operation.
- D. The Contractor shall maintain dated and initialed calibration and verification sheets and provide a copy to the Owner. Include verification of enhanced alarming with messages for all points selected by the Owner. Typical points with messages include control air compressors, 24 hour fans and pumps, critical systems and animal areas. Point verification sheets can be obtained in Central Control.

- E. Upon successful completion of system generation the Owner shall be requested in writing to inspect and approve the satisfactory operation of the EMCS, sub-systems, and accessories.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION